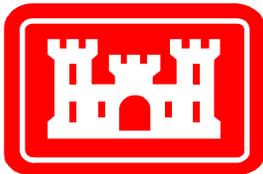


**FINAL
INTEGRATED
FEASIBILITY REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT
COASTAL STORM DAMAGE REDUCTION
BOGUE BANKS, CARTERET COUNTY
NORTH CAROLINA
APPENDIX B
Economics, Parking and Access**



**US Army Corps
of Engineers
Wilmington District**

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1.0 INTRODUCTION.

The purpose and need for coastal storm damage reduction is to reduce damages and land loss resulting from beach erosion, wave attack, and flooding along the ocean shoreline of the study area. A wide variety of possible measures would reduce the impacts of erosion, waves, and flooding on commercial and residential property and infrastructure within the study area. Some of the measures would also provide incidental environmental and recreational benefits

1.01 Coastal Storm Damage Study Area.

The island of Bogue Banks is located in Carteret County near the center of North Carolina's coast. The island faces the Atlantic Ocean on the south and extends approximately 25.4 miles from Bogue Inlet on the west to Beaufort Inlet on the east. Bogue Sound separates Bogue Banks from the mainland to the north. Communities of the island, from west to east are Emerald Isle, Indian Beach, Salter Path, Pine Knoll Shores, and Atlantic Beach. To the east of Atlantic Beach is Fort Macon State Park. The island is, on average, approximately ½ mile wide.

Over the past 35 years Bogue Banks has developed rapidly as a family ocean resort community for outdoor recreation. Land use is primarily recreational, residential and a few commercial properties, with the highest density along the oceanfront and Bogue Sound. Based on the 2010 census, the permanent, off season population is about 6,600 residents, but increases vastly in the summer. During the summer months a large portion of the homes within the study area are available as summer rentals to vacationers primarily from inland North Carolina and other locations around the Eastern United States. With the exception of some dune areas, the entire island is subject to hurricane storm surge flooding.

The study area is roughly the incorporated towns located on Bogue Banks in Carteret County, North Carolina. The study area extends from Bogue Inlet at the west end to Atlantic Beach on the east end, approximately 23 miles. For coastal engineering analysis the study area extends another 2 miles eastward through Fort Macon and Beaufort Inlet, although this area is not being considered for coastal storm damage reduction. From the ocean shoreline the study area extends landward approximately 500 feet. Seaward the study area extends from the shoreline approximately 1 mile. The study area also includes three offshore borrow sites lying 1 to 8 miles from the shoreline (shown in Figure B-1), including the Offshore Dredged Material Disposal Site (ODMDS).



Figure B-1 Coastal Storm Damage Reduction Study Area

1.02 Recreation Day User Study Area

Overnight visitors come from as far away as 3,000 miles; however, the 46 counties listed in Table B-1 and shown in Figure B-2 were selected as being within a reasonable driving distance Bogue Banks. The purpose of the survey of potential day users was to collect data that will show the frequency of visits and the total number of trips to Bogue Banks. It is expected that the analysis will show that persons from nearby counties will visit more frequently than persons from the more distant counties.

Table B-1 - North Carolina Counties within Driving Distance of the Bogue Banks Study Area and Carteret County

Anson	Edgecombe	Martin	Robeson
Beaufort	Franklin	Montgomery	Sampson
Bertie	Granville	Moore	Scotland
Bladen	Greene	Nash	Stanly
Brunswick	Halifax	New Hanover	Vance
Carteret	Harnett	Northampton	Wake
Chatham	Hertford	Onslow	Warren
Columbus	Hoke	Orange	Washington
Craven	Johnston	Pamlico	Wayne
Cumberland	Jones	Pender	Wilson
Duplin	Lee	Pitt	
Durham	Lenoir	Richmond	

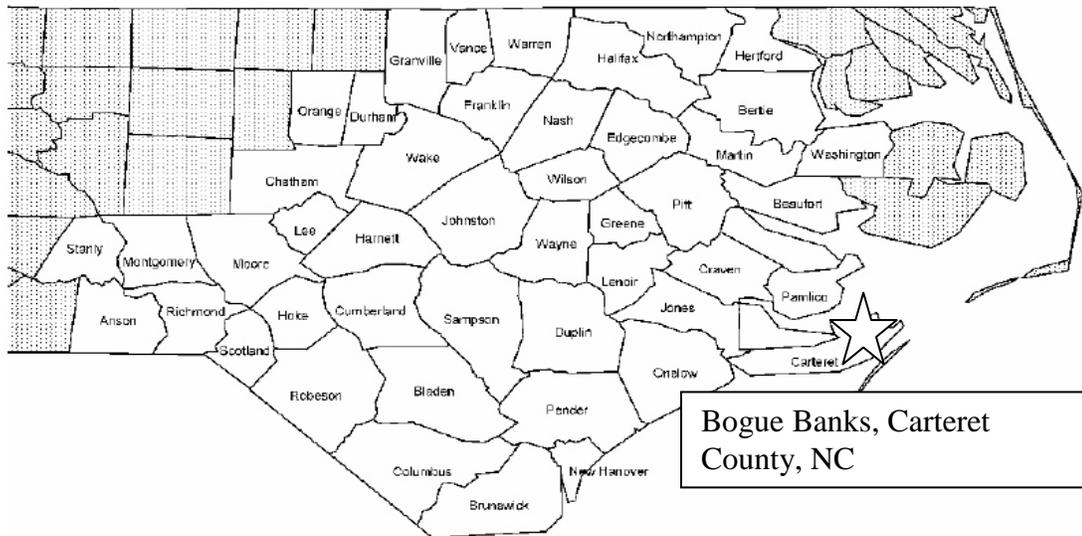


Figure B-2 – Recreation Demand Study Area

The recreation demand and methodology recommended for the beach user benefit analysis are presented later in this Appendix. According to the U.S. Census and the North Carolina Office of State Budget Management, the population of the forty-five-county area grew from 3,700,000 in 2000 to 4,400,000 in 2009, an increase of more than 20 percent in the decade.

1.03 Regional Economic Impact Area

The local economic impact area includes all of Bogue Banks and the nearby areas of Carteret County, North Carolina. Comprising the Bogue Banks study area are the towns of Emerald Isle, Indian Beach, Salter Path, Pine Knoll Shores, and Atlantic Beach

2.0 EXISTING ECONOMIC CONDITIONS:

2.01 Basic Economic Assumptions

This study is in compliance with the evaluation procedures outlined in the Water Resource Council's Economic and Environmental Principles and Guidelines (P&G) for Water and Related Land Resources Implementation Studies, dated 10 March 1983, and Corps of Engineers policy guidance on Coastal Storm Damage Reduction, ER 1105-2-100, dated 22 April 2000. The following basic economic assumptions were used in the analysis of damages, benefits, and costs of the NED Plan

■ **Interest rate.** The FY 2011 Federal interest rate used in the analysis of alternatives was 4.125 percent. Final cost updating and certification of the Recommended Plan used an Oct14 discount rate of 3.5%.

■ **Price level.** October 2011 price levels were used in the analysis of alternatives, at 4.125 percent. Final cost updating and certification of the Recommended Plan used an Oct14 discount rate of 3.5%.

■ **Period of Analysis.** The analysis is based on a 50-year period.

The economic comparison of alternatives was performed using the FY2011 interest rate of 4.125% (*appropriate at the time of that analysis*). It should be noted that the Recommended Plan was analyzed using the Oct 2014 discount rate of 3.5%

2.02 Demographics

Demographics for the existing economic conditions for the study area include census data for population, housing, and personal income, which are shown in Table B-2. The full-time resident population was estimated to be nearly 6,600 in 2010. Estimates of peak season population vary.

Table B-2 - Population, Income, Housing Summary

	Carteret County	Emerald Isle	Indian Beach*	Salter Path*	Pine Knoll Shores	Atlantic Beach
Population Year Round	66,469	3,655	112	N/A	1,339	1,495
Average Household Size	2.27	2.11	1.7	N/A	2.04	1.78
Housing Units	48,179	6,735	1,565	N/A	2,049	4,935
Occupied Year Round	28,870	1,732	66	N/A	653	840
Seasonal or Vacant	19,309	5,003	1,499	N/A	1,396	4,095
In Labor Force						
Civilian	32,504	1,784	52	N/A	578	1,016
Unemployed	2,780	207	0	N/A	30	110
Armed Forces	948	127	0	N/A	0	40
Employment By Leading Industry						
Construction	3,366	80	N/A	N/A	66	96
Arts, Entertainment, Food Service, Recreation, and Accommodation	1,936	189	N/A	N/A	108	199
Retail Trade	3,801	261	N/A	N/A	76	196
Education, Health & Social Services	5,631	340	N/A	N/A	93	199
Per Capita and Household Income						
Per Capita Money Income	\$26,791	\$34,279	\$28,763	N/A	\$43,068	\$31,196
Median Household Income	\$46,155	\$50,380	\$51,467	N/A	\$60,521	\$48,112

*Census Specific data is not available for Salter Path and is incomplete for Indian Beach

Source: U.S. Census Bureau (<http://factfinder.census.gov>) and U.S. Dept. of Commerce – Bureau of Economic Analysis (<http://bea.doc.gov/bea>)

Office of State Budget and Management (2010 population estimates)

2.03 Shoreline Ownership

Public ownership of the shore in the towns of Bogue Banks includes dedicated roads and lands below mean high water (MHW) owned by the State of North Carolina. Other parcels are owned by the towns of Bogue Banks, including the Coastal Area Management Act (CAMA) public access points. The primary ownership of the oceanfront parcels is private. Privately-owned properties included in the Project area are considered to be in fee-simple ownership. Included within the project limits are single-family residential units, multi-family and condominium units, and commercial properties, including the fishing piers. Other information related to ownership of the shoreline is contained in the Real Estate Appendix.

2.04 Commercial and Recreational Fishing

The North Carolina Division of Marine Fisheries (NCDMF) reported nearly 600,000 pounds of commercial finfish and shellfish landings in the vicinity of Bogue Banks (including Carteret County) from 2009 and 2010. Total landings for commercial fish and shellfish were around 6 million pounds. The commercial value of these landings were reported to be over \$9 million dollars.

Recreational fishing includes fishing from head boats, charter boats, private boats, piers, and the surf. Fishing from head boats is best in the winter months for snapper and grouper. Fishing from charter boats is excellent for King mackerel and bottomfish during the winter. Offshore, gulfstream species, like yellowfin tuna and Wahoo are present. Inside fishing has been successful for inshore species such as red drum, speckled trout, and flounder.

Private boat anglers can find bluefin tuna in the nearshore area, king mackerel and other bottomfish species in the offshore, and other species such as speckled trout, red drum, and flounder can be found in the inside areas of the creeks and Atlantic Intracoastal Waterway. NCDMF reports that shore fishing activity is limited in this area.

2.06 Storm-Related Emergency Costs

Information was collected from officials in nearby counties and municipalities sharing similar properties with the Bogue Banks study area, including: Pender and Onslow Counties, and also State, and Federal sources related to recent hurricanes and storms. At the time of this feasibility study, a study of emergency costs and benefits in the Bogue Banks study area had not been conducted. To demonstrate a reasonable equivalent for potential benefits for emergency activities, nearby Surf City and North Topsail beaches were used as proxies, at \$99,000 for Surf City and \$235,000 for North Topsail Beach, for a total of \$334,000 over the associated area. This category of benefits is not very precise

and is relatively minor compared to CSDR benefits (1 to 2%) and so, was not included in the Bogue Banks economic analysis.

2.07 Determination of Structure Values

The value of residential structures is limited to replacement cost less depreciation. Replacement value is the cost to the owner if a structure is destroyed. If a significantly depreciated structure is destroyed and replaced, the difference between the old and new value is a betterment where the additional cost is offset by the additional utility and comfort of the new construction. Other measures of property value include fair market value and the income-producing value. These measures are not considered appropriate for National Economic Development benefits to protection of beach property. Fair market value is influenced by proximity to the ocean or sound, corresponding views of the beach and ocean, and short-term fluctuations in the local real estate market. Basing value on income can also produce significantly higher estimates. It is assumed that rental income lost to the owner will be transferred to some other owner in an alternate location. Therefore, the loss of income is considered a regional economic loss and not a loss to the National Economic Development account.

2.07.1 Cost of Residential Construction.

The average cost of residential construction on Emerald Isle was determined according to the quality of initial construction, at \$193/ square foot (sf). Values for Indian Beach, Salter Path, Pine Knoll Shores and Atlantic Beach was determined to be \$274/sf, \$321/sf, \$154/sf, and \$137/sf, respectively. The “per square foot” structure values were determined by aggregating all structure values and square footage, then dividing that total value by total square footage. No structure was assigned a greater value regardless of the quality or construction type. The square footage areas for most structures were available at the Carteret County tax offices.

Structure values represent replacement value, less depreciation at the current price levels. In the case of Bogue Banks, depreciated replacement cost equals structure size multiplied by construction cost multiplied by a factor of depreciation (Depreciated Replacement Cost=Size x Unit Construction Cost x [1-% depreciation]).

2.07.2 Commercial Structure Values.

Values for commercial structures were based on visual surveys and talking to business managers and owners. Carteret County tax data was also used for comparison.

2.07.3 Value of Structures

Damage elements were not assigned a single structure or content value, but instead were given a low value, a most-likely value, and a high value. This is done to account for potential uncertainties in the assignment of these structure and content values..

The most likely structure value is based on the replacement cost less depreciation calculation. The low value is determined as 95% of the most likely value, while the high value is determined as 105% of the most likely value.

Total structure values for all damage elements (most-likely value) are estimated at \$714.8 million and total contents are valued at \$290.6 million for a total of about \$1 billion in existing property (October 2011 price level at the time of analysis; re-verified in 2014 for Final Report) that could potentially be damaged from incoming storms.

2.08 Land Values

Land values in all North Carolina coastal counties are escalating in general due to increased population growth in the U.S. coastal regions. Lot sales in Carteret County are designated as ocean front, second row, and interior lots. To prevent the influence of water view or proximity to the ocean overriding the value, only the interior lot values are used in the analysis. A summary of values for ocean front lots, second row lots, and interior lots is presented below.

2.08.1 Ocean Front Lots

Ocean front lots are higher in risk for storm damage and erosion but continue to be highly desirable. These values were not used in the land loss estimates. The reason interior lots are used in this analysis versus oceanfront properties is defined in NED Manual for Coastal Storm Risk Management, and states “we use the nearshore market value to estimate the loss of private land from coastal storms. This represents the net loss assuming that the ocean front is the most valuable factor with a rent gradient declining as you move inshore. As the shoreline recedes, the extra ocean front differential value is transferred landward so the net economic loss is measured at nearshore value.”

2.08.2 Second Row Lots

These values were not used in the land loss estimates.

2.08.3 Interior Lots

The value and desirability of interior lots vary greatly; however, values based on sold prices continue to increase. Higher interior lot values may be due to the

limited number of all vacant lots in Bogue Banks and the fact that interior lots are less susceptible to storm and erosion damages. This data supports the estimated value of \$12.55 per square foot in Pine Knoll Shores, Indian Beach, and Atlantic Beach. Emerald Isle data suggests \$14.03 per square foot. Interior lot values are used to estimate the losses to land caused by long-term erosion.

3.0 FUTURE ECONOMIC CONDITIONS (WITHOUT PROJECT)

3.01 Projected Population Growth

Projected population growth for Carteret County is found at the North Carolina State Demographer's website. Figure B-3 shows both historical population from 1920 to 2000 and population projections for Carteret County through 2029.

According to the North Carolina demographics office, the population of this 45-county recreation day user demand area is expected to reach 4.3 million in 2010, 5.0 million in 2020, and over 5.6 million in 2029. Therefore it is reasonable to expect recreation visitation at Bogue Banks to increase over the next 25 to 50 years.

3.02 Assumed Conditions at Beginning of Period of Analysis: Without Project Condition

The period of analysis begins when the project improvement is in place and the benefits to the public begin to accrue. It is assumed that this condition could occur by FY2019. 15A NCAC 07H .2501 allows for a great deal of latitude for meeting rebuilding criteria following damages due to hurricanes or tropical storms. Issuing emergency permits for rebuilding on lots meeting a minimal setback restriction is generally the rule, not the exception in North Carolina. Common practice and historical evidence allow for rebuilding structures lost in storms provided setback restrictions are met, so the number of replacements is not limited in the analysis. However, after long-term erosion has claimed more distance on the oceanfront lot than the building requires to be put back, the model ceases to reinstate the same property. This assumption will prevent the overestimation of the without project coastal storm damages. Since all suitable lots are expected to be developed by the base year 2019, no additional growth in the number of residential or commercial structures is projected for the analysis. The assumptions used for structure replacement could result in fewer structures if storms destroyed a structure following its earlier replacement.

3.03 Summary of Future Without Project Economic Conditions

In summary, the future economic conditions are assumed to have the same distribution of residential use and commercial development as the existing

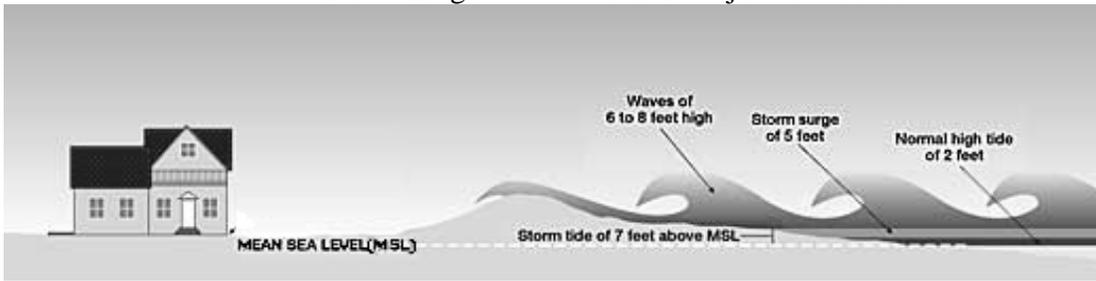
condition. Structures that are significantly damaged or destroyed are assumed to be replaced by an identical structure, and will continue to be replaced until rebuilding is no longer allowed per coastal regulations. All structures not damaged or destroyed are assumed to remain without any modification. No “teardowns” are built into the analysis where older structures are assumed to be torn down/demolished and replaced by more expensive units based on investment speculation related to the high demand for coastal real estate.

4.0 COASTAL STORM DAMAGES WITHOUT PROJECT

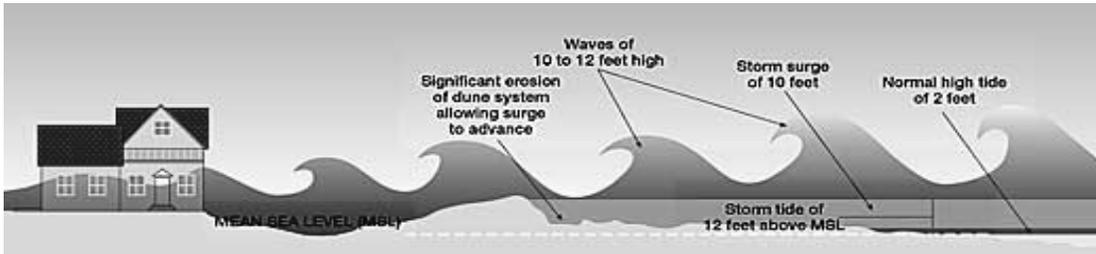
The average annual present value of coastal storm damages over the 50-year period of analysis without a damage reduction project totals \$14,556,000 in October 2011 price levels. Average annual damages (average annual equivalent amounts, 50-yrs, 4.125%) were calculated by using the 50-year interest and amortization factor shown in Table B-7. These values were updated after screening and plan selection, to reflect October 2014 price levels, at 3.5% interest rate.

4.01 Damage Categories Defined: Figure B- 3 graphically shows the impact of tides, storm surge, and wave action that may occur during minimal and major hurricanes. (USACE, Mobile District, 1999). It should be noted that hurricane wind speed, the deciding factor in storm category by FEMA, does not determine the level of damages in the storm damage model. The impact of wind is not shown in the figure and wind damage is not estimated in the storm damage model. Coastal storm damages are calculated under with and without project conditions for damages to structures and contents, roadways, and land lost due to long-term erosion. In many cases damages are calculated for more than one category since storms frequently generate flood inundation, waves, and storm erosion simultaneously. The damage model, Beach-fx, calculates damages in all the appropriate categories and selects the category with the greatest damage and ignores the other damages. This technique prevents the overestimation or double counting of damages.

Storm Surge in Minimal and Major Hurricanes



In a Category I Hurricane, the storm surge will usually cause damage to beach dunes and structures placed on the seaward side of the dune line.



In a Category III Hurricane, the combined wave attack and storm surge erodes the dunes, exposing coastal structures to the most damaging effects of the surge. Although his wind speeds only placed Georges in Category II, the storm surge estimates were in line with Category III.

Courtesy of Escambia County Department of Public Safety.

Figure B- 3 Hurricane Surge and Wave Impacts

4.01_Damage Categories Defined (continued)

4.01.1 Storm Erosion

Storm erosion damages result from the undermining of structure pilings and foundations due to hurricane and tropical storms. Damages due to storm-induced erosion are the major damages that are generally computed by the economic damage model. The first element in determining the potential impact of storm induced erosion on the amount of damage to a coastal structure is how much of the protective beach (either existing or projected) remains in front of and under the structure during the storm. If the storm-induced erosion only reaches the front of the building, damage due to storm erosion is assumed to be zero and any damage to the structure would be that caused by either wave impact or inundation.

4.01.2 Flood

Flood damages are caused by inundation related to rises in tide and storm surge. Damages begin when flooding and overwash reaches the structure or enclosure.

4.01.3 Wave

Wave damages result from waves over and above the storm surge making contact with the structures. Waves impacting the structure three feet or more above the first living area elevation are expected to result in total loss of the structure. Figure B-3 illustrates the effect of both flood from storm surge and waves.

4.01.4 Land Lost or Long Term Erosion (LTE)

Land losses result from long-term erosion based on the analysis of historical erosion including rises in sea level. Land lost to long-term erosion is computed by multiplying the expected annual loss of land in acres by the value of nearshore interior lots. Fill material was also considered to reduce land losses due to long-term erosion. However, in the formulation of alternative plans, no suitable upland borrow sites were identified. Therefore, the cost of fill is not considered a practical limiting factor or substitute for the value of interior lots in the calculation of land lost or long-term erosion.

4.01.5 Summary of Damages

Examples of coastal storm erosion damage in coastal North Carolina are shown in Figure B-4. The present value of coastal storm damages by structure, content, and reach is shown in table B-3 for the without project condition.



Figure B-4- Coastal storm damage after Hurricane Fran 1996

Table B-3 – Present Value of Coastal Storm Damages (Without Project)

Average Annual Damages by Reach, Bogue Banks, Without Project, 4.125% Discount Rate			
Reach	Structure	Contents	Total Damages (AA)
1	\$1,935,661	\$749,793	\$127,696
2	\$1,749,783	\$682,013	\$115,634
3	\$2,126,602	\$751,788	\$136,870
4	\$2,410,341	\$930,630	\$158,866
5	\$4,154,547	\$1,312,800	\$259,978
6	\$4,066,477	\$1,578,847	\$268,441
7	\$1,416,603	\$527,251	\$92,432
8	\$781,007	\$300,667	\$51,435
9	\$924,141	\$316,398	\$58,989
10	\$432,924	\$153,745	\$27,897
11	\$1,079,802	\$369,595	\$68,920
12	\$1,431,991	\$460,706	\$90,000
13	\$2,196,798	\$833,313	\$144,085
14	\$2,016,075	\$772,682	\$132,608
15	\$4,941,951	\$1,912,575	\$325,939
16	\$735,421	\$285,363	\$48,539
17	\$1,240,518	\$547,922	\$85,042
18	\$217,445	\$70,343	\$13,685
19	\$279,490	\$101,813	\$18,131
20	\$549,592	\$215,919	\$36,401
21	\$188,821	\$75,529	\$12,570
22	\$2,397,056	\$1,113,645	\$166,937
23	\$0	\$0	\$0
24	\$106,045	\$42,204	\$7,049
25	\$16,965	\$6,779	\$1,129
26	\$18,612	\$7,478	\$1,241
27	\$146,980	\$57,757	\$9,735
28	\$171,789	\$68,725	\$11,437
29	\$41,532	\$16,610	\$2,765
30	\$296,704	\$112,433	\$19,455
31	\$78,764	\$31,198	\$5,229
32	\$155,245	\$61,301	\$10,297
33	\$130,829	\$52,048	\$8,696
34	\$85,251	\$33,242	\$5,634
35	\$320,543	\$127,851	\$21,322
36	\$176,060	\$69,929	\$11,697
37	\$1,040,319	\$407,278	\$68,835
38	\$590,433	\$227,222	\$38,880
39	\$765,699	\$300,566	\$50,702
40	\$3,581,398	\$229,689	\$181,221
41	\$883,176	\$353,370	\$58,799

42	\$263,760	\$105,365	\$17,552
43	\$1,278,250	\$491,945	\$84,175
44	\$965,062	\$375,355	\$63,738
45	\$842,765	\$317,032	\$55,149
46	\$820,944	\$316,725	\$54,097
47	\$945,772	\$369,359	\$62,536
48	\$546,847	\$207,139	\$35,853
49	\$684,046	\$264,899	\$45,123
50	\$419,402	\$161,435	\$27,619
51	\$0	\$0	\$0
52	\$74,252	\$14,216	\$4,207
53	\$160,900	\$1,323	\$7,714
54	\$501,435	\$200,551	\$33,380
55	\$1,055,752	\$0	\$50,202
56	\$0	\$0	\$0
57	\$0	\$0	\$0
58	\$0	\$0	\$0
59	\$8,599	\$3,208	\$561
60	\$77,975	\$20,260	\$4,671
61	\$479,599	\$189,354	\$31,809
62	\$9,769,852	\$3,847,710	\$647,529
63	\$184,686	\$57,731	\$11,527
64	\$136,070	\$48,627	\$8,782
65	\$863,681	\$342,326	\$57,347
66	\$110,032	\$35,653	\$6,927
67	\$25,459	\$9,213	\$1,649
68	\$834,944	\$331,274	\$55,455
69	\$2,062,346	\$810,363	\$136,600
70	\$5,769,607	\$2,303,825	\$383,900
71	\$2,156,388	\$769,697	\$139,138
72	\$1,415,978	\$536,394	\$92,837
73	\$544,334	\$209,655	\$35,853
74	\$196,797	\$78,841	\$13,107
75	\$126,233	\$48,421	\$8,305
76	\$1,592,634	\$10,057	\$76,210
77	\$124,722	\$49,106	\$8,266
78	\$15,870,116	\$6,346,782	\$1,056,436
79	\$2,027,002	\$798,765	\$134,368
80	\$5,152,032	\$2,063,545	\$343,108
81	\$430,573	\$155,858	\$27,885
82	\$238,362	\$93,970	\$15,803
83	\$2,269,422	\$899,029	\$150,663
84	\$1,733,096	\$691,907	\$115,311
85	\$850,527	\$329,632	\$56,118
86	\$842,519	\$319,590	\$55,259
87	\$5,693,579	\$2,276,103	\$378,966
88	\$121,245	\$43,966	\$7,856
89	\$8,079,503	\$654,784	\$415,324

90	\$830,882	\$285,107	\$53,066
91	\$1,104,911	\$184,361	\$61,306
92	\$11,930,665	\$4,771,321	\$794,196
93	\$20,292,821	\$7,964,599	\$1,343,668
94	\$1,341,348	\$516,540	\$88,344
95	\$2,052,013	\$815,240	\$136,341
96	\$1,832,484	\$732,004	\$121,944
97	\$2,822,493	\$1,126,713	\$187,789
98	\$2,098,514	\$829,723	\$139,241
99	\$1,771,978	\$702,204	\$117,650
100	\$2,044,206	\$814,819	\$135,949
101	\$2,120,251	\$765,535	\$137,222
102	\$1,401,517	\$565,289	\$93,524
103	\$3,035,528	\$1,214,735	\$202,104
104	\$2,016,834	\$806,816	\$134,267
105	\$1,006,357	\$428,186	\$68,214
106	\$5,914,066	\$500,796	\$305,033
107	\$1,842,431	\$566,597	\$114,552
108	\$1,236,379	\$495,669	\$82,361
109	\$1,182,854	\$468,921	\$78,544
110	\$1,313,205	\$521,594	\$87,247
111	\$2,341,173	\$912,179	\$154,700
112	\$1,806,727	\$1,214,493	\$143,662
113	\$1,155,428	\$388,934	\$73,436
114	\$2,539,300	\$992,022	\$167,918
115	\$8,099,766	\$3,188,903	\$536,787
116	\$12,291,266	\$4,797,630	\$812,594
117	\$3,172,992	\$1,249,638	\$210,300
TOTAL	\$224,824,875	\$81,290,578	\$14,556,093

Note: Addendum 1 to Appendix B (Attachment 4) provides additional information on structure types and building characteristics that constitute higher damages relative to other reaches.

5.0. ECONOMIC VARIABLES, ASSUMPTIONS, AND METHODOLOGY APPLIED IN COASTAL STORM DAMAGE MODEL

In Beach-fx the economic input includes a set of general global data that applies to the entire analysis, the estimated base year when damage reduction measures could be in place, flood damage curves, erosion damage curves, miscellaneous benefits to be included, and the variable inputs for each structure in the structure inventory data base or structure file. More information on the Beach-fx is presented in Appendix A, Coastal Engineering.

5.01 General Global Data

Based on the general economic assumptions, the global values are as follows:

■ **Interest rate.** The FY 2011 Federal interest rate used in the analysis of alternatives was 4.125%. Final cost updating and certification of the Recommended Plan used an Oct14 discount rate of 3.5%.

■ **Price level.** October 2011 price levels were used in the analysis of alternatives, at 4.125%. Final cost updating and certification of the Recommended Plan used an Oct14 discount rate of 3.5%.

■ **Period of Analysis.** The analysis is based on a 50-year period.

The economic comparison of alternatives was performed using the FY2011 interest rate of 4.125% (*appropriate at the time of that analysis*). It should be noted that the Recommended Plan was analyzed using the Oct 2014 discount rate of 3.5%

5.02 Base Year

The Base Year is defined as the first year coastal storm damage reduction measures could be in effect. It is expected that damage reduction measures would be implemented by 2019.

5.03 Interior Lot Value per Square Foot

Long term erosion damages or land losses are based on the estimated value of interior lots. The data on lots actually sold support a value of \$12.55 to \$14.03 per square foot at the October 2011 price level, which was updated to 2014 values for the Final Report.

5.04 Initial Benefits

At the time of the scoping runs, the detailed construction schedule had not been developed. Therefore, no initial benefits were included in the analysis.

5.05 Update of Structure Benefits

The initial structure valuation was completed in 2009 -2010 time frame. USACE requires that a structure analysis be conducted to ensure that the initial benefits would remain adequate for use in the current (2014) iteration of the Bogue Banks study report. After consulting with MSC leadership on a proposed methodology, this was achieved by conducting a sample of first and second row structure values, using the Carteret County tax database, and comparing them to the same structure values in the existing project database. Of the 2,400 structures in the original database, a significant sample of 1,258 structures was taken. The resulting values indicate that the current structure values of those sampled are approximately 3% lower than those from the 2009-2010 structure databases. District leadership does not believe that the 3% difference in value is significant, and supports use of the existing database as a proxy for structure valuation.

5.06 Flood Damage Curves

Flood damages due to inundation are determined by the combined height of the storm still water level and a superimposed wave height. Based on the elevation of this combined height and the elevation of the structures first floor, the amount of inundation damage is determined from a standard set of inundation damage curves. Unless the predicted amount of storm induced erosion is sufficient to completely erode the ocean front dune, the residual height of the seaward edge of the beach is generally sufficient to limit the height of the wave that could be transmitted across the beach face without breaking. Accordingly, since the conditions necessary to cause a prediction of significant inundation related damages is rather severe, damages due to the inundation (combined storm still water level and wave height) rarely controls.

5.07 Damage Functions and Damage Curves

Damage functions are used within Beach-fx to estimate storm-induced damages sustained by the damage elements. Damages are estimated separately for the structure and contents of each impacted damage element. Damages are caused by three processes: erosion, inundation, and wave attack. Beach-fx has an inherent set of rules for combining damages when multiple damage processes produce damages to a structure or contents during a storm event.

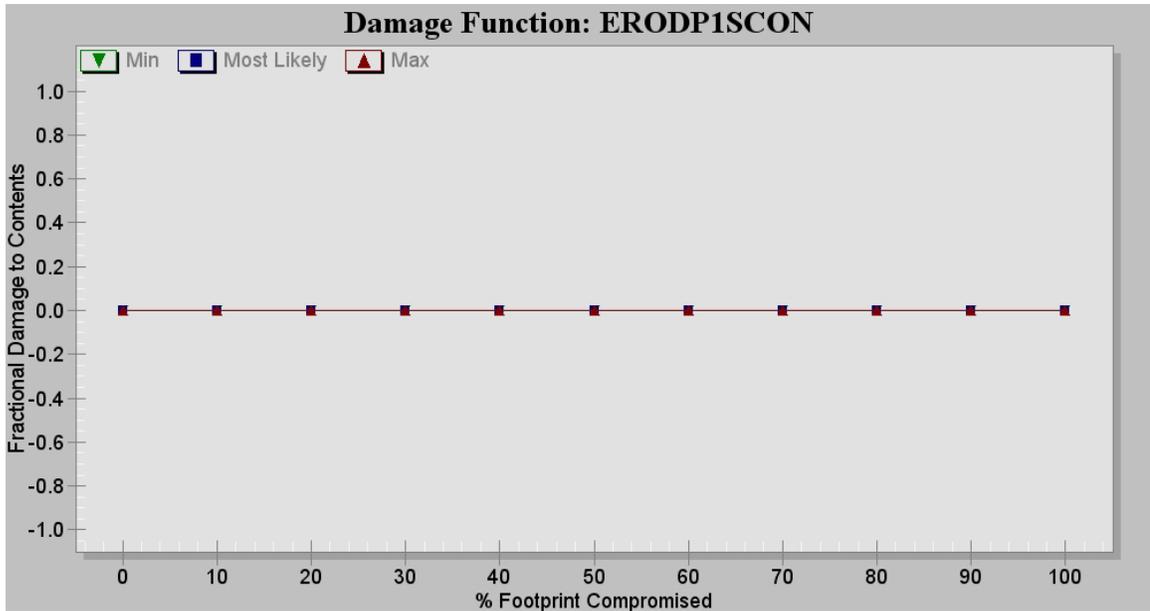
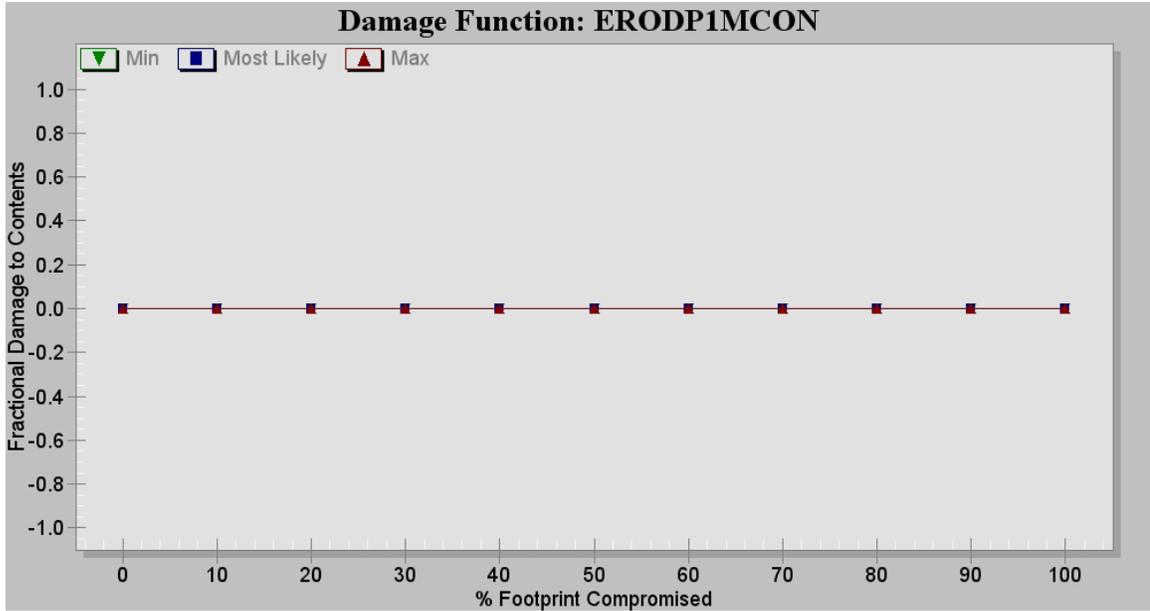
Damage functions are user-defined within Beach-fx. Damage function types and definitions are included, but the specific functions must be developed and defined for each project. A specific damage function must be assigned to each combination of damage element type, foundation type, and construction type. Damage functions are expressed as a percent of the structure or content valuation compromised. The damage functions utilized are listed in table B-7

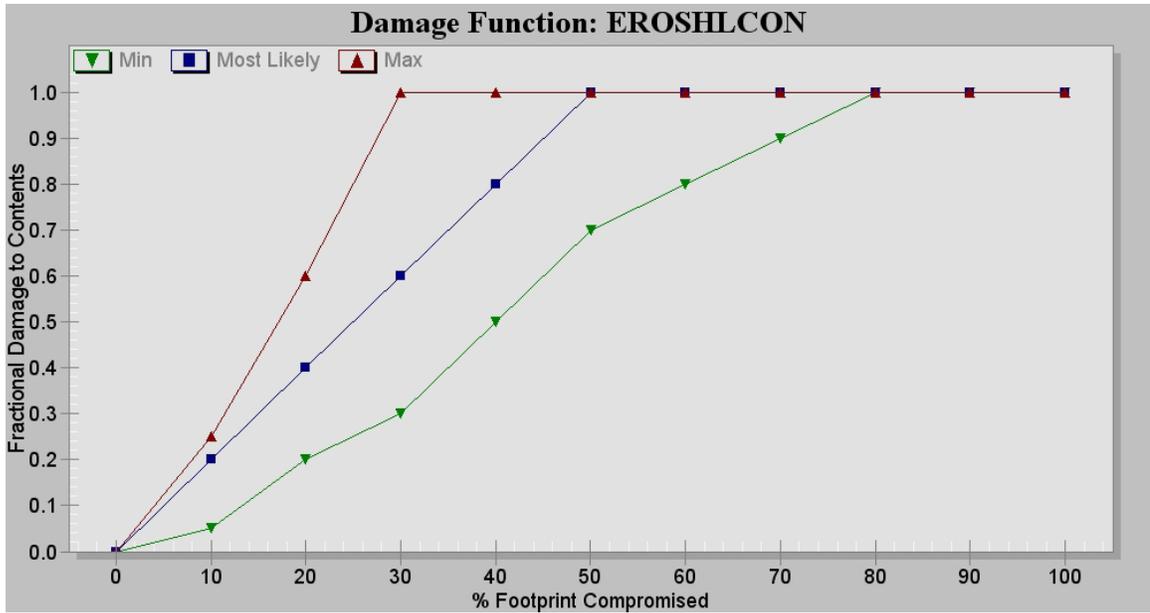
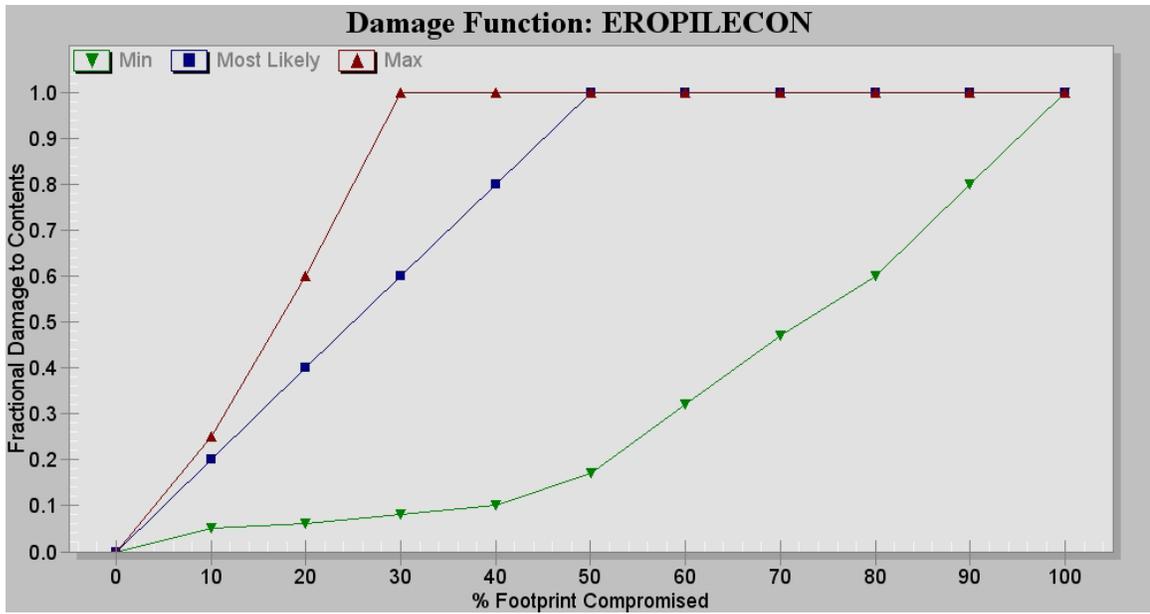
Damage functions were developed for the Bogue Banks project by the Wilmington District. In all, 23 damage functions were specified, as shown in Figures B5 to B25. Triangular distributions were developed for each of the damage functions representing minimum, most likely, and maximum values at each point along the X axis.

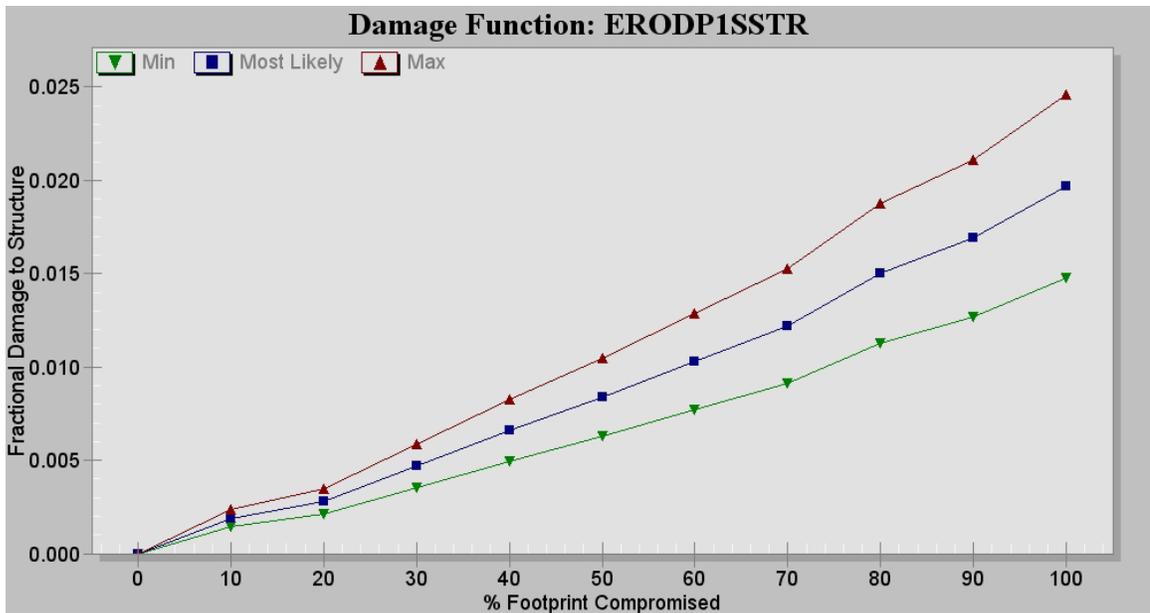
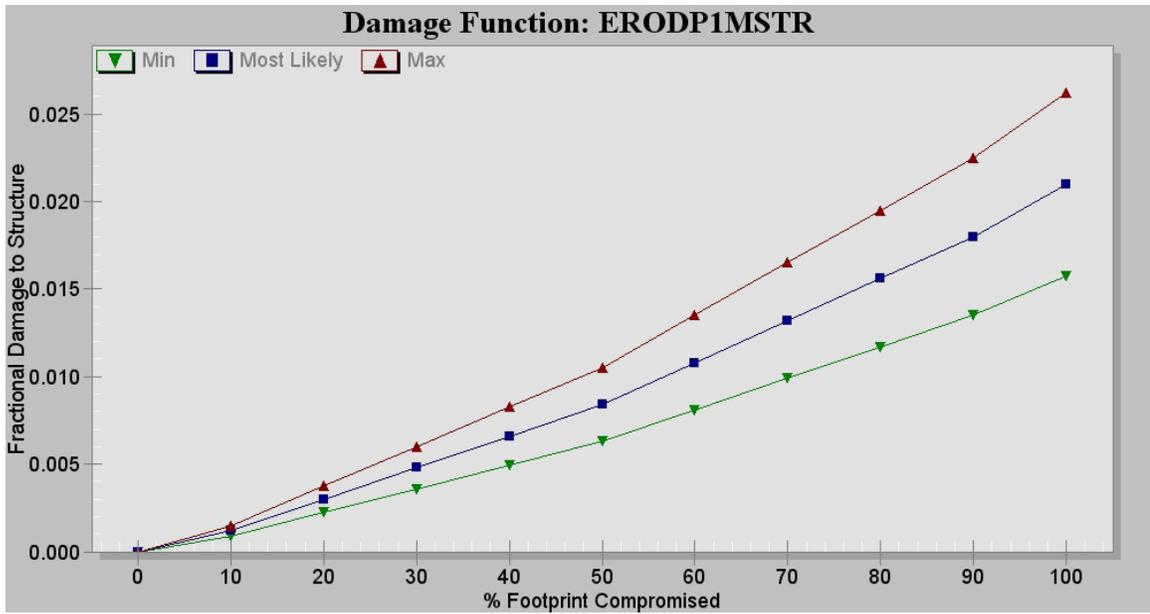
Table B-4 Damage Elements

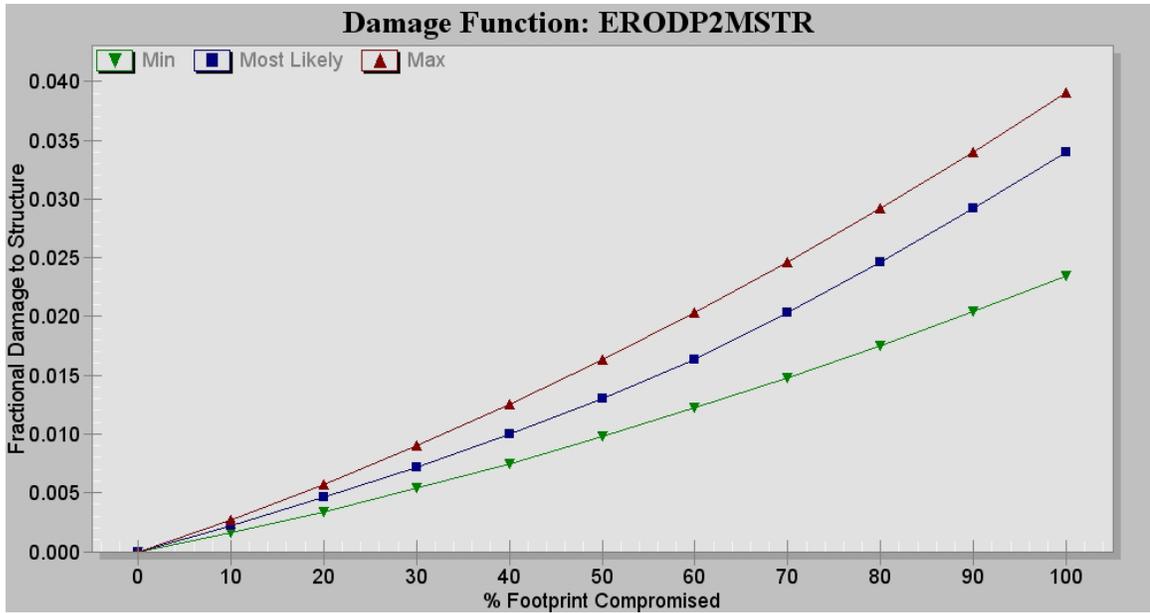
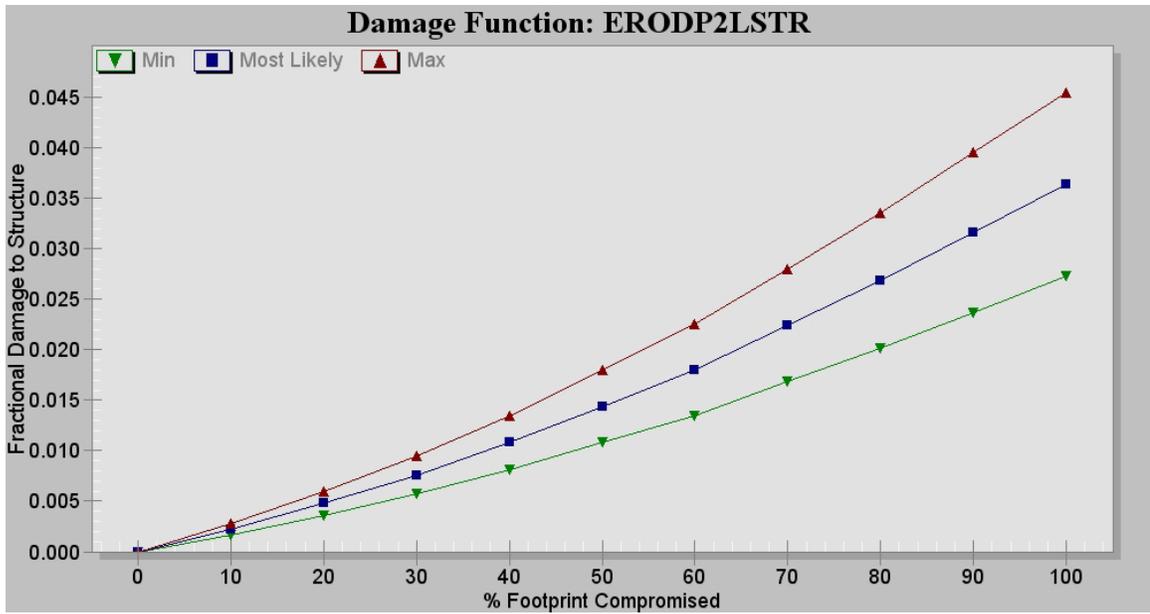
Damage Elements, Bogue Banks			
Function	Function Description Group Description	X-axis	Y-axis
ERODP1MCON	Erosion -Pile16 -MF -Contents	% Footprint com- promised	Fractional damage to contents or structure
ERODP1SCON	Erosion -Pile16 -SF -Contents		
EROPILECON	Erosion -Pile Foundation -Contents		
EROSHLCON	Erosion -Shallow Foundation -Contents		
ERODP2LSTR	Erosion -Deep Piles 2 Floors Large -Structure		
ERODP2MSTR	Erosion -Deep Piles 2 Floors Large -Structure		
ERODP2SSTR	Erosion -Deep Piles 2 Floors Large -Structure		
ERODP3MSTR	Erosion -Deep Piles 3 Floors Medium -Structure		
ERODP4LSTR	Erosion -Deep Piles 4 Floors Large -Structure		
ERODP4SSTR	Erosion -Deep Piles 4 Floors Small -Structure		
ERODP5LSTR	Erosion -Deep Piles 5 Floors Large -Structure		
ERODP1MSTR	Erosion -Pile16 -MF -Structure		
ERODP1SSTR	Erosion -Pile16 -SF -Structure		
EROPILESTR	Erosion -Pile Foundation -Structure		
EROSHLSTR	Erosion -Shallow Foundation -Structure		
4SNBC	Inundation -4 story -Contents	Water depth above 1st floor	
2SNBC	Inundation -1-2 story -Contents		
INUNALLSTR	Inundation -All Structures up to 3 floors -Structure		
INUM4FL	Inundation -4-5 floors -Structure		
WAVENPC	Wave -Not On Piles -Contents		
WAVEPC	Wave -On Piles -Contents		
WAVENPS	Wave -Not On Piles -Structure		
WAVEPS	Wave -On Piles -Structure		

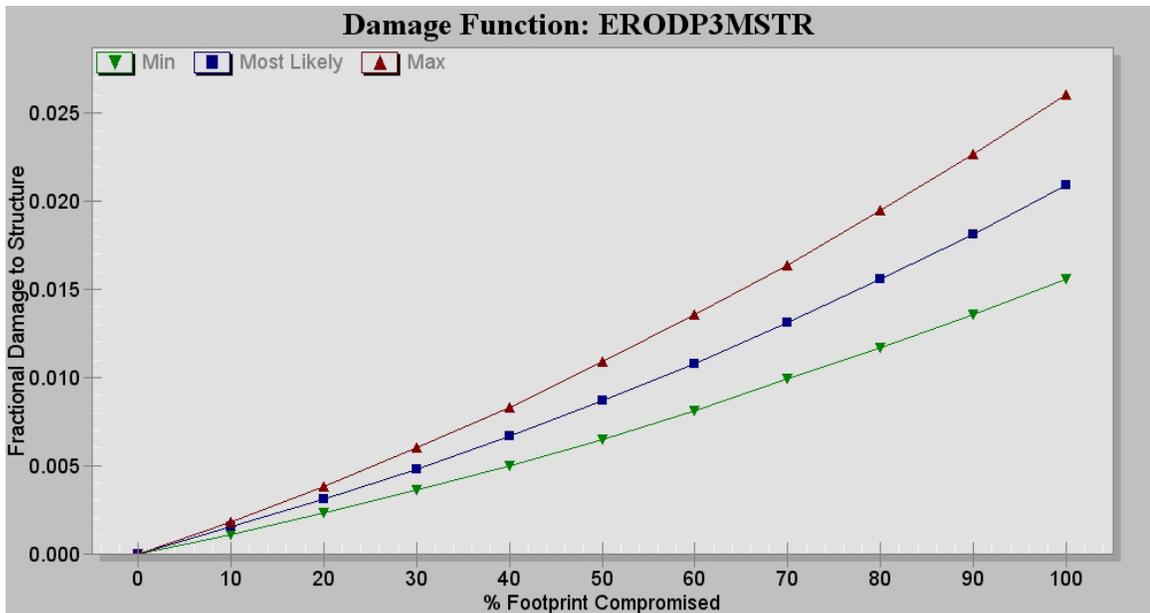
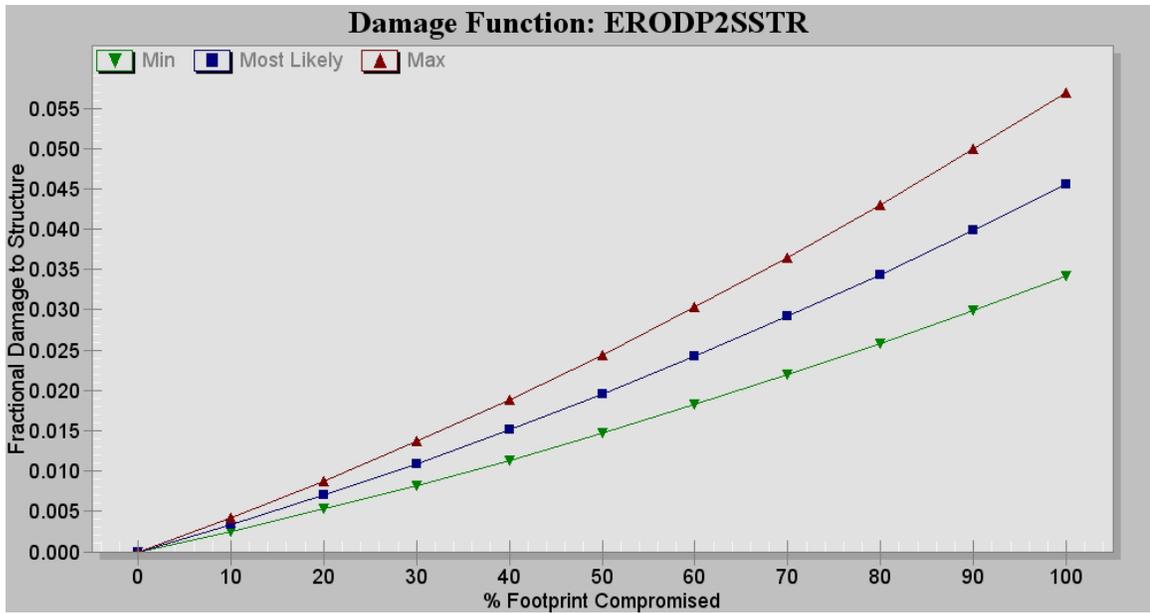
Figures B5-B25 - Composite Damage Curves

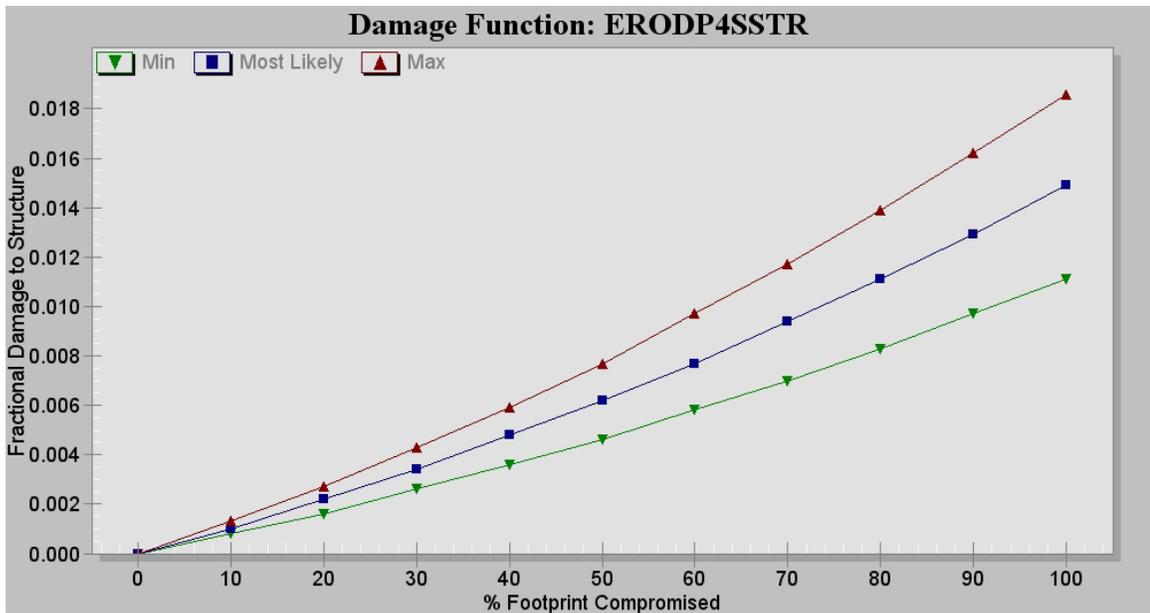
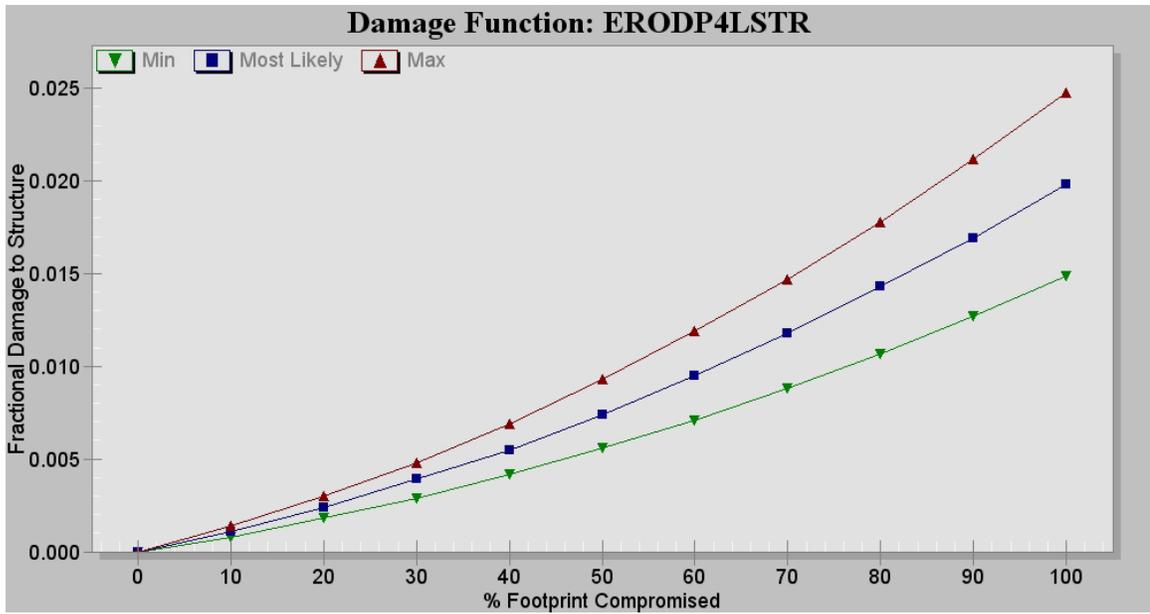


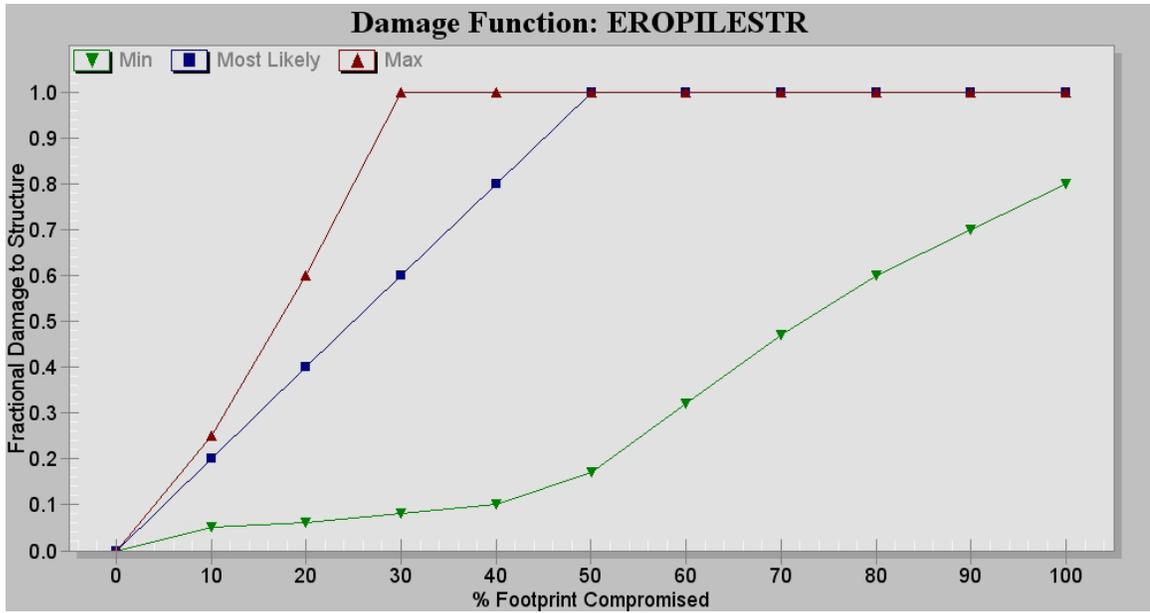
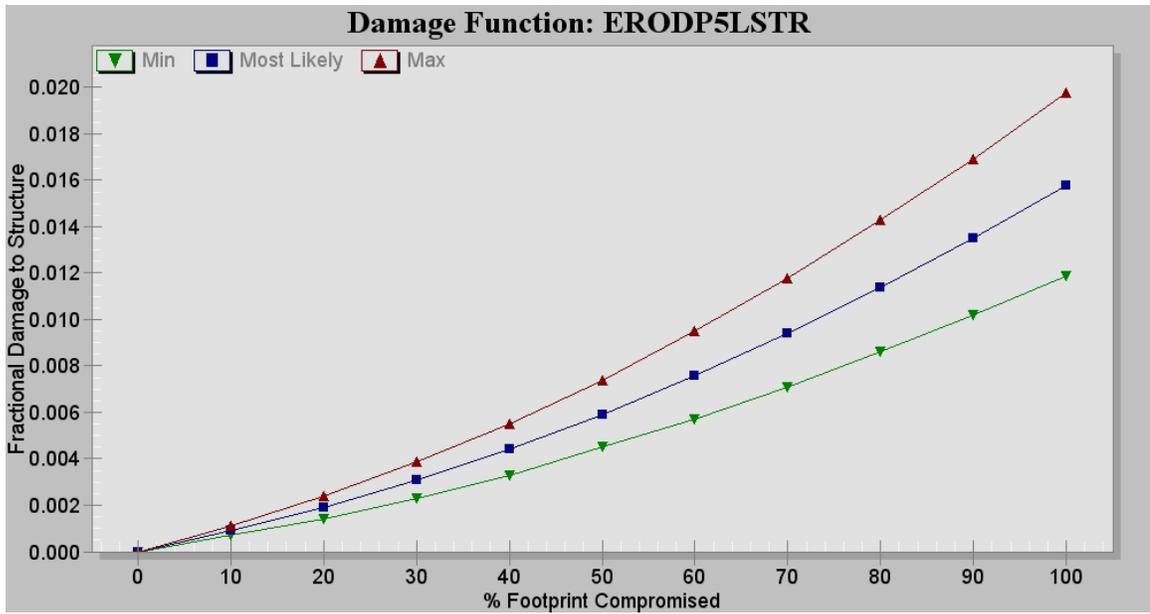


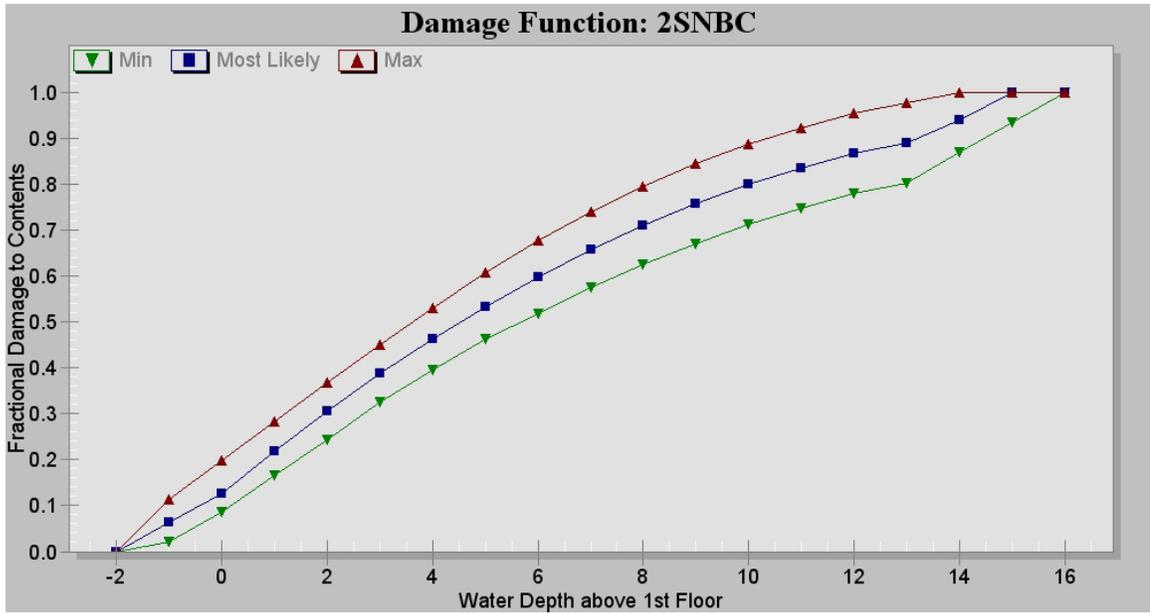
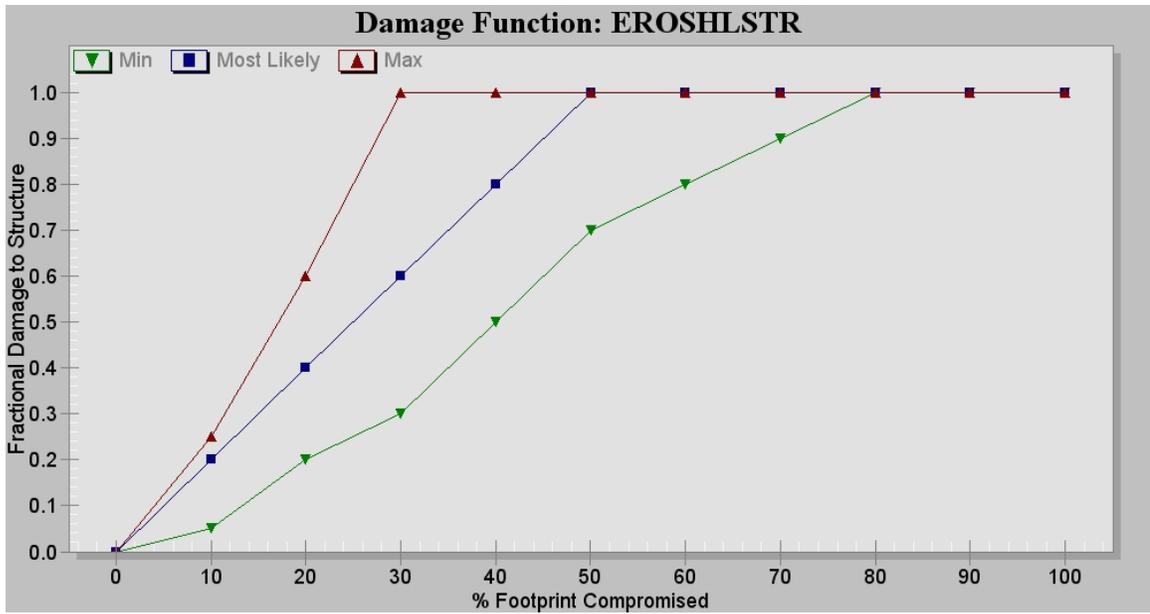


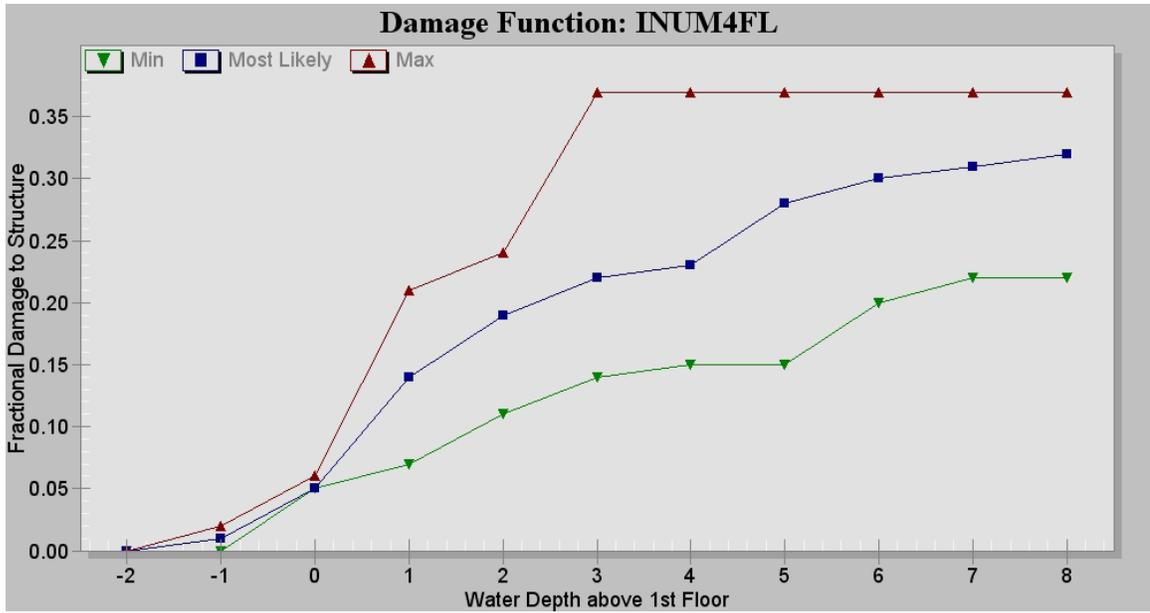
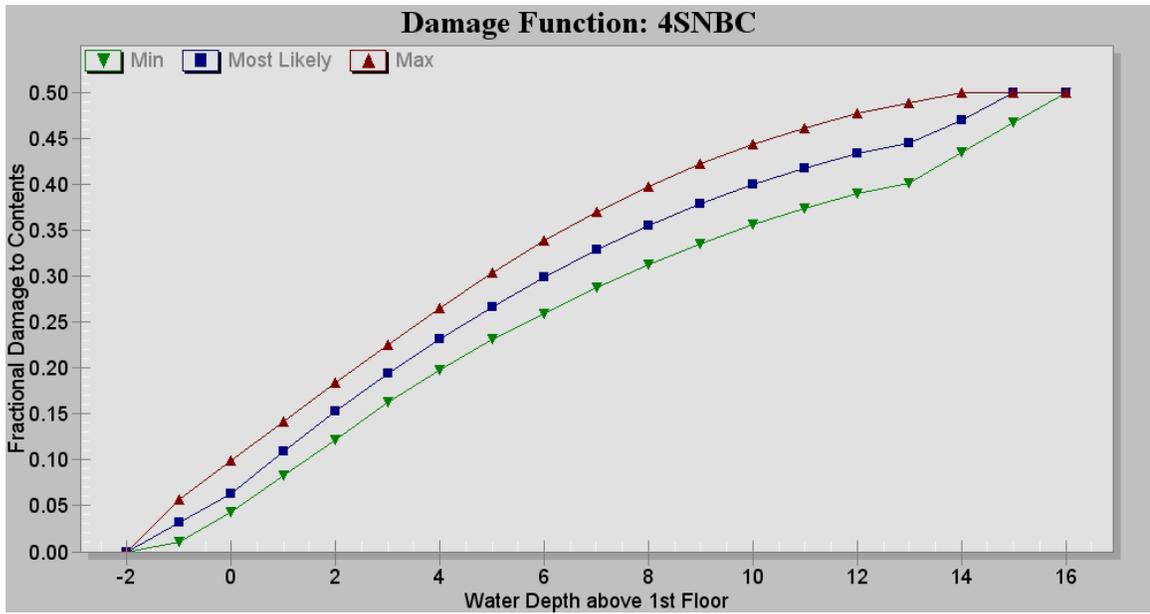


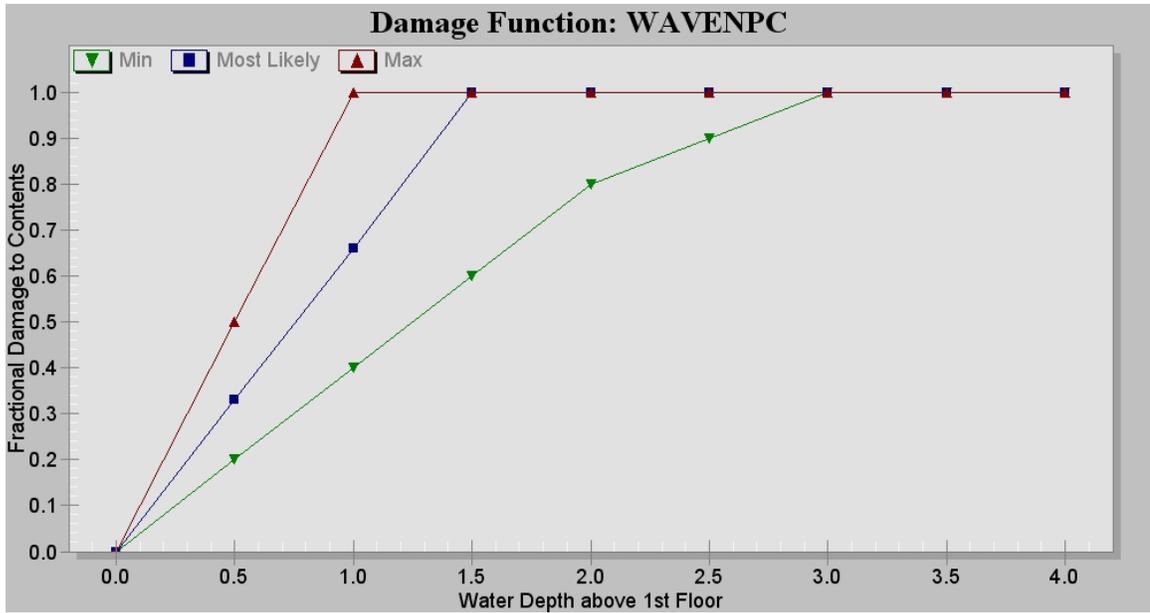
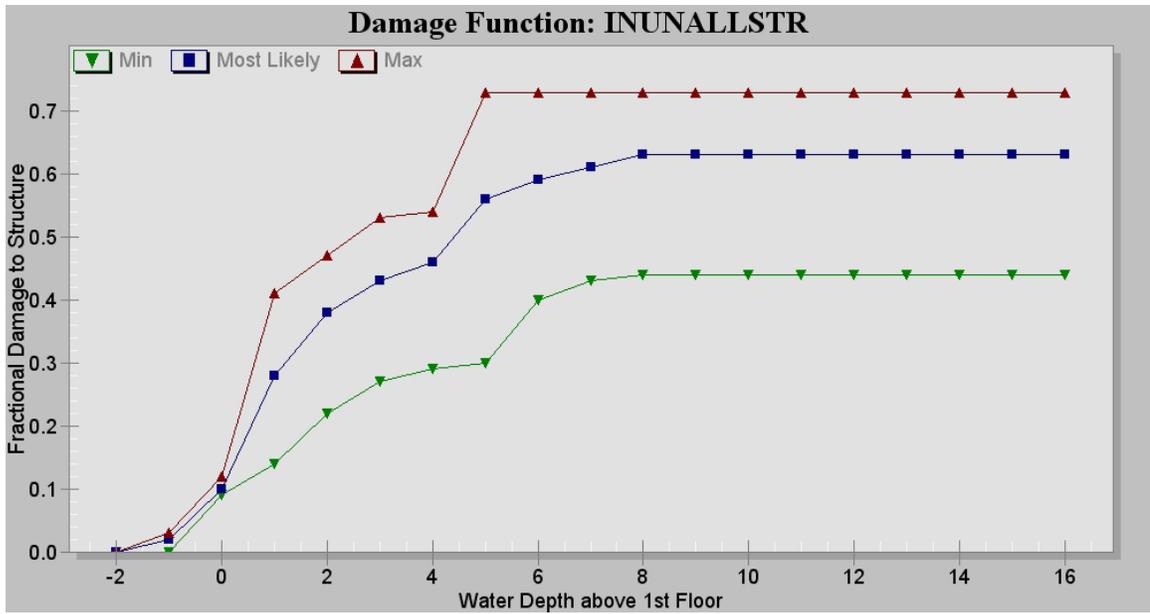


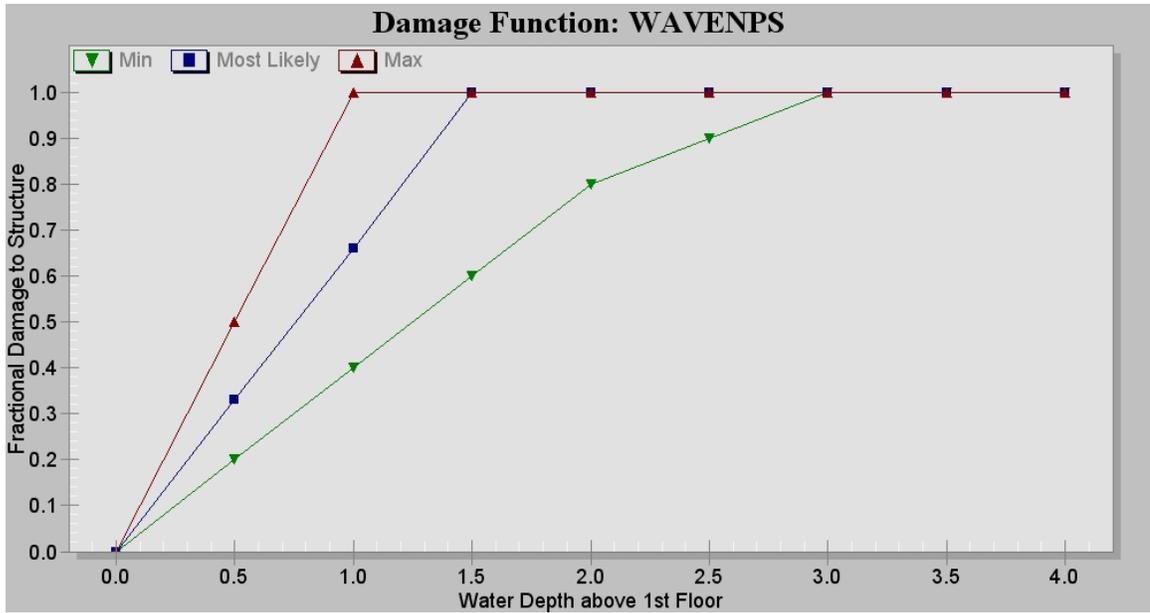
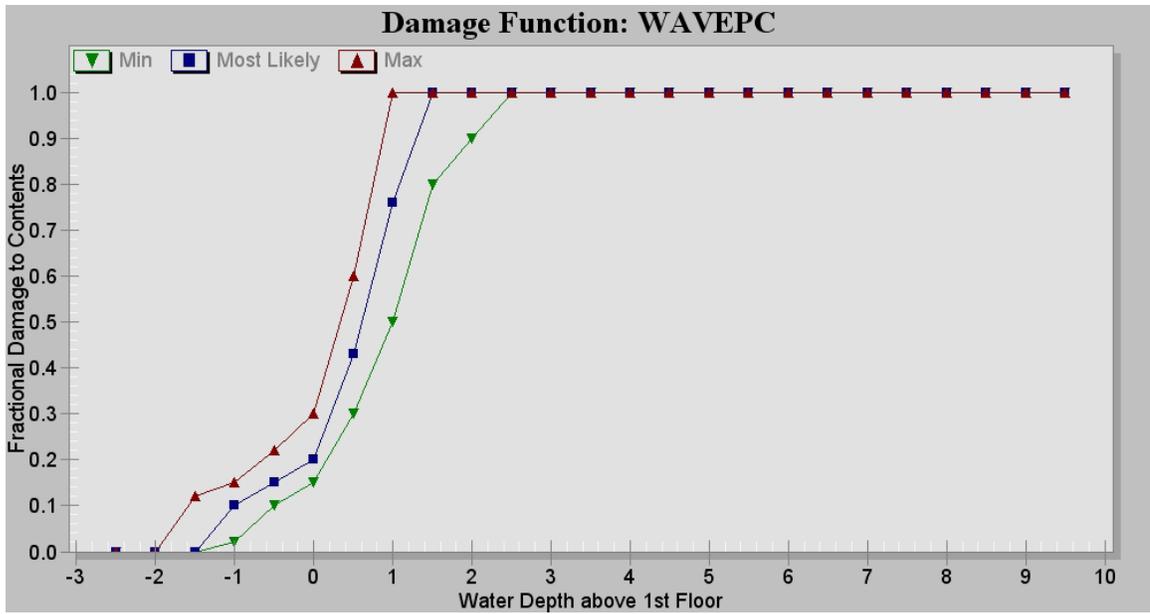












5.08 Variables Specific to Structure File

5.08.1 Structure Type/Damage Element – Flood Damage Curve

A damage element is any physical structure that can endure storm damages, including a residential home, deck, pool, restaurant, pier house, etc. Damage elements are represented by X,Y coordinates in Beach-fx. Damage element types, or categories, are defined by the user and are project specific. Foundation and construction categories for damage elements are also project specific and defined by the user. Critical vertical erosion amounts that compromise the structure are defined by foundation type. Damage element specific data include: type, description (typically address) foundation type, construction type, armor data, coordinates, number of rebuilds allowed, and triangular distributions of content value, structure value, rebuilding time, and first floor elevation.

For the Bogue Banks study area, the above mentioned data requirements were collected for nearly 2,000 damage elements. Construction types include wood or masonry, with all but one structure being built of wood. Foundation types include slab, 8-foot deep pile, or 16-foot pile. The majority of the structures within the study were built on 8-foot deep piles. Rebuilding was not limited over the project life cycle. Damage element type codes cover the range of structures in the study area, as shown in Table B-5

Table B-5 Damage Element Types

Damage Elements, Bogue Banks			
Code	Description	Code	Description
SF1	1 story SF on slab	SF1_SM	SF 1 story on piles with small footprint
SF2	2 story SF on slab	SF2_SM	SF 2 story on piles with small footprint
MF1	apartments/condos	SF1_LG	SF 1 story on piles with large footprint
Condo HOA	condo, HOA	SF2_LG	SF 2 story on piles with large footprint
MOBHM	mobile home	POOLH	pool house, garage
HOTEL	hotel or hi-rise	STRT	street / highway
MOTEL	motel (1 to 2 stories)	PARK	parking lot
OFFIC	office Building	DECK	decks
POOL_TEN	swimming pool, tennis court	DUNE	dune walkovers
CLUB	private club	PU_ACC	public access--improved
RESTU	restaurant	WAREH	storage building / warehouse
BAR	tavern	PIERHOUSE	pier house or storage

5.08.2 Structure Value

Structure values are entered in dollars based on the replacement cost less depreciation. Determinations of commercial structure values and description of the business type were made by district personnel with additional checking against tax records. Structure values represent the replacement value less depreciation at the current price levels. The district personnel consulted with local real estate agents, appraisers, business owners, and building contractors as needed.

5.08.3 Content Value

Contents to residential structures include personal possessions, including furniture, clothing, dishes, cooking utensils, linens, jewelry, stereo equipment, etc. For homeowners' insurance coverage, the standard coverage for contents is 50 percent of the dwelling coverage (consistent with a detailed Residential Flood Damage survey taken in the Northern Gulf Coast). For beach communities like the Bogue Banks communities, the estimated value of contents of an average residential structure would be up to 40 percent of the value of the structure. The main factor in this conclusion is that nearly 75 percent of the structures are not owner-occupied year round. Many of the seasonal 75 percent are rented to vacationers during the spring and summer beach season. Typical contents of rental properties include: beds, furniture, reclining chairs, color cable televisions, VCR's and DVD players, microwave ovens, clothes washers and dryers, and telephones, but do not typically contain higher-value personal possessions. Built-in appliances are included in the value of the structure. This percentage is consistent with a detailed Residential Flood Damage survey taken in the Northern Gulf Coast

It should be noted that elicitation from home owners (S. Greene, personal interview, 4 March, 2014), rental management companies, and real estate agents (R. Herring, personal interview, 1 March 2014) was sought and cited to back up the proxy claim of 40 percent content value. While this number may not be consistent with similar project's content value, the District feels that it is accurate given the nature of home ownership (many rentals) in the Bogue Banks study area.

5.08.4 Elevation at ground

Ground elevations for the vast majority of Bogue Banks structures were taken from FEMA elevation, established by surveys and in some cases were estimated from 2-foot contour maps.

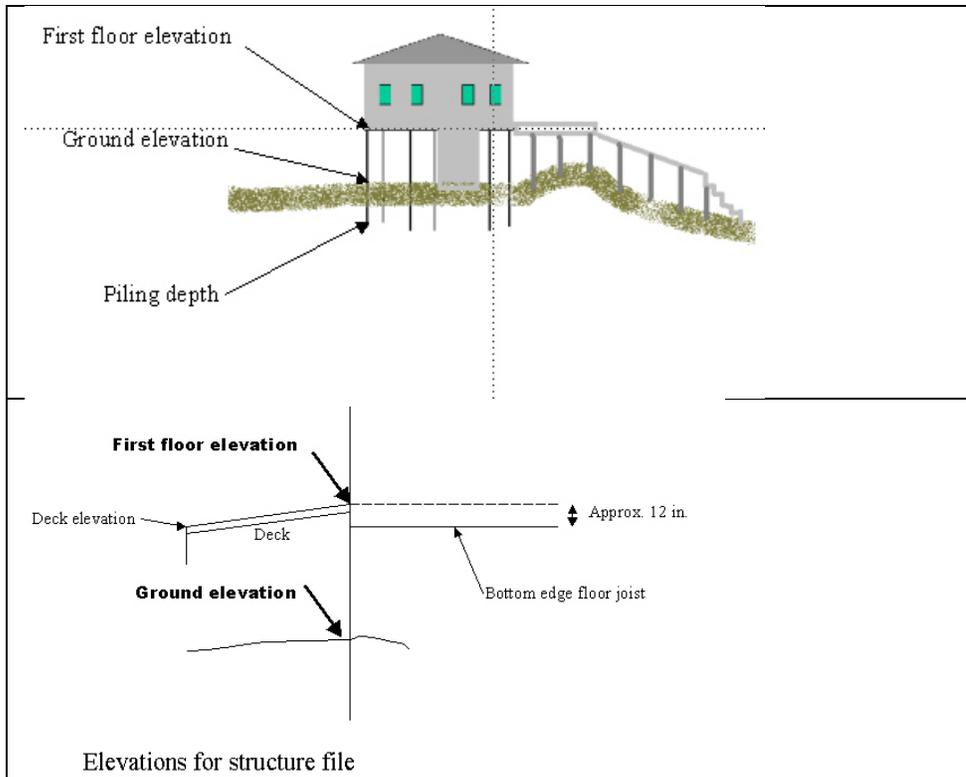


Figure B- 26 - Illustration of Residential Structure Elevations

5.08.5 Elevation at First Floor

The first-floor elevations were taken from FEMA elevation certificates or surveyed by the location of the front entry threshold as shown in Figure B-26. Data collected by North Carolina State University students for FEMA following Hurricane Fran in 1996 were also compared and used for missing structures. In these cases the first floor elevation was adjusted by one foot to get the top of the floor joist versus the bottom of floor joist measured by NCSU. In a few cases first floor elevations were estimated by adding 10 or 12 feet to the ground elevations. Likewise, this assumption was used to indicate the first floor elevation of all structures replaced during the period of analysis.

6.0. ALTERNATIVES TO REDUCE COASTAL STORM DAMAGES

6.01 Beachfill Alternatives Evaluation

Nine beachfill alternatives were economically evaluated in a sequential process using the Beach-fx model. The Beach-fx model was used to produce the actual benefits and borrow volumes needed for each alternative; however, it should be noted that the costs produced by the model and presented at this stage are for comparative purposes only, as they only factor in mobilization/de-mobilization and borrow placement costs, but not other miscellaneous costs (monitoring, tilling, walkway replacement, vegetation planting, real estate, administration, PED, etc). The miscellaneous costs were similar among the various beachfill alternatives, and hence their exclusion would not affect the comparison of alternatives. A full and detailed project cost was only developed for the Recommended Plan. The final cost contained those additional elements, and thus, was higher than the costs presented during the alternatives comparison.

A four year renourishment cycle was specified for these initial comparative runs. Descriptions of each of these alternatives are presented in table B-6. Alternatives 1-5 were analyzed initially. These alternatives were chosen based on an assessment as to what general dimensions of a beachfill plan might be economically viable, gleaned from previous experience with other coastal storm damage studies in North Carolina. Based on analysis of the results from those 5 alternatives, alternatives 6-8 were developed and run in order to better “bracket” the plan with the highest average annual net storm damage reduction of benefits at each of the 12 reaches. Bracketing is done to demonstrate that a larger or smaller sized alternative would not produce greater net benefits than the alternatives that were already run. The net benefits are the average annual prevention of structure, content, and land loss damages (as compared to the without project condition), minus the average annual costs of the alternative. A full display of these values for each of the alternatives is included in Attachment 2 (Titled “Summary of Net Benefits, By Alternative”). Also, Net Benefits were used as the most cost effective criterion during the alternative screening process.

In some reaches, the highest net benefits are achieved through a larger plan which includes dune construction, and in other reaches, the highest net benefits are produced with a “berm only” plan, where the dune is not renourished. Therefore, a 9th, “hybrid” alternative, was also created and analyzed. The hybrid alternative was designed, based on the output from the other 8 alternatives, to generally maximize benefits across the entire study area while also maintaining a fairly consistent profile template (for instance, by not varying the plan within a single coastal reach) for engineering and construction purposes. Varying the template too much would create “bulges” in the shoreline that would be difficult to maintain.

It should be noted that the berm widths in the analyzed alternatives do not include any advanced maintenance. Advanced maintenance is additional berm width that is placed in front of the design berm in order to ensure the design berm does not fall below a certain width prior to renourishment. With advanced maintenance, a 50-ft berm plan would maintain a *minimum* 50 ft berm width for the entire period of Federal participation. However, in this study, a 50-ft berm would be constructed to equilibrate to a *maximum* of 50 ft. The berm would erode and then be built back to 50 ft during each renourishment cycle.

		Existing Condition (2010 profile)			Alternative 1			Alternative 2			Alternative 3			Alternative 4		
		Profiles based on 2010 survey			50 ft berm width throughout project, 5-10 ft dune width additions in reaches 2-12, 2 ft dune height addition in Reach 1			50 ft berm width throughout project, 10-20 ft dune width additions in reaches 2-12, 2 ft dune height and 10 ft dune width addition in Reach 1			50 ft berm width throughout project, 20-30 ft dune width additions in reaches 2-12, 4 ft dune height addition in Reach 1			100 ft berm width throughout project, 5-10 ft dune width additions in reaches 2-12, 2 ft dune height addition in Reach 1		
Coastal Reach	Economic Reaches	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width	Berm Width
1	1-10	11	95	135	13	95	50	13	105	50	15	95	50	13	95	100
2	11-15	15	15	125	15	25	50	15	35	50	15	45	50	15	25	100
3	16-20	20	5	70	20	10	50	20	15	50	20	25	50	20	10	100
4	21-29	26	25	85	26	30	50	26	35	50	26	45	50	26	30	100
5	30-42	20	25	70	20	30	50	20	35	50	20	45	50	20	30	100
6	43-52	22	15	55	22	20	50	22	25	50	22	35	50	22	20	100
7	53-58	28	90	65	28	95	50	28	100	50	28	110	50	28	95	100
8	59-73	18	100	80	18	105	50	18	110	50	18	120	50	18	105	100
9	74-85	20	30	65	20	35	50	20	40	50	20	50	50	20	35	100
10	86-92	18	100	65	18	105	50	18	110	50	18	120	50	18	105	100
11	93-110	18	10	75	18	15	50	18	20	50	18	30	50	18	15	100
12	111-117	14	40	30	14	50	50	14	50	50	14	60	50	14	50	100
		Alternative 5			Alternative 6			Alternative 7			Alternative 8			Alternative 9		
		50 ft berm width throughout project, no dune additions (berm only plan)			75 ft berm width throughout project, no dune additions (berm only plan)			50 ft berm width throughout project, 20-30 ft dune width additions in reaches 3-12, 35 ft dune width addition in reach 2, 5 ft dune height addition in Reach 1			50 ft berm width throughout project, 20-30 ft dune width additions in reaches 3-10, 12, 40 ft dune width addition in reach 11, 6 ft dune height addition in Reach 1			50 ft berm width throughout project, 30 ft dune width addition in reach 2 and 11, 5 ft dune width addition in reach 3, 5 ft dune height addition in reach 1		
Coastal Reach	Economic Reaches	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width	Berm Width
1	1-10	x	x	50	x	x	75	16	95	50	17	95	50	16	95	50
2	11-15	x	x	50	x	x	75	15	50	50	15	50	50	15	45	50
3	16-20	x	x	50	x	x	75	20	25	50	20	25	50	20	10	50
4	21-29	x	x	50	x	x	75	26	45	50	26	45	50	x	x	50
5	30-42	x	x	50	x	x	75	20	45	50	20	45	50	x	x	50
6	43-52	x	x	50	x	x	75	22	35	50	22	35	50	x	x	50
7	53-58	x	x	50	x	x	75	28	110	50	28	110	50	x	x	50
8	59-73	x	x	50	x	x	75	18	120	50	18	120	50	x	x	50
9	74-85	x	x	50	x	x	75	20	50	50	20	50	50	x	x	50
10	86-92	x	x	50	x	x	75	18	120	50	18	120	50	x	x	50
11	93-110	x	x	50	x	x	75	18	40	50	18	50	50	18	40	50
12	111-117	x	x	50	x	x	75	14	60	50	14	60	50	x	x	50

Table B-6. Descriptions of the 9 beachfill alternatives that were evaluated. An 'x' indicates no Federal maintenance of the dune feature.

6.02 Nonstructural Alternative Evaluation

As described in Section 5.05 (Identification, Examination, and Screening of Measures) of The Main Report, one non-structural alternative (alternative 10) was analyzed. The structures included in the analysis are generally those in the first row from the ocean. Those structures further landward from the shoreline are not likely to be as severely threatened for several decades and therefore were not included in the analysis. Of the 1,764 active structures in the structure database, 1,071 were considered for the nonstructural alternative. Several broad assumptions were necessary to make a manageable evaluation of the plan. These assumptions include an identical demolition cost across all properties, 100% compliance by property owners, and immediate implementation at the start of the project. The goal of this screening evaluation was to estimate if a non-structural measure or plan would: a) be economically feasible, and: b) if it was economically feasible, the magnitude of net benefits would be comparable to those derived from a structural plan. A more refined non-structural analysis would only be conducted if *a* and *b* were found to be true through the initial analysis.

The benefits of the non-structural plan were measured by removing all first row structures from the structure file, then running the without project condition again in Beach-fx. The difference in average annual damages between this run and the future without project condition with all structures in place is the benefit of the non-structural plan.

The costs of the non-structural plan included structure acquisition cost, a land value acquisition cost, and a demolition/removal cost. These were the only costs used in the analysis. The replacement cost minus depreciation value of the structure from the structure database was also used as the structure acquisition cost. For simplification, an identical demolition/removal and land value acquisition cost was used for every structure and lot. Based on the average costs of some demolition/removal activities that took place recently at North Topsail Beach, NC, a \$100,000 per lot demolition/removal cost was used in this analysis. An average lot acquisition value of \$650,000 was used, which was based on a survey of recent beachfront property real estate comps from the Bogue Banks area.

6.03 Combined Structural/Non-Structural Alternative Evaluation

A combined structural/non-structural alternative would involve structure removal in parts of the study area, and beachfill in other parts. These structures are described in more detail in Addendum 1 to Appendix B (Attachment 4). Generally, in a combined plan, the non-structural aspects would have to be implemented at the “ends” of a project or along a lengthy, contiguous stretch of beach, so as not to leave unsustainable small gaps in between the areas where the structural alternative is implemented. The non-structural analysis showed 5 reaches that had positive net benefits – reaches 78, 89, 93, 106 and 114. However, these reaches are all relatively short (average 1,000 feet) and are separated from one another by a good distance. For this reason, from an engineering perspective, it would be infeasible to transition into and out of these gap areas because

transition length areas would be longer than the gap lengths themselves. Additionally, the net benefits from the structural plans at these reaches are even higher. Therefore, there is not a viable combined structural/non-structural alternative, and such a plan was screened from further consideration. Further discussion of screening is included in Addendum 2 to Appendix B (Attachment 4).

6.04 NED Comparison of Alternatives

The average annual NED costs, benefits, and net benefits of each of the beachfill alternatives and the non-structural alternative analyzed are shown in table B-7. A detailed breakdown of costs and benefits for each alternative by each reach is contained in Attachment 2. The alternative with the highest net benefits is Alternative 9, the “hybrid” alternative. The costs and benefits used in table B-7 do not match the costs and benefits used in the description of the Recommended Plan, as these were used for plan selection, while a more detailed and USACE certified set of costs were produced for the Recommended Plan. Updated costs for the Recommended Plan are detailed in section 7.0.

Alternative	AA Benefits	AA Costs	AA Net Benefits
No Action	\$0	\$0	\$0
1	\$9,600,000	\$3,173,000	\$6,427,000
2	\$10,209,000	\$3,564,000	\$6,645,000
3	\$11,644,000	\$4,428,000	\$7,216,000
4	\$10,493,000	\$6,145,000	\$4,348,000
5	\$8,667,000	\$2,715,000	\$5,952,000
6	\$9,031,000	\$4,049,000	\$4,982,000
7	\$12,022,000	\$4,594,000	\$7,428,000
8	\$12,114,000	\$4,770,000	\$7,344,000
9	\$11,249,000	\$3,333,000	\$7,916,000
10 (Non-Structural)	\$11,080,000	\$58,873,000	(\$47,793,000)

Table B-7 Comparison of alternative costs and benefits, October 2010 price level, FY 2011 interest rate (4.125%). Costs and benefits shown here were used at the time of this analysis, but were updated to Oct 2014 price levels for the Final Report.

6.05 Incremental Plan Justification

According to ER-1105-2-100, plans should be incrementally justified, meaning that the benefits of each added increment of the plan should exceed the costs of that increment. In the case of this study, these increments are additional lengths of beach, as represented by the 117 economic reaches used in the analysis. It should be noted that with beachfill projects, small unjustified increments that are bordered by justified reaches on either side may still be included as part of the project, since having short

gaps in the project is undesirable and unsustainable from a coastal engineering perspective. If the reach is unjustified due to a lack of damageable structures, then that portion of the project would be paid for at 100% non-Federal expense if the area remains undeveloped prior to the signing of a Project Partnership Agreement (PPA) for construction. Greater than 50% of the benefits used to justify a reach (i.e., to achieve a benefit/cost ratio (BCR) of > 1) need to come from coastal storm damage reduction benefits. Recreational benefits, however, are incidental to the provision of storm damage reduction (per USACE 1105-2-100) The remainder can come from any recreation benefits realized. Once a BCR of >1 is achieved, then all recreation benefits can be claimed, even if they exceed the storm damage reduction benefits. The 117 economic reaches used in the alternatives analysis were used as the basis for demonstrating incremental justification. Table B-8 shows the costs and benefits (split out by storm damage reduction and recreation) at each of these reaches for Alternative 9, which is the plan with the highest storm damage reduction benefits. As shown in this table, reaches 23 and 56 are not economically justified. However, for the engineering reasons stated earlier, these single reaches should not be excluded from the project. Reaches 25, 51-53, 57, 58, and 88 are not justified on the basis of storm damage reduction benefits only, but are justified once recreation benefits are factored in. Hence, the entire length of beach analyzed (reaches 1-117) is incrementally justified and can be included as part of the Recommended Plan. By definition, residual damages are those damages that remain with the project in place. In Table B-8, the residual damages are represented in the Total Damage column, as these are "With Project" damages.

Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)	Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)
1	\$35,883	\$91,813	\$11,908	\$79,905	60	\$2,031	\$26,424	\$22,580	\$3,843
2	\$29,170	\$86,464	\$8,401	\$78,063	61	\$25,455	\$31,561	\$22,072	\$9,488
3	\$36,663	\$100,207	\$13,851	\$86,356	62	\$231,593	\$441,437	\$20,985	\$420,452
4	\$40,163	\$118,703	\$10,916	\$107,787	63	\$4,160	\$47,423	\$35,798	\$11,625
5	\$76,838	\$183,140	\$18,498	\$164,642	64	\$8,055	\$11,973	\$9,672	\$2,302
6	\$74,165	\$194,276	\$18,182	\$176,094	65	\$40,655	\$21,791	\$4,461	\$17,330
7	\$25,677	\$83,912	\$38,073	\$45,839	66	\$2,404	\$49,686	\$41,846	\$7,841
8	\$14,697	\$60,692	\$40,257	\$20,435	67	\$211	\$16,431	\$13,243	\$3,188
9	\$16,214	\$63,339	\$36,492	\$26,846	68	\$53,009	\$19,621	\$15,884	\$3,736
10	\$7,574	\$33,691	\$23,372	\$10,319	69	\$113,494	\$65,598	\$41,603	\$23,994
11	\$30,737	\$62,729	\$14,910	\$47,819	70	\$232,074	\$180,912	\$26,192	\$154,720
12	\$35,889	\$93,616	\$23,917	\$69,699	71	\$110,492	\$63,846	\$34,050	\$29,796
13	\$92,242	\$106,212	\$34,783	\$71,429	72	\$71,681	\$53,578	\$29,950	\$23,628
14	\$73,169	\$100,422	\$24,973	\$75,449	73	\$29,989	\$27,779	\$20,021	\$7,758
15	\$195,437	\$176,199	\$26,836	\$149,363	74	\$316	\$40,795	\$33,151	\$7,645
16	\$31,230	\$35,610	\$14,572	\$21,038	75	\$5,173	\$19,700	\$16,791	\$2,909
17	\$30,183	\$79,132	\$18,883	\$60,249	76	\$19,093	\$63,453	\$6,219	\$57,234
18	\$3,116	\$37,010	\$20,073	\$16,937	77	\$4,632	\$22,570	\$20,596	\$1,974
19	\$4,988	\$37,600	\$18,380	\$19,220	78	\$336,938	\$743,560	\$30,615	\$712,945
20	\$7,685	\$55,160	\$17,082	\$38,077	79	\$29,255	\$131,853	\$33,592	\$98,261
21	\$5,162	\$20,764	\$1,189	\$19,575	80	\$282,382	\$76,018	\$18,526	\$57,491
22	\$164,160	\$6,205	\$807	\$5,398	81	\$5,968	\$48,527	\$32,900	\$15,628
23	\$0	\$0	\$671	(\$671)	82	\$5,094	\$34,146	\$28,963	\$5,182
24	\$4,854	\$2,196	\$370	\$1,826	83	\$17,707	\$175,466	\$53,801	\$121,665
25	\$658	\$471	\$601	(\$130)	84	\$15,831	\$140,956	\$52,477	\$88,479
26	\$711	\$530	\$351	\$179	85	\$4,524	\$100,806	\$62,221	\$38,585
27	\$9,405	\$2,432	\$1,157	\$1,275	86	\$28,546	\$77,559	\$71,040	\$6,519
28	\$10,224	\$1,213	\$642	\$571	87	\$165,555	\$280,848	\$95,043	\$185,805
29	\$2,287	\$478	\$390	\$88	88	\$462	\$42,944	\$49,304	(\$6,360)
30	\$7,698	\$15,577	\$3,884	\$11,693	89	\$216,501	\$227,147	\$37,376	\$189,771
31	\$1,360	\$7,188	\$3,816	\$3,371	90	\$4,931	\$81,587	\$45,337	\$36,251
32	\$2,050	\$10,433	\$3,950	\$6,483	91	\$18,216	\$82,521	\$54,305	\$28,216
33	\$2,201	\$9,618	\$4,278	\$5,340	92	\$589,873	\$269,274	\$87,901	\$181,373
34	\$1,228	\$5,848	\$3,017	\$2,831	93	\$284,497	\$1,102,082	\$72,959	\$1,029,123
35	\$4,522	\$28,155	\$6,700	\$21,455	94	\$29,854	\$91,095	\$55,560	\$35,535
36	\$6,381	\$5,846	\$2,716	\$3,131	95	\$49,325	\$108,336	\$37,487	\$70,849
37	\$60,629	\$15,319	\$5,262	\$10,058	96	\$46,342	\$93,600	\$31,881	\$61,719
38	\$27,850	\$14,580	\$4,519	\$10,062	97	\$78,336	\$129,465	\$36,389	\$93,076
39	\$33,234	\$20,291	\$3,386	\$16,906	98	\$55,365	\$112,838	\$50,436	\$62,402
40	\$72,020	\$117,555	\$6,203	\$111,353	99	\$35,004	\$100,416	\$30,454	\$69,961
41	\$53,012	\$20,814	\$5,849	\$14,965	100	\$37,751	\$121,390	\$39,076	\$82,314
42	\$10,598	\$19,179	\$5,536	\$13,643	101	\$34,833	\$131,636	\$50,005	\$81,631
43	\$44,076	\$79,577	\$46,300	\$33,277	102	\$31,893	\$83,403	\$36,390	\$47,013
44	\$33,971	\$61,648	\$38,781	\$22,866	103	\$65,371	\$160,850	\$40,608	\$120,242
45	\$9,293	\$98,045	\$64,646	\$33,399	104	\$37,815	\$116,709	\$35,181	\$81,528
46	\$20,104	\$61,964	\$34,024	\$27,940	105	\$20,245	\$65,305	\$29,963	\$35,342
47	\$33,206	\$55,570	\$31,580	\$23,990	106	\$59,011	\$254,736	\$15,163	\$239,573
48	\$16,945	\$44,442	\$30,642	\$13,800	107	\$22,298	\$108,172	\$27,664	\$80,508
49	\$23,277	\$45,484	\$27,881	\$17,603	108	\$28,669	\$72,544	\$32,242	\$40,302
50	\$16,254	\$27,827	\$19,186	\$8,640	109	\$22,205	\$79,193	\$38,112	\$41,081
51	\$0	\$9,083	\$10,172	(\$1,089)	110	\$25,628	\$88,402	\$42,493	\$45,909
52	\$2,964	\$35,706	\$41,302	(\$5,596)	111	\$121,696	\$73,347	\$45,049	\$28,298
53	\$18	\$50,068	\$55,050	(\$4,981)	112	\$126,501	\$88,947	\$78,752	\$10,195
54	\$2,858	\$41,063	\$13,351	\$27,712	113	\$55,511	\$66,276	\$53,121	\$13,155
55	\$3,659	\$73,156	\$34,475	\$38,681	114	\$77,724	\$142,422	\$56,506	\$85,916
56	\$0	\$25,754	\$35,164	(\$9,410)	115	\$178,864	\$414,591	\$61,187	\$353,404
57	\$0	\$8,899	\$11,203	(\$2,304)	116	\$179,774	\$679,570	\$50,326	\$629,244
58	\$0	\$23,526	\$28,179	(\$4,653)	117	\$125,759	\$140,906	\$60,787	\$80,119
59	\$7	\$38,874	\$34,806	\$4,068	Total	\$6,055,161	\$11,249,325	\$3,332,701	\$7,916,625

Table B-8. Values used for incremental plan justification, Alternative 9. October 2010 price levels, FY 2011 interest rate (4.125%).

7.0 ECONOMICS OF NED PLAN

7.01 Recommended Plan— CSDR Benefits:

The total expected average annual coastal storm damage reduction benefits (at 4.125% interest rate) for the Recommended Plan were estimated from the Beach-fx model to be \$11,511,000, or for October 2014 price levels, at a 3.5% interest rate, CSDR benefits are \$11,688,082.

7.02 Recommended Plan— Recreation Benefits

Per ER 1105-2-100, the USACE policy on the application of recreation benefits is that “recreation must be incidental in the formulation process and may not be more than fifty percent of the total benefits required for justification. If the criterion for participation is met, then all recreation benefits are included in the benefit to cost analysis.” The Recommended Plan is justified based solely on CSDR benefits, therefore all incidental recreation benefits were claimed for the project.

Recreation benefits for the project were based on an analysis of willingness to pay for a beach day for the average visitor within a travel cost method (TCM) framework. The TCM makes use of the basic idea that the time and money that households expend in traveling to beaches provide a signal of the value of such resources. Additional socioeconomic characteristics of the individuals using the beach and information concerning substitute sites and environmental quality indicators, based on on-site and telephone surveys, were also included. On-site visitation data for 17 North Carolina beaches were collected between July and August 2003. A telephone survey was conducted in May 2004, with a target population based on the results of the on-site survey conducted in 2003. Results from the TCM measure the incremental value of having access to a beach when other substitute beaches are available, and the value of changes in beach characteristics, such as beach width. More detail on the recreation benefits calculation is provided in Attachment 1.

The average annual recreation benefit for the Recommended Plan (at 4.125% interest rate) was calculated at \$3,432,000, or for October 2014 price levels, at a 3.5% interest rates, recreation benefits would be \$3,148,607

7.03 Recommended Plan— Total Benefits

Combining the CSDR benefits and the recreation benefits yields a total average annual benefit for the Recommended Plan for October 2014 price levels, at a 3.5% interest rates of \$14,836,688. Residual damages, at the 3.5% interest rate, are \$127,994,713 or an average annual amount of \$5,456,889.

7.04 Recommended Plan—Costs

Determining the economic costs of the Recommended Plan consists of four basic steps. First, project First Costs are computed. First Costs include expenditures for project design and initial construction and related costs of supervision and administration. First Costs also include the lands, easements, and rights-of-way for initial project construction and periodic nourishment. Total First Costs are estimated to be \$37,327,000 at October 2014 price levels. Details regarding determination of this cost are contained in the Cost Engineering Appendix.

Second, Interest during Construction was added to the project First Cost. Interest during Construction is computed from the start of construction through the 4 month initial construction period. Interest during Construction for the Recommended Plan, at a 3.5% interest rate, is estimated to be \$161,051. The project First Cost plus Interest during Construction represents the Initial Investment Cost required to place the project into operation. Initial Investment Cost for the Recommended Plan is estimated to be \$37,488,051.

Third, Scheduled Renourishment Costs were computed. Those costs are incurred in the future for each of the 16 planned renourishments. Discounting to present value is included in the determination of these costs. As detailed in Appendix D, the estimated cost is \$14,341,000 for each renourishment.

Fourth, Expected Annual Costs were computed. Those costs consist of interest and amortization of the Total Investment Cost and the equivalent annual cost of project OMRR&R and beachfill monitoring. The Expected Annual Costs provide a basis for comparing project costs to expected annual benefits. Expected Annual Costs for the Recommended Plan are estimated to be \$6,065,000. A summary of costs is presented in table B-9.

ANNUAL COSTS			
interest rate =	3.500%	years of analysis =	50
ITEM	FISCAL YEAR	AMOUNT	PRESENT VALUE, 2014
Total Investment Cost	2019	\$37,327,000	\$37,327,000
Renourishment, HB	2023	\$14,341,000	\$12,497,000
Renourishment, HB	2026	\$14,341,000	\$11,272,000
Renourishment, HB	2029	\$14,341,000	\$10,167,000
Renourishment, HB	2032	\$14,341,000	\$9,170,000
Renourishment, HB	2035	\$14,341,000	\$8,271,000
Renourishment, HB	2038	\$14,341,000	\$7,460,000
Renourishment, HB	2041	\$14,341,000	\$6,728,000
Renourishment, HB	2044	\$14,341,000	\$6,068,000
Renourishment, HB	2047	\$14,341,000	\$5,473,000
Renourishment, HB	2050	\$14,341,000	\$4,937,000
Renourishment, HB	2053	\$14,341,000	\$4,453,000
Renourishment, HB	2056	\$14,341,000	\$4,016,000
Renourishment, HB	2059	\$14,341,000	\$3,622,000
Renourishment, HB	2062	\$14,341,000	\$3,267,000
Renourishment, HB	2065	\$14,341,000	\$2,947,000
Renourishment, HB	2068	\$14,341,000	\$2,658,000
Subtotal, Renourishments		\$229,456,000	\$103,006,000
Interest During Initial Construction, 3.5%			\$161,051
Total Investment Cost, Present Value			\$140,494,051
Annual Costs			
Interest & Amortization, 50 years at 3.5 %			\$5,990,000
OMRR&R			\$75,000
Total Annual Cost			\$6,065,000

Table B-9. Recommended Plan annual costs (October 2014 price level).

7.05 Benefit to Cost Ratio

With expected annual benefits of \$14,836,688 and average annual costs of \$6,065,000, the benefit to cost ratio for the Recommended Plan, is 2.45 to 1. The annual net benefits are \$8,771,688.

8.0. REGIONAL ECONOMIC DEVELOPMENT (RED) IMPACTS

The following regional economic impacts will be addressed based on the interest of the local sponsor and the surrounding Jones, Onslow, Craven, and Pamlico counties. Local governments seek to preserve the tax base and encourage the growth in overall property values, to create stability in the labor force and the employment of the labor force. The steady growth of the local community and surrounding region is considered a worthy goal by the state and local governments. Displacement of people, businesses and farms in the study area is not a desirable outcome that sometimes may result from either continued storm damages or even some types of construction. Additionally, preservation of rental property will ensure that earning potential of these properties is preserved, keeping money in the region.

8.01 Preserve Tax Base and, Property Values

Real property, including land and structures, in the towns of Bogue Banks is subject to property tax by Carteret County and the towns. The tax base and property values will be preserved with implementation of a coastal storm damage reduction plan. Land loss and long-term erosion eventually renders lots unbuildable with a significantly lower economic value. Typically, the tax valuation of the ocean front lots is severely reduced to reflect the diminished utility of the land. Lower tax valuations may result in lower county and town tax revenues unless there is offsetting development in other areas.

8.02 Employment Stability

Tourism is highly valued as a source of employment and income. Employment related to recreation can be less than ideal because of the seasonal nature of recreation and tourism. Increased recreation visitation may improve the income of service industries in the two-county study area. It is unlikely that employment will be significantly impacted with or without storm damage reduction measures. Gains or losses in income or employment are considered regional impacts.

8.03 Community and Regional Growth

Implementation of effective damage reduction measures will ensure that the current growth trends in population and recreation visitation will continue. Protection of the

streets and highways in the study area preserve community cohesion and encourage the tourism industry on the island, including the towns of Bogue Banks.

8.04 Displacement of People, Businesses, and Farms

Implementation of damage reduction measures under consideration is not expected to displace people, businesses, or farms.

9.0. OTHER SOCIAL EFFECTS

9.01 Preservation of Life, Health, and Safety

Implementation of the effective damage reduction measures may produce a significant reduction in stress related to concern over the amount of damage and recovery during and after storm events

9.02 Community Cohesion

The proposed plan is anticipated to reduce periodic displacements of residents and visitors as a result of storm events

9.03 Community Growth

Growth trends in population and recreation visitation will continue with implementation of the proposed plan.

9.04 Traffic and Transportation

The proposed plan has the potential to reduce damage to streets and highways, through reduction in tidal over wash. However, water vessel traffic may see a short term increase as a result of dredging operations during initial construction and scheduled renourishments.

9.05 Environmental Justice

No impact to Environmental Justice is anticipated as a result of the proposed plan.

ATTACHMENT 1

RECREATION ANALYSIS

1.0 INTRODUCTION

In December of 2002 the Wilmington District United States Army Corps of Engineers (USACE) contracted with the University of North Carolina at Wilmington (UNCW) to collect data and develop methodologies for an in-depth and multi-faceted study of the recreation demand and benefits of visitors to four barrier islands on the North Carolina Coast: Bogue Banks, Topsail Island, Oak Island, and Holden Beach.

Planning and Guidance (P&G) describes recreation benefits as incidental benefits of the National Economic Development Account. As described in ER 1105-2-100: Single purpose shore protection projects are formulated exclusively for hurricane and storm damage reduction (HSDR) and recreation is an incidental benefit, but is typically predicated on beach width driven user utility. Recreation benefits can be included in the benefit/cost ratio for a project. However, HSDR benefits must account for at least half of the total benefits required to justify the project or the federal government will not share the project costs for that shoreline reach. Therefore, when calculating net benefits for a storm damage reduction project, recreation benefits are added into the net benefits after the storm damage reduction benefits have been estimated from coastal and economic models and after a plan has been selected.

The focus of this collaborative study effort was on day trip visitors who use public access and parking facilities. This study employed multiple methodologies that incorporated:

- An on-site field survey administered during the summer vacation season of 2003
- A telephone survey of residents living in eastern North Carolina within a 120 mile radius of each beach community incorporated into the survey instrument in the spring of 2004 (Office of Management and Budget approved, control number 0710-0001, Attachment 2)
- A focus group session with each municipality and representatives from its major business organizations
- A secondary data literature search, and aerial photography and parking counts of the project area on the days that the onsite surveys were conducted.

This study focused on four projects. These are:

- West Onslow Beach and New River Inlet GRR study
- Surf City/North Topsail Beach feasibility study
- Bogue Banks feasibility study
- Brunswick County Beaches feasibility study

The non-Federal sponsors for the four projects are, respectively, the Town of Topsail Beach; the Town of Surf City, the Town of North Topsail Beach; Carteret County; and the Town of Caswell Beach, the Town of Oak Island, and the Town of Holden Beach; Brunswick County.

A telephone survey instrument was used to gather comparative data for New Hanover County Beaches including Wrightsville Beach, Carolina Beach, Kure Beach, Masonboro Island, and Fort Fisher State Park; remaining Brunswick County beaches including Ocean Isle and Sunset Beach, and the Fort Macon State Park at Bogue Banks.

This report provided an outline methodology that will be used to analyze data collected from the on-site survey, telephone survey, parking counts, and aerial photography. The final analysis was used to determine the peak recreation demand for each beach community under study in the without project condition, the latent and expected future demand in the with project condition, and the recreational benefits of the with and without project conditions that were calculated using the travel cost method (TCM) and the contingent valuation method (CVM).

This analysis answered the following key questions for the reader:

- What is an individual beach recreationist's willingness to pay (WTP) per day trip for each of the beaches in our study region?
- How would the number of beach trips made by an individual beach recreationist to each of the beaches change with a change in beach width?
- How would WTP for an individual beach recreationist change with a change in beach width?
- What would be the change in value in aggregate WTP across all recreationists visiting a particular beach should a change occur in beach width? For example, what would be the increase in recreation value (i.e., aggregate WTP) associated with a 50 foot increase in beach width on Bogue Banks?

Additionally, this report provided an overview of how the data will be used to establish baseline parking and access needs for Bogue Banks and project future parking needs in the with project condition.

As a note, on January 17, 2013, the District met with the Sponsor to provide them with an updated briefing on the NED plan and reiterate the specific parking and access requirements needed to support Federal interest in project implementation. At this meeting, the consequences of failure to meet these requirements including a reduction in Federal cost-sharing percentage and/or a potential loss of Federal interest in project implementation was discussed. At the project Alternative Formulation Briefing on May 10, 2013, the Sponsor reiterated their awareness of these requirements and the importance of ensuring and maintaining public access for moving forward with the Federal project. Another meeting was held with the Sponsor and the Carteret County Beach Commission on June 24, 2013 to reiterate these requirements. In addition, the PDT met again with the Sponsor to review public access requirements on October 9, 2013. The District requested that the Sponsor acknowledge these requirements within their Letter of Intent and support for the project. Additional discussion pertaining to "Peak Demand" was added to the report.

2.0. METHODOLOGY

A multi-method approach was used to examine this study research questions. The primary methods included on-site and telephone surveys and econometric analyses to examine data within the framework of TCM and CVM. Historically, Wilmington District used the unit day value (UDV) method to determine recreation benefits for Hurricane and Storm Damage Reduction projects. The UDV method for estimating recreation benefits relies on expert or informed opinion and judgment to approximate the average willingness to pay of users of a particular project. However, given sufficient data, the UDV can be replaced with the TCM and the CVM estimates to provide a more valid and reliable monetary value of the recreation benefits for each project under feasibility study.

Questions on both the on-site survey and the telephone survey were specifically designed to generate data necessary to employ the TCM and the CVM. Survey data obtained from telephone and on-site survey invariably suffer from spurious records coming from missing values, outliers, and duplicate values, etc. Therefore, basic analysis methods for survey data required first and foremost cleaning data, filtering out unreliable answers from respondents whose answers lie distant from the most conceivable results. LIMDEP (2002)ⁱ, a statistical software having specialized features for the statistical analysis of complex survey data, was employed to analyze the survey data. The analysis was accomplished by fitting nonlinear econometric models to observed data. These econometric models differ from standard regression models in that they can be adapted to handle the unique characteristics of survey data. In addition, the econometric models were developed to estimate economic values, such as a beach recreationist's willingness to pay, or the amount of money the recreationist would be willing to spend for a day of beach recreation.

One objective of this study is to estimate peak and latent demand of the beaches under study. Latent or potential demand is the number of individuals who would come to the beach if conditions were more conducive for recreation. This demand is modeled from the stated preference of the respondent versus their revealed preference. The recommended methodology and data collected from the surveys will be used to develop a model to estimate the number of trips taken to each beach in 2003 and the additional trips that the respondent would take if the width of the beach were increased. The model was also used to predict a decrease in trips with a decrease in beach width caused by erosion of the beach.

Table 1: 2003 Demographic Information

Variable	Demographic Areas		On Site Survey Models		Telephone Survey Models	
	North Carolina	Phone Sampling	WTP Simple	WTP Clogit	Analysis 1	Analysis 2
Mean Age	36*	37	Respondents over 18 years old		42	42
Mean Household Income	\$42,536*	\$36,072*	\$54,255	\$68,081	\$58,833	\$59,153
Sex						
Female	51%	51%	54%	57%	63%	62%
Male	49%*	49%*	46%	43%	37%	38%
Race						
White	72%	64%	Not used in model		81%	82%
Minority	28%*	36%*			19%	18%
Population / Observations	8,421,050	3,891,199	571	2,131	15	3,424

*All variables are in 2003 values except those notated with asterisks and described below (<http://www.nist.gov/itl/div898/strd/>).

North Carolina Demographics Age from July 2004 from NC State Demographics website.

North Carolina Demographics Sex and Race are from the 2000 US Census.

North Carolina Demographics Household Income was inflated to 2003 value from 1999 value from the 2000 US Census.

Telephone Sampling Area Demographics Sex and Race are from the 2000 US Census.

Telephone Sampling Area Demographics Household Income was inflated to 2003 value from 1999 value from the 2000 US Census.

The 2003 beach width will be used as a baseline for this study. The without project condition assumes that the baseline condition remains constant over an equivalent period of time to the expected life of the selected alternative for a hurricane and storm damage reduction project. The average annual benefits will be calculated for a 50 feet decrease in beach width to capture the effects of erosion on recreation. Long term erosion and hurricane impacts will be evaluated separately from the recreation analysis using coastal storm damage models.

Data collected from the aerial photography counts, parking counts and demographic data was employed in this model. Table 1 presents the demographic information of North Carolina and the sampling area.

3.0 ESTIMATING AVERAGE ANNUAL BENEFITS

This section of the appendix details the steps that were taken to derive average annual benefits (AAB) for Bogue Banks and the other beaches included in the surveys. Willingness to pay for beach improvement was used to calculate AAB. It was hypothesized that changes in beach characteristics such as beach width lead to an increase/decrease in the expected number of day user trips per household per year. Changes in the expected number of day user trips per household per year due to changes in beach characteristics can be found by calculating the difference between the expected number of trips per household under baseline conditions and the expected number of trips per household under alternative beach conditions. Since recreationists' responses to changes in beach improvement cannot be observed from market data, we used the contingent valuation method to estimate the WTP.

3.1 – Step 1 Estimating Willingness to Pay Using Contingent Valuation Method (CVM)

The first step in developing average annual benefits (AAB) was to determine a person's willingness to pay (WTP) for a visit to the beach and how certain factors will increase or decrease the likelihood that they pay more or less to visit a certain beach. Contingent valuation survey questions focused on specific environmental service(s) and the context that clearly defined and understood by survey respondents. To determine the average day-user's net willingness to pay (WTP) for beach recreation for each project, we used a binomial probit model (Haab and McConnell 2002, Chapter 2). In this study, we used the procedure to generate an equation that expresses willingness to pay (WTP) as a function of a set of socioeconomic and attitudinal variables. We specified WTP as a function of gender, age, income, beach width in feet, number of parking spaces per mile of beach length, weather condition and holiday.

3.2 – Step 2 – Estimating WTP for Site Access Using Travel Cost Method (TCM)

A conditional logit regression model was used to estimate the component of WTP that is beach-specific, known as "WTP for site access." In contrast, the WTP estimates for CVM measured the total of two components of beach recreation value: the value of visiting any beach in the study region and the WTP for site access to the particular beach on which the recreationist was surveyed. A conditional logit regression model was used to separately estimate WTP for site access alone (Haab and McConnell 2002, Chapter 8).

The conditional logit model attempts to explain the proportions of beach visitors visiting each beach as a function of beach characteristics such as beach length, beach width, the number of parking spaces at each beach, the weather forecast for each beach, and the cost of traveling to each beach per each respondent known as the 'access price.' WTP for site access may be estimated based on the estimated proportions. Because travel cost (access price) is used to predict beach choice, this model is a type of travel cost model (TCM).

Several alternative policy scenarios involving changes in beach quality characteristics can be evaluated using the conditional logit model results. This analysis focused only on the change in beach width effecting WTP. The purpose of developing project scenarios is to calculate WTP for specified changes in beach width compared to the 2003 base year. Beach width changes of -50ft, +50ft, +100ft, and +150ft were the selected scenarios. Econometric regression analyses will be performed for each beach separately, which allowed us to investigate the impact of changes in beach width of one town while assuming that the beach widths at the other towns remain constant at the 2003 base year levels.

The final requirement necessary to calculate the average annual benefits (AAB) was to determine the annual visitation for each beach. The telephone survey data was used to estimate an annual visitation model for each beach. For this analysis a Poisson

regression model was used to develop a trip index to establish how many trips individuals took to the beach in 2003. These estimated trips account only for trips originating from the geographic “area of influence” identified using the onsite survey data. The “area of influence” is the geographic area where seventy percent of the onsite survey day trips originated or a 120-mile radius of the beaches under study. The area of influence corresponds roughly to the eastern half of North Carolina. A random sample of telephone households in the area of influence was conducted in the spring of 2003. Of the 1,876 households surveyed, 1,187 (63 %,) reported taking a trip to one or more of the beaches included in this study in 2003. Survey questions gathered information on each respondent’s number of trips to each project beach in 2003. The 1,067 survey respondents who answered beach destination questions reported taking 9,002 trips to study area beaches in 2003.

Recreation Benefits, Bogue Banks, 3.5% Discount Rate

Reach	Length (ft)	Total Length	Percent	With Project		Without Project		AA Net Benefit
				AA Rec Benefit	Benefit By Reach	AA Rec Benefit	Benefit By Reach	
1	595	6594	0.0902901	\$ 6,437,690	\$ 581,260	\$ 6,011,353	\$ 542,766	\$ 38,494
2	425		0.064432		\$ 414,793		\$ 387,323	\$ 27,470
3	700		0.1061037		\$ 683,063		\$ 637,827	\$ 45,236
4	550		0.0833855		\$ 536,810		\$ 501,260	\$ 35,550
5	931		0.1412107		\$ 909,071		\$ 848,867	\$ 60,203
6	751		0.1138514		\$ 732,940		\$ 684,401	\$ 48,539
7	838		0.1270184		\$ 817,705		\$ 763,552	\$ 54,153
8	694		0.1052579		\$ 677,618		\$ 632,742	\$ 44,875
9	682		0.1033856		\$ 665,564		\$ 621,487	\$ 44,077
10	429		0.0650883		\$ 419,018		\$ 391,269	\$ 27,750
11	681	5633	0.1208478	\$ 5,755,551	\$ 695,546	\$ 5,457,115	\$ 659,480	\$ 36,065
12	1113		0.1975779		\$ 1,137,170		\$ 1,078,205	\$ 58,964
13	1300		0.2308558		\$ 1,328,702		\$ 1,259,807	\$ 68,896
14	1111		0.1971698		\$ 1,134,821		\$ 1,075,978	\$ 58,843
15	1429		0.2535975		\$ 1,459,593		\$ 1,383,911	\$ 75,683
16	690	5569	0.1239286	\$ 2,302,220	\$ 285,311	\$ 2,046,418	\$ 253,610	\$ 31,701
17	994		0.1785378		\$ 411,033		\$ 365,363	\$ 45,670
18	1135		0.2038628		\$ 469,337		\$ 417,189	\$ 52,149
19	1096		0.1968649		\$ 453,226		\$ 402,868	\$ 50,358
20	1653		0.2968828		\$ 683,490		\$ 607,546	\$ 75,943
21	1322	83375	0.0158573	\$ 7,782,784	\$ 123,414	\$ 7,064,406	\$ 112,022	\$ 11,392
22	1437		0.0172372		\$ 134,153		\$ 121,770	\$ 12,383
23	1651		0.0198074		\$ 154,157		\$ 139,927	\$ 14,229
24	1483		0.0177815		\$ 138,390		\$ 125,616	\$ 12,774
25	1834		0.0219939		\$ 171,173		\$ 155,374	\$ 15,800
26	1439		0.0172604		\$ 134,334		\$ 121,935	\$ 12,400
27	1873		0.0224647		\$ 174,838		\$ 158,700	\$ 16,138
28	1648		0.0197643		\$ 153,821		\$ 139,623	\$ 14,198
29	956		0.0114606		\$ 89,196		\$ 80,962	\$ 8,233
30	1089		0.013063		\$ 101,667		\$ 92,283	\$ 9,384
31	1245		0.0149318		\$ 116,211		\$ 105,485	\$ 10,727
32	1113		0.0133504		\$ 103,903		\$ 94,312	\$ 9,591
33	1484		0.017797		\$ 138,510		\$ 125,725	\$ 12,785
34	856		0.0102697		\$ 79,927		\$ 72,549	\$ 7,378
35	1499		0.0179774		\$ 139,914		\$ 127,000	\$ 12,915
36	945		0.0113285		\$ 88,167		\$ 80,029	\$ 8,138

37	1408	0.0168934	\$ 131,477	\$ 119,342	\$ 12,136
38	1488	0.0178493	\$ 138,917	\$ 126,095	\$ 12,823
39	1059	0.0127047	\$ 98,878	\$ 89,751	\$ 9,127
40	1701	0.0204069	\$ 158,823	\$ 144,163	\$ 14,660
41	1648	0.0197636	\$ 153,815	\$ 139,618	\$ 14,198
42	1089	0.0130626	\$ 101,663	\$ 92,279	\$ 9,384
43	1968	0.0236013	\$ 183,684	\$ 166,729	\$ 16,955
44	1329	0.0159379	\$ 124,041	\$ 112,592	\$ 11,449
45	1646	0.0197413	\$ 153,642	\$ 139,461	\$ 14,182
46	1095	0.0131385	\$ 102,254	\$ 92,816	\$ 9,438
47	1107	0.0132738	\$ 103,307	\$ 93,771	\$ 9,536
48	1096	0.0131501	\$ 102,344	\$ 92,897	\$ 9,447
49	1101	0.0132071	\$ 102,788	\$ 93,300	\$ 9,488
50	850	0.0101974	\$ 79,364	\$ 72,039	\$ 7,326
51	518	0.0062118	\$ 48,345	\$ 43,883	\$ 4,462
52	1575	0.0188859	\$ 146,985	\$ 133,418	\$ 13,567
53	1593	0.0191017	\$ 148,665	\$ 134,942	\$ 13,722
54	426	0.0051137	\$ 39,799	\$ 36,125	\$ 3,674
55	1010	0.0121113	\$ 94,260	\$ 85,559	\$ 8,700
56	870	0.0104294	\$ 81,170	\$ 73,677	\$ 7,492
57	387	0.0046474	\$ 36,170	\$ 32,831	\$ 3,339
58	1129	0.0135442	\$ 105,412	\$ 95,682	\$ 9,730
59	1294	0.0155176	\$ 120,770	\$ 109,623	\$ 11,148
60	737	0.0088445	\$ 68,834	\$ 62,481	\$ 6,354
61	913	0.0109497	\$ 85,219	\$ 77,353	\$ 7,866
62	1042	0.0124982	\$ 97,271	\$ 88,292	\$ 8,978
63	1431	0.0171664	\$ 133,602	\$ 121,270	\$ 12,332
64	431	0.0051671	\$ 40,214	\$ 36,502	\$ 3,712
65	188	0.002256	\$ 17,558	\$ 15,937	\$ 1,621
66	1499	0.017984	\$ 139,966	\$ 127,046	\$ 12,919
67	546	0.0065428	\$ 50,921	\$ 46,221	\$ 4,700
68	575	0.0068967	\$ 53,676	\$ 48,721	\$ 4,954
69	1388	0.016643	\$ 129,529	\$ 117,573	\$ 11,956
70	1114	0.0133639	\$ 104,009	\$ 94,408	\$ 9,600
71	1183	0.0141941	\$ 110,469	\$ 100,273	\$ 10,197
72	1185	0.0142133	\$ 110,619	\$ 100,409	\$ 10,211
73	816	0.0097869	\$ 76,169	\$ 69,139	\$ 7,031
74	1290	0.0154702	\$ 120,401	\$ 109,288	\$ 11,113
75	1000	0.0119954	\$ 93,358	\$ 84,741	\$ 8,617
76	401	0.0048057	\$ 37,402	\$ 33,950	\$ 3,452
77	1026	0.0123109	\$ 95,813	\$ 86,969	\$ 8,844
78	871	0.0104527	\$ 81,351	\$ 73,842	\$ 7,509
79	1039	0.0124662	\$ 97,022	\$ 88,066	\$ 8,955
80	641	0.0076917	\$ 59,862	\$ 54,337	\$ 5,526
81	1039	0.0124662	\$ 97,022	\$ 88,066	\$ 8,955
82	920	0.0110337	\$ 85,873	\$ 77,947	\$ 7,926

83	1466		0.0175875		\$ 136,880		\$ 124,245	\$ 12,634
84	1431		0.0171595		\$ 133,549		\$ 121,222	\$ 12,327
85	1463		0.0175493		\$ 136,582		\$ 123,975	\$ 12,607
86	1417		0.0169905		\$ 132,233		\$ 120,028	\$ 12,206
87	1797		0.0215551		\$ 167,758		\$ 152,274	\$ 15,485
88	1034		0.0123997		\$ 96,504		\$ 87,597	\$ 8,908
89	827		0.0099154		\$ 77,169		\$ 70,046	\$ 7,123
90	846		0.0101493		\$ 78,989		\$ 71,698	\$ 7,291
91	908		0.0108912		\$ 84,764		\$ 76,940	\$ 7,824
92	1648		0.0197687		\$ 153,855		\$ 139,654	\$ 14,201
93	1243	15274	0.0814022	\$ 2,387,488	\$ 194,347	\$ 1,364,279	\$ 111,055	\$ 83,291
94	1139		0.0746016		\$ 178,110		\$ 101,777	\$ 76,333
95	954		0.0624849		\$ 149,182		\$ 85,247	\$ 63,935
96	856		0.056055		\$ 133,831		\$ 76,475	\$ 57,356
97	1063		0.0695982		\$ 166,165		\$ 94,951	\$ 71,214
98	1171		0.0766946		\$ 183,107		\$ 104,633	\$ 78,475
99	638		0.0417564		\$ 99,693		\$ 56,967	\$ 42,726
100	807		0.0528326		\$ 126,137		\$ 72,078	\$ 54,059
101	1079		0.0706379		\$ 168,647		\$ 96,370	\$ 72,277
102	726		0.0475247		\$ 113,465		\$ 64,837	\$ 48,628
103	839		0.0549398		\$ 131,168		\$ 74,953	\$ 56,215
104	877		0.0574306		\$ 137,115		\$ 78,351	\$ 58,763
105	719		0.0471039		\$ 112,460		\$ 64,263	\$ 48,197
106	392		0.0256837		\$ 61,320		\$ 35,040	\$ 26,280
107	709		0.0463909		\$ 110,758		\$ 63,290	\$ 47,468
108	709		0.0463909		\$ 110,758		\$ 63,290	\$ 47,468
109	703		0.0460344		\$ 109,906		\$ 62,804	\$ 47,103
110	649		0.0424694		\$ 101,395		\$ 57,940	\$ 43,455
111	711	4943	0.1438777	\$ 895,308	\$ 128,815	\$ 468,971	\$ 67,474	\$ 61,340
112	1133		0.2291463		\$ 205,157		\$ 107,463	\$ 97,694
113	721		0.1459598		\$ 130,679		\$ 68,451	\$ 62,228
114	672		0.1360134		\$ 121,774		\$ 63,786	\$ 57,988
115	687		0.1390387		\$ 124,482		\$ 65,205	\$ 59,277
116	498		0.10075		\$ 90,202		\$ 47,249	\$ 42,953
117	520		0.105284		\$ 94,262		\$ 49,375	\$ 44,886
Total					\$25,561,798		\$22,413,192	\$3,148,607

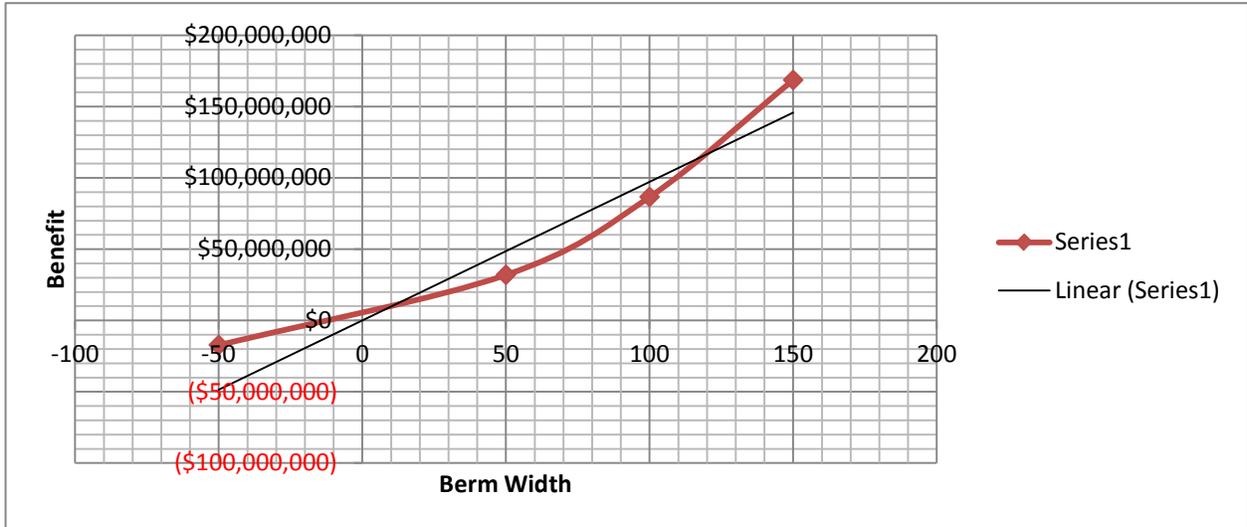
3.3. – Step 3 – Calculating Project Average Annual Benefits (AAB)

Finally the average annual benefits (AAB) for recreation under baseline 2003 conditions at each of the project beaches (updated to 2014 price levels for the Final Report) were calculated using estimates of annual trips to each beach in the study area, based on the telephone survey data, and estimates of recreation value per trip (net willingness to pay) based on the onsite survey data. Each of the models used to develop a demand curve of benefits is expressed in present worth.

Attachment 1, Recreation Curves by Sbeach Reach

Union of Coastal and Economic Reaches

Coastal Reaches (SBeach)	Economic Reaches
1	1-10
2	11-15
3	16-20
4	21-29
5	30-42
6	43-52
7	53-58
8	59-73
9	74-85
10	86-92
11	93-110
12	111-117



Emerald Isle, Sbeach Reaches 1-6



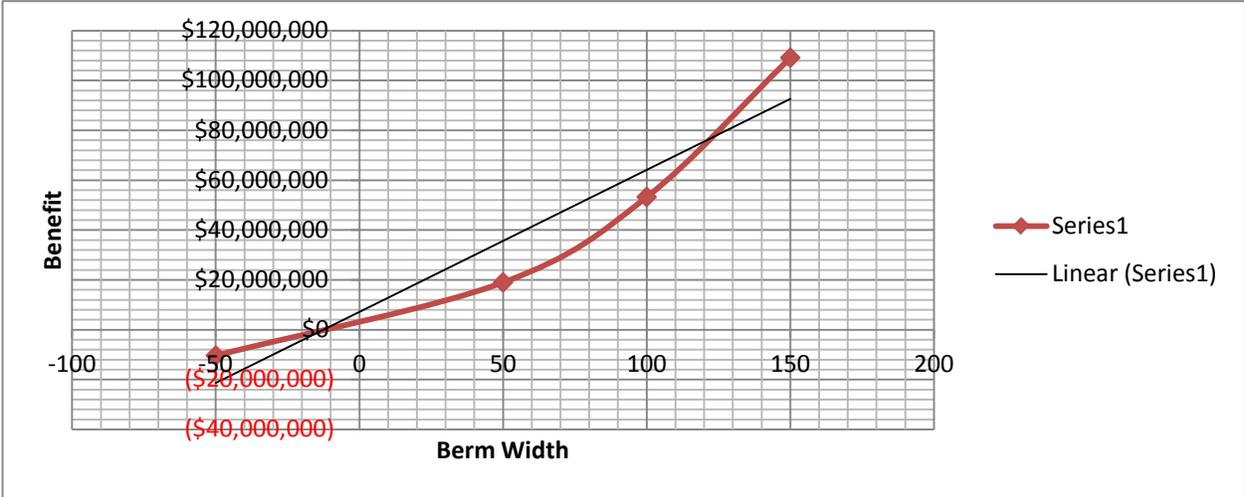
Salter Path, Sbeach Reach 7



Indian Beach, Sbeach Reach 7



Pine Knoll Shores, Sbeach Reaches 8-9



Atlantic Beach, Sbeach Reaches 10-12

ATTACHMENT 2

PARKING AND ACCESS

1.0 INTRODUCTION

The Army Corps of Engineers has several requirements that must be met in order to fully cost share in a coastal storm damage reduction project (see ER 1105-2-100 and ER 1165-2-130). These requirements include that the beaches must be available for public use and provide adequate parking and access. As described in ER 1165-2-130 (Federal Participation in Shore Protection, paragraph 6.h.), “Parking should be sufficient to accommodate the lesser of the peak hour demand or the beach capacity”, and “public use is construed to be effectively limited to within one-quarter mile from available points of public access to any particular shore. In the event public access points are not within one-half mile of each other, either an item of local cooperation specifying such a requirement and public use throughout the project life must be included in the project recommendations or the cost sharing must be based on private use.” The Corps’ Wilmington District, additionally, has developed more specific public access and parking requirements for participation in coastal storm damage reduction projects within the District’s boundaries of North Carolina and Virginia. The Wilmington District requirement requires that a minimum of 10 public parking spaces be located within one-quarter mile of a public access point. The criteria for 10 spaces was based on using an average lot size along the shoreline area and determining how many parking spaces could be provided in that lot size (e.g. a 50’ x 95’ lot size can provide 10 spaces).

This Appendix contains an analysis of the current parking and access situation at Bogue Banks and how it relates to the distribution and peak demand requirements. The local sponsor will need to address any parking and access deficiencies prior to the signing of the PPA, otherwise project cost sharing would be adjusted. If the required number of parking spaces cannot be obtained, in some cases a public transportation system adequate for the needs of projected beach users may suffice instead (see ER 1165-2-130, section 6h(2)). Recognizing that circumstances can change between the time that this initial analysis was done and the PPA is signed, the parking and access needs as presented in this Appendix may be revisited at some point prior to the PPA signing.

As a note, on January 17, 2013, the District met with the Sponsor to provide them with an updated briefing on the NED plan and reiterate the specific parking and access requirements needed to support Federal interest in project implementation. At this meeting, the consequences of failure to meet these requirements including a reduction in Federal cost-sharing percentage and/or a potential loss of Federal interest in project implementation was discussed. At the project Alternative Formulation Briefing on May 10, 2013, the Sponsor reiterated their awareness of these requirements and the importance of ensuring and maintaining public access for moving forward with the Federal project. Another meeting was held with the Sponsor and the Carteret County Beach Commission on June 24, 2013 to reiterate these requirements. In addition, the PDT met again with the Sponsor to review public access requirements on October 9, 2013. The District requested that the Sponsor acknowledge these requirements within their Letter of Intent and support for the project, which was provided in April 2014. Additional discussion pertaining to "Peak Demand" was added to the report.

2.0 Data

The spatial analysis of available public access and parking within the project areas was conducted using the following data:

Existing spatial data assembled for this analysis:

- Public Beach Access 2004 – Source: State of North Carolina CAMA Office
- Carteret County Tax Parcels 2010 – Source Carteret County Tax Office

New spatial data layers created for this analysis:

- Beach Access ½ Mile Diameter – ½ mile diameter buffers were created from the Public Beach Access Points. These circles represent the maximum distance allowed between Public Beach Access Points.
- Access Distance Greater than ½ Mile – Line segments were created between each Public Access Point. Data layer contains a definition query limiting display to only those segments that exceed ½ mile, or the maximum distance allowed between Public Access facilities per USACE Policy.
- Town Properties – Properties owned by the towns were derived from the Carteret County Tax Parcel Data to illustrate where potential Public Beach Access may be obtained if needed.

3.0 BEACH ACCESS

3.1 Methodology

Public Access Points were compared to the Project Area. Those Public Access Points adjacent to the given Project Area were selected for further analysis. Circular buffers with ½ mile diameter were generated from the selected Public Access Points. These circular features were given the layer name "Beach Access ½ Mile Diameter" and are

depicted as hollow blue circles in Maps 1-9 (all maps are contained at the end of this Appendix). These features, originating at each Public Access Point, must intersect with a Public Access Point on both east and west sides to meet the required maximum distance between public access points per USACE Policy. Instances where Public Access fails to meet this requirement are found on Access Maps (Attachment 3) 1, 2,5,6,7,8, and 9 within Emerald Isle, Indian Beach, Salter Path, Pine Knoll Shores, and Atlantic Beach.

Further analysis was conducted to determine the distance between those Public Beach Access Points that were more than ½ mile apart. The line feature “Access Distance Greater than ½ mile” was generated using the Public Beach Access Points. The lengths of these line segments were calculated and a definition query used to select those segments with a length exceeding ½ mile. These selected lines were then labeled with their calculated lengths to illustrate the magnitude of public access deficiencies within the project areas.

3.2 Results

There are 109 existing access points distributed throughout the study area.

Maps 1 and 2 define two instances within Emerald Isle that fail to meet the USACE public access density requirement. The distance between Public Access points located Wyndtree and Randy’s Way has been calculated as .66 miles (see Map 1). To meet access density requirements, two additional Public Access Points are required between these two points. The distance between Public Access points located at Heavenly and Bogue Inlet Pier has been calculated as .35 miles (see Map 2). One additional Public Access Point is required between these two points to meet access density requirements.

Map 5 illustrates two instances of public beach access deficiency. The distance between the Indian Beach Regional Access and the Salter Path Regional Access has been calculated to be 0.09 miles. Technically, to meet access density requirements, an additional Public Access is required between these two points. Additionally, the distance between Salter Path Regional Access and the Sea Plantation West Access has been calculated to be 0.09 miles.

There are two instances of Public Beach Access deficiency in Pine Knoll Shores on Map 6. The distance between Beacon’s Reach West Access and the Beacon’s Reach East Access has been calculated to be 0.38 miles. One additional Public Beach Access points is required between these two points. Additionally, the distance between The Qualls Regional Access and the Iron Steamer Regional Access has been calculated to be 0.38 miles as well, requiring one additional Public Beach Access.

An additional two Public Beach Access deficiencies in Pine Knoll Shores can be found on Map 7. The distance between the Dogwood Regional Access and Memorial Park Regional Access has been calculated to be 0.06 miles, requiring an additional Public

Beach Access between these two points. The distance between Memorial Park Regional Access and the Knollwood Dr Regional Access has been calculated to be 0.14 miles. One additional Public Beach Access is required between these two points to meet the minimum access requirement.

Map 8 shows three Public Beach Access deficiencies of the project in Atlantic Beach. The distance between the Knollwood Dr Regional Access and the Coral Bay Club (west) Regional Access has been calculated to be 0.19 miles. One additional Public Beach Access is required between these two points. The distance between the Coral Bay Club (west) Regional Access and the Durham Avenue Regional Access has been calculated to be 0.84 miles, requiring two additional Public Beach Access points between these two points.

Map 9 shows a deficiency between the Commerce Way Regional Access and The Fort Macon Bathhouse Regional Access, with a distance of .07 miles outside of the ½ mile diameter.

In summary, at least 13 additional beach access points are needed throughout the project area to meet the USACE requirement for adequate distribution.

4.0 PARKING DISTRIBUTION

4.1 Methodology

Public Access Points and Parking Data were compared to the Project Areas. Those Public Access Points adjacent to the given Project Area were selected for further analysis. Circular buffers with ¼ Mile radii were generated from the selected Public Access Points. These circular features were given the layer name "Parking Radius ¼ Mile" and are depicted as hollow blue circles in Maps 1-9. These features, originating at each Public Access Point, must contain a minimum of 10 public parking spaces within ¼ mile per USACE Policy. Instances where Public Access Parking fails to meet this requirement are found on Parking Maps (Attachment 3) 1, 2, 3, 4, 8, and 9.

4.2 Results

There are an estimated 1,861 existing parking spots distributed throughout the study area (including Fort Macon). Beach Access Points were symbolized with a Green Filled Circle where the number of parking spaces met or exceeded the minimum of 10 spaces. Beach Access Points were symbolized with a Red Filled Circle where the number of parking spaces was less than the required 10 spaces. Each Beach Access was labeled with the number of known Parking Spaces.

The Beach Access Points Channel Drive, Inlet and Coast Guard Road (Station Street Park), and Wyndtree are all within ¼ mile of each other. Each Access point in this group has 10 Parking Spaces within ¼ mile. None of the other Beach Access Points on Map 1 meet the minimum requirement for parking.

The Beach Access Points Western Regional Access and Janell are located within ¼ mile of each other and both have 10 or more parking spaces available within ¼ mile. No other Beach Access Points on Map 2 meet the minimum requirement for parking.

Only Beach Access Point Dog Leg meets the minimum requirement for parking on Map 3. Dog Leg is located within ¼ mile of Old Pier Eastern Regional Access and has access to 10 or more parking spaces.

On Map 4, Beach Access Points at Old Pier Eastern Regional Access, 25th, 5th, 3rd, and 2nd all have 10 Parking Spaces within ¼ mile. None of the other Beach Access Points on Map 4 meet the minimum requirement for parking.

All Beach Access Points on Map 5 meet minimum parking requirements. Beach Access 1st, Baptist Church Gazebo, Ocean Club, Indian Beach Regional Access, Salter Path, Sea Plantation West, and Trinity Center Regional Access all meet the minimum parking requirements with access to 10 or parking spaces within ¼ mile.

Beacon's Reach West Regional Access, Beacon's Reach East/Clamdigger Inn/The Qualls Regional Access, Iron Steamer and Dayton Place located on Map 6 all meet or exceed the minimum parking requirement.

The Dayton Place, Dogwood, Memorial Park, Knollwood and the Amerisuites Regional Access and the Amerisuites Regional Access points on Map 7 meet the minimum requirement for parking, along with the Iron Steamer Regional Access also visible on Map 7. However, the Sheraton West Regional Access does not meet minimum parking requirements.

On Map 8, Durham Street Regional Access, Charlotte Avenue Regional Access, Raleigh Avenue Regional Access, Bath House Regional Access, The Circle Regional Access and Beaufort Avenue Regional Access all meet the minimum parking requirements by having 10 available parking spaces within ¼ mile.

New Bern Street Regional Access and Club Colony Drive Regional Access both meet required minimum of 10 Parking Spaces within ¼ mile, as do Tom Doe, Ocean Avenue , and Commerce Way Regional Access points. Of the remaining Beach Access Points On Map 9, only the Bathhouse Regional Access meets the minimum requirement for parking.

4.0 PEAK PARKING

A study/survey was conducted by the University of North Carolina at Wilmington (UNCW) in 2003 was used as the basis for estimating potential peak hour parking demand in the area (this study can be made available upon request) at the time a project is constructed (currently estimated to be 2019 for the Bogue Banks Project). Peak hour demand is defined here as the average number of non-overnight visitors at

the beaches at 1 p.m. on July 4, 5, 12, 13 and Aug 2, 3, 9, 10, 30, and 31. Sufficient parking capacity is defined here as having enough parking spaces to accommodate peak hour demand on 60% of peak days. This means that on average, there would be enough public parking to accommodate all beach visitors year round, with the exception of at peak hour (1 p.m.) on four of the busiest (peak) days of the year.

The increase in peak demand is based on increases to the width of the beach. Because beach width will vary over the life of the project, an average annual change in beach width between the with and without project condition was calculated. This difference in beach width was measured for each of the individual towns in the project area (Emerald Isle, Indian Beach, Salter Path, Pine Knoll Shores, and Atlantic Beach) and used as the basis for determining project recreation benefits (see Appendix B – Economics) and the peak hour parking demand in each of these towns with a project in place in 2019. The number of parking spaces required to meet the peak hour parking demand requirement, as well as the current number of parking spaces in each of the towns is shown in Table 1 below.

Town	Total Parking Spaces Needed for Peak Demand	Current Parking Spaces	Additional Parking Spaces Needed
Emerald Isle	662	529	133
Salter Path/Indian Beach	96	141	0
Pine Knoll Shores	210	180	30
Atlantic Beach	1,100	1,011*	89
Total	2,068	1,861	252

*Includes 594 parking spots available at Fort Macon State Park

Table 1. Number of parking spaces needed to meet peak parking requirement, and estimated number of current parking spaces.

PUBLIC PARKING AND ACCESS MAPS

Are posted at the end of this appendix

Introduction to Methods and Procedures

This write-up provides an overview of the data and methodology that was used to determine the peak parking space requirements. The data on which the analysis is based comes from telephone and onsite surveys conducted by the University of North Carolina at Wilmington in 2003 (the full report can be made available upon request). This data was used to establish parking requirements for Bogue Banks at the estimated start of project construction.

Methodology

The telephone survey asked respondents about trips taken in a 120-mile radius of the North Carolina coast during a typical peak summer season. The data was used to construct an index of the number of recreational day trip (TRIPINDX) to a beach. $TRIPINDX_i$ is the estimated number of recreational day trips taken to beach i per year by 1,067 households in the telephone survey sample. PC Miler, a Poisson/negative-binomial cluster regression model, was used to generate TRIPINDX. Other data collected for this study include stay time, STAYTIME, which is the average length of time in hours that a visitor remained at the beach. The duration of stay is assumed to affect parking demand. If the duration of stay is usually long, more parking spaces should be provided.

The on-site survey collected parking space data for ten beaches on peak (weekend) days in July and August 2003. For this analysis the variable SPACES, which gives the existing number of parking spaces at each beach, is used as a censoring variable by the Tobit regression procedure. Each beach has a separate censoring limit, as specified by the $SPACES_i$ variable. Two holidays were included in the survey effort: the Fourth of July weekend and the Labor Day Weekend. To test for the effect of holiday on parking demand, a dummy variable, $HOLIDAY_d$, was generated equal to 1 if the day is July 4 or 5, or August 30 or 31, days corresponding to the Fourth of July and Labor Day holidays.

To account for fixed effects in the model, beach-specific dummy variables, DB00, DB09, that shift the intercept were generated for nine beaches. The dummy for beach 10 is omitted to avoid a dummy variable trap. Observe that beach 08 is omitted from the whole analysis. Dummy variables capturing time of day effects were constructed as follows: if $t = 9\text{am}-11\text{am}$, $DMORN = 1$, $DMORN = 0$ otherwise; if $t = 3\text{pm}-5\text{pm}$, $DAFTN = 1$, $DAFTN = 0$ otherwise. Note that potential dummy variable $DMID = 1$ when $t = 12\text{noon}-2\text{pm}$ is omitted to avoid the dummy variable trap. Under this specification, with all dummy variables set to zero, the regression predicts uncensored FILLEDSP (dependent variable) at midday on a non-holiday weekend day on beach 10 (Atlantic Beach). Setting one of the various dummy variables to the value "1" adjusts the

regression predictions for an alternative time of day or an alternative beach destination. Table A1 summarizes key statistics for the survey data sample.

Variable	Description	Mean	Std.Dev.	Minimum	Maximum
FILLEDSP	Filled Parking Spaces	2.5666	2.2871	0	9.09
STAYTIME	Stay Time at beach	4.339445	1.318575	0.1875	9.5
HOLIDAY	Holiday {Fourth of July and Labor Day}	0.532934	0.49929	0	1
TRIPINDX	Trip index	428.956	255.16	146	924
DMORN	Day time dummy variable	0.377246	0.48506	0	1
DAFTN	Afternoon time dummy variable	0.211078	0.408379	0	1
DB00	Caswell Beach	0.0329	0.178598	0	1
DB01	Oak Island Beach	0.0449	0.207262	0	1
DB02	Holden Beach	0.0404	0.197088	0	1
DB03	North Topsail Beach	0.0449	0.207262	0	1
DB04	Surf City Beach	0.0404	0.197088	0	1
DB05	Topsail Beach	0.0404	0.197088	0	1
DB06	Pine Knoll Shores Beach	0.0389	0.193554	0	1
DB08	Indian Beach	0.0404	0.197088	0	1
DB09	Emerald Isle Beach	0.0434	0.203938	0	1

Notes: Only aggregate statistics are reported in table. The descriptive statistics for the 10 individual beaches are not presented to economize on space.

Table A1. Summary statistics of survey data.

It is likely that some visitors may not use the beach because parking capacity is limited. Suppose that out of 500 potential beach visitors, 200 are unable to use the beach because they cannot find parking space. One strategy of dealing with this difficulty is to ignore or drop these observations from the sample. However, by eliminating this subset from the sample not only do we lose degrees of freedom and therefore precision, we also risk biased estimates of the effects of independent variables. That is, important factors correlated with the dependent variable may characterize this group of visitors that has been dropped. In situations such as these, a better strategy that allows use of the entire sample is to assume that the dependent variable FILLEDSP (number of parking spaces filled at a give beach) has a censored distribution; that is, the dependent variable cannot be observed above or below some threshold value, and therefore is reported as this threshold value.

The underlying model of censored regression assumes that the true value of the dependent variable is unobservable. The basic form of the censored regression model is given by the latent variable formulation:

$$Y_i^* = X_i' \beta + \varepsilon_i \quad (1)$$

Where y_i^* is the latent variable, X_i' is a vector of exogenous variables and ε_i is a normal error term with zero mean and standard deviation σ .

Define the censored random variable Y_i as

$$y_i = 0 \text{ if } y_i^* \leq 0$$

$$y_i = y_i^* \text{ if } y_i^* > 0$$

The dependent variable of the censored regression model is observed when $y_i^* > 0$. With the survey we can obtain the observable response (y_i) which represents the unobservable outcome of a particular range.

When the range of dependent variable is limited, censored regression methodology are used to analyze the data. Given the censored nature of the dependent variable, performing OLS on equation (1) will result in inconsistent coefficient estimates. To account for censored dependent variable and to obtain consistent estimates of the parameters, we estimate a censored regression within a maximum likelihood Tobit model.

The Tobit regression model (with upper and lower tail censoring) is specified as:

$$\begin{aligned} \text{Ln}(\text{FILLEDSP}_{idt}) = & \beta_0 + \beta_1 \text{DMORN} + \beta_2 \text{DAFTN} + \beta_3 \text{DB00} + \dots \beta_{11} \text{DB09} \\ & + \beta_{12} \text{STAYTIME}_{id} + \beta_{13} \text{HOLIDAY}_d + \beta_{14} \text{TRIPINDX}_i + e_{idt} \end{aligned} \quad (2)$$

If $\text{Ln}(\text{FILLEDSP}_{idt}) \leq 0$, then $\text{Ln}(\text{FILLEDSP}_{idt}) = 0$,

If $\text{Ln}(\text{FILLEDSP}_{idt}) \geq \text{Ln}(\text{SPACES}_i)$, then $\text{Ln}(\text{FILLEDSP}_{idt}) = (\text{SPACES}_i)$,

where:

FILLEDSP, STAYTIME, SPACES, HOLIDAY, DMORN, DAFTN, DB00...DB9, and TRIPINDX are variables defined above, e_{idt} is a heteroskedastic error term. The error term is specified as $e_{idt} \sim N(0, \sigma^2 \cdot \exp(\alpha \cdot \text{TRIPIND}_i))$, where σ (the standard deviation of the uncensored dependent variable in the absence of heteroskedasticity), α and $\beta_0 - \beta_{14}$ are the parameters to be estimated.

Parameters of the distribution of the latent dependent variable are estimated by maximum likelihood in LIMDEP (2002). The Tobit regression model estimates the probability distribution of FILLEDSP, including the number of FILLEDSP that would occur if the number of parking spaces were not constrained. The resulting probability distribution can be used to estimate parking requirements beyond current parking space capacity.

Results:

Projected Annual Visitation

As state population increases, the number of visitors to Bogue Banks is expected to increase, assuming that the number of trips per household remains constant. Table A1 shows baseline annual visitation to each of the towns in future years, as well as with various changes in beach width.

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
NC State Govt projections of households in telephone survey area	1,800,076	1,826,960	1,854,353	1,881,535	1,929,183	1,957,774	1,987,225	2,016,205	2,042,055	2,068,172	2,094,974
EMERALD ISLE											
Baseline Trips to this beach	986,726	1,001,463	1,016,478	1,031,378	1,057,497	1,073,169	1,089,314	1,105,199	1,119,369	1,133,685	1,148,377
Trips w. -50 width	875,400	888,474	901,796	915,015	938,186	952,091	966,413	980,506	993,078	1,005,779	1,018,813
Trips w. +50 width	1,112,210	1,128,820	1,145,745	1,162,540	1,191,980	1,209,646	1,227,843	1,245,749	1,261,721	1,277,858	1,294,417
Trips w. +100 width	1,253,651	1,272,374	1,291,452	1,310,382	1,343,566	1,363,478	1,383,990	1,404,172	1,422,176	1,440,365	1,459,030
Trips w. +150 width	1,413,080	1,434,184	1,455,687	1,477,026	1,514,430	1,536,874	1,559,994	1,582,743	1,603,036	1,623,538	1,644,578
INDIAN BEACH & SALTER PATH											
Baseline Trips to this beach	158,483	160,850	163,262	165,655	169,850	172,367	174,960	177,512	179,788	182,087	184,447
Trips w. -50 width	140,603	142,703	144,842	146,965	150,687	152,920	155,221	157,484	159,504	161,543	163,637
Trips w. +50 width	178,638	181,306	184,024	186,722	191,450	194,288	197,210	200,086	202,652	205,244	207,903
Trips w. +100 width	201,356	204,363	207,427	210,468	215,797	218,996	222,290	225,532	228,423	231,345	234,343
Trips w. +150 width	226,962	230,352	233,806	237,233	243,241	246,846	250,559	254,213	257,472	260,765	264,144
PINE KNOLL SHORES											
Baseline Trips to this beach	193,522	196,412	199,357	202,279	207,401	210,475	213,641	216,757	219,536	222,344	225,225
Trips w. -50 width	171,688	174,252	176,865	179,457	184,002	186,729	189,538	192,302	194,767	197,258	199,814
Trips w. +50 width	218,132	221,390	224,709	228,003	233,777	237,242	240,811	244,322	247,455	250,620	253,867
Trips w. +100 width	245,872	249,544	253,286	256,999	263,507	267,412	271,435	275,393	278,924	282,491	286,152
Trips w. +150 width	277,140	281,279	285,496	289,681	297,017	301,419	305,954	310,415	314,395	318,416	322,543
ATLANTIC BEACH											
Baseline Trips to this beach	871,446	884,461	897,722	910,881	933,949	947,790	962,048	976,077	988,592	1,001,236	1,014,211
Trips w. -50 width	773,126	784,673	796,438	808,113	828,577	840,857	853,506	865,953	877,055	888,273	899,784
Trips w. +50 width	982,269	996,939	1,011,887	1,026,720	1,052,720	1,068,322	1,084,393	1,100,207	1,114,313	1,128,564	1,143,189
Trips w. +100 width	1,107,186	1,123,722	1,140,570	1,157,289	1,186,596	1,204,182	1,222,297	1,240,122	1,256,021	1,272,085	1,288,571
Trips w. +150 width	1,247,988	1,266,627	1,285,618	1,304,463	1,337,497	1,357,319	1,377,738	1,397,830	1,415,752	1,433,858	1,452,440

Table A2. Projected annual visitation at Bogue Banks communities.

Total visits include both day and overnight visitors. For instance, about 52% of the visitation at Atlantic Beach is from day visitors, as compared to about 35% of the visitation at Emerald Isle. This leads to greater peak parking needs at Atlantic Beach, despite there being more overall visitation at Emerald Isle.

Projected Parking Needs

Estimates of the beach parking demand model using the two-limit Tobit regression estimation procedure is shown in Table A2.

Explanatory Variables	Coefficient	Std. Error.	t-ratio	P-value	Mean
Constant	4.557***	0.506	9.00	0	1
DMORN	-0.666	0.488	-1.36	0.1727	0.3772
DAFTN	-0.307	0.490	-0.63	0.5311	0.2111
DB00	-0.518	0.567	-0.92	0.3601	0.0329
DB01	0.699	0.512	1.37	0.1723	0.0449
DB02	-0.379	0.527	-0.719	0.4722	0.0404
DB03	0.166	0.595	0.279	0.7803	0.0449

DB04	-0.706	0.564	-1.252	0.2105	0.0404
DB05	-0.101	0.543	-0.186	0.8521	0.0404
DB06	-0.262	0.5577	-0.47	0.6383	0.0389
DB07	-0.946*	0.5378	-1.76	0.0785	0.0404
DB09	-1.271**	0.5544	-2.293	0.0218	0.0434
STAYTIME	0.008	0.0206	0.362	0.7175	4.339
HOLIDAY	0.364***	0.0536	6.78	0	0.5329
TRIPINDX	0.003***	0.00018	12.6	0	428.656
Sigma	0.451***	0.0161	28.023	0	----
Alpha	0.0007***	0.000067	10.992	0	----
Log-likelihood	-623.66				

Notes: ***, **, and * refer to significance at the 1%, 5%, and 10% levels, respectively. The chi-square and overall likelihood ratio statistics are 29.1 and 546.7, respectively. Number of observations =699. Dependent variable: FILLEDSP. D13 is the omitted time of day dummy variable.

Table A3. Tobit regression results - Dependent Variable: FILLEDSP

As expected the coefficient on the beach specific index of recreation demand, TRIPINDX, is positive and strongly significant. The large t statistic, 12.6, allows us to reject the null hypothesis of no trip demand at the 1% level of significance. This provides evidence that beach trip demand impacts the number of parking spaces. The heteroskedasticity parameter α is positive and strongly significant, indicating that larger values of TRIPINDX increase the variance of $\ln(\text{FILLEDSP})$. There is evidence to indicate that HOLIDAY has a positive and significant effect on filled spaces. We also find evidence that STAYTIME has a positive but insignificant effect on filled spaces. Fixed effects dummy variables DB00...DB09 vary in sign, reflecting differences in the estimated value of filled parking spaces, $\ln(\text{FILLEDSP})$, at midday across beaches. However, after controlling for other variables in the regression, only DB07 and DB09 are statistically significant at the 10% and 5% level, respectively. There is no evidence to indicate that this data suggests that time of day variables, DMORN and DAFTN, significantly impact beach-parking demand. In all, the explanatory power of the regression is reasonably good given the individual cross section data. The likelihood ratio test indicates that the overall regression is significant at $p < 0.01$.

As mentioned earlier, an important component of this analysis was to determine parking spaces that would be required to accommodate all peak (weekend holiday) day beach visitors. With the estimated Tobit coefficients, it is possible to calculate the number of spaces that would be required to accommodate all peak (weekend holiday) day beach visitors 60% of the time, 95% of the time, etc. For each beach, $\ln(\text{FILLEDSP}_i)$ follows a normal distribution, with a beach-specific mean value given by the Tobit regression equation (with variables replaced by their mean values), and a beach-specific standard deviation given by $(\sigma^2 \cdot \exp[\alpha \cdot \text{TRIPINDX}_i])^{0.5}$. The unconditional mean of $\ln(\text{FILLEDSP}_i)$, denoted $\bar{\mu}$, is given by: $\bar{\mu} = \beta_0 + \beta_1 \text{DMORN} + \beta_2 \text{DAFTN} + \beta_3 \text{DB00} + \dots + \beta_{11} \text{DB09} + \beta_{12} \text{STAYTIME}_{id} + \beta_{13} \text{HOLIDAY}_d + \beta_{14} \text{TRIPINDX}_i$,

where mean values are inserted for independent variables. The standard deviation of $\ln(\text{FILLEDSP}_i)$, denoted SD , is given by: $\text{SD} = (\sigma^2 \cdot \exp[\alpha \cdot \text{TRIPINDX}_i])^{0.5}$. The unconditional 90 percentile, for example, of FILLEDSP_i is then given by: 90 percentile $\text{FILLEDSP}_i = \text{EXP}(\text{NORMINV}(0.90, \bar{\mu}, \text{SD}))$, where NORMINV is the inverse normal cumulative distribution function.

For each beach, the frequency of FILLEDSP can be graphed against FILLEDSP to determine the number of spaces that would be necessary to accommodate all peak (weekend holiday) day beach visitors 60% of the time, 95% of the time, etc. Furthermore, changes in beach conditions may shift the frequency distribution of FILLEDSP . An increase in beach width attracts additional beach visitation, which shifts the frequency distribution to the right. As the distribution shifts to the right, the current number of parking spaces accommodates all visitors less frequently.

Tables A3-A6 shows the number of parking spaces needed to meet peak demand at each of the Bogue Banks communities 60%, 70%, 80%, 90% and 95% of the time at future years with the various beach width increases associated with the Recommended Plan.

The average change in beach width at each of the communities, as compared to the without project condition, is as follows:

Emerald Isle: +6 ft

Salter Path and Indian Beach: +26 ft

Pine Knoll Shores: +21 ft

Atlantic Beach: +54 ft

The project year of project construction is 2019. Having sufficient parking to meet peak demand 60% of the time at the start of project construction is considered sufficient for satisfying the USACE requirement for accommodating peak demand.

USACE		EMERALD ISLE Parking Space Requirements, with +6 ft beach width									
Telephone Survey											
Region											
Population											
	Index		Mean	Std. Dev.	Mean	60%tile	70%tile	80%tile	90%tile	95%tile	
Year	(2004 Base)	TRIPINDX	ln(FILLEDSP)	ln(FILLEDSP)	FILLEDSP	0.6	0.7	0.8	0.9	0.95	
2013	1.142909226	1072	6.11E+00	0.674463107	448	532	638	791	1064	1359	
2014	1.158993672	1087	6.14E+00	0.678298367	464	551	662	821	1106	1415	
2015	1.175403086	1103	6.17E+00	0.682233588	480	571	687	853	1151	1475	
2016	1.191880291	1118	6.21E+00	0.686208039	497	592	713	886	1198	1538	
2017	1.208539311	1134	6.24E+00	0.690249885	515	614	740	921	1248	1604	
2018	1.225643369	1150	6.28E+00	0.694424477	534	637	769	959	1301	1674	
2019	1.243302456	1166	6.32E+00	0.698761028	555	662	800	999	1358	1751	
2020	1.260632105	1182	6.36E+00	0.703043004	575	688	832	1040	1417	1829	
2021	1.275861877	1197	6.39E+00	0.706827781	594	711	861	1077	1470	1901	
2022	1.291205705	1211	6.42E+00	0.710661507	614	735	891	1117	1527	1976	
2023	1.306920061	1226	6.45E+00	0.714609364	635	761	923	1158	1586	2057	

Table A4. Peak parking demand requirements for +6 ft beach width at Emerald Isle.

USACE		INDIAN BEACH & SALTER PATH Requirements, with +26 ft beach width									
Telephone Survey											
Region											
Population											
	Index		Mean	Std. Dev.	Mean	60%tile	70%tile	80%tile	90%tile	95%tile	
Year	(2004 Base)	TRIPINDX	ln(FILLEDSP)	ln(FILLEDSP)	FILLEDSP	0.6	0.7	0.8	0.9	0.95	
2013	1.142909226	181	4.41E+00	0.482447833	82	93	106	123	153	182	
2014	1.158993672	183	4.42E+00	0.482908849	83	93	107	124	154	183	
2015	1.175403086	186	4.42E+00	0.483379634	83	94	107	125	155	184	
2016	1.191880291	188	4.43E+00	0.483852826	84	95	108	126	156	185	
2017	1.208539311	191	4.43E+00	0.48433171	84	95	109	127	157	187	
2018	1.225643369	194	4.44E+00	0.484823881	85	96	109	127	158	188	
2019	1.243302456	196	4.45E+00	0.485332547	85	96	110	128	159	189	
2020	1.260632105	199	4.45E+00	0.485832242	86	97	111	129	160	191	
2021	1.275861877	202	4.46E+00	0.486271813	86	98	111	130	161	192	
2022	1.291205705	204	4.46E+00	0.486715078	87	98	112	131	162	193	
2023	1.306920061	206	4.47E+00	0.487169466	87	99	113	131	163	194	

Table A4. Peak parking demand requirements for +26 ft beach width at Indian Beach and Salter Path.

USACE		PINE KNOLL SHORES Parking Space Requirements, with +21 ft beach width								
Telephone Survey										
Region										
Population										
	Index		Mean	Std. Dev.	Mean	60%tile	70%tile	80%tile	90%tile	95%tile
Year	(2004 Base)	TRIPINDX	ln(FILLEDSP)	ln(FILLEDSP)	FILLEDSP	0.6	0.7	0.8	0.9	0.95
2013	1.142909226	218	5.18E+00	0.489335203	178	201	230	268	333	398
2014	1.158993672	221	5.19E+00	0.489900521	179	203	232	270	335	401
2015	1.175403086	225	5.19E+00	0.490477933	180	204	233	273	338	404
2016	1.191880291	228	5.20E+00	0.491058415	182	206	235	275	341	407
2017	1.208539311	231	5.21E+00	0.491646001	183	207	237	277	344	411
2018	1.225643369	234	5.22E+00	0.492250016	184	209	239	279	346	414
2019	1.243302456	237	5.22E+00	0.492874409	186	210	240	281	349	418
2020	1.260632105	241	5.23E+00	0.493487925	187	212	242	283	352	421
2021	1.275861877	244	5.24E+00	0.494027729	188	213	244	285	355	424
2022	1.291205705	247	5.24E+00	0.494572173	190	215	246	287	357	428
2023	1.306920061	250	5.25E+00	0.495130387	191	216	247	290	360	431

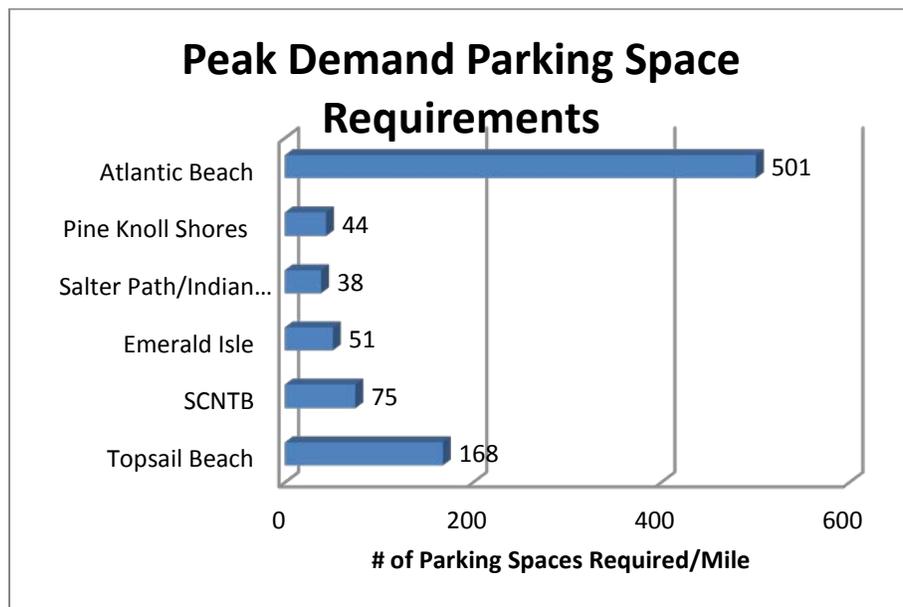
Table A5. Peak parking demand requirements for +21 ft beach width at Pine Knoll Shores.

USACE		ATLANTIC BEACH Parking Space Requirements, with +54 ft beach width								
Telephone Survey										
Region										
Population										
	Index		Mean	Std. Dev.	Mean	60%tile	70%tile	80%tile	90%tile	95%tile
Year	(2004 Base)	TRIPINDX	ln(FILLEDSP)	ln(FILLEDSP)	FILLEDSP	0.6	0.7	0.8	0.9	0.95
2013	1.142909226	1062	7.35E+00	0.671860737	1563	1854	2224	2752	3698	4721
2014	1.158993672	1077	7.39E+00	0.675644439	1617	1919	2305	2856	3844	4914
2015	1.175403086	1092	7.42E+00	0.679526545	1674	1988	2391	2966	3999	5119
2016	1.191880291	1107	7.46E+00	0.683447134	1733	2060	2480	3080	4161	5333
2017	1.208539311	1123	7.49E+00	0.68743398	1795	2136	2574	3201	4331	5560
2018	1.225643369	1139	7.53E+00	0.691551531	1860	2217	2674	3329	4513	5802
2019	1.243302456	1155	7.57E+00	0.695828576	1931	2303	2781	3468	4710	6064
2020	1.260632105	1171	7.60E+00	0.700051546	2002	2391	2890	3609	4911	6333
2021	1.275861877	1185	7.63E+00	0.703783963	2067	2471	2990	3738	5095	6579
2022	1.291205705	1200	7.67E+00	0.707564455	2135	2554	3094	3873	5287	6837
2023	1.306920061	1214	7.70E+00	0.71145729	2207	2643	3205	4016	5492	7112

Table A6. Peak parking demand requirements for +54 ft beach width at Atlantic Beach.

Review of the results for Atlantic Beach indicated the need to adjust these figures to a number more reasonable for this segment of the study area. Though the model makes valid assumptions to project parking demand, it is important to ground truth the results throughout the project area to assess whether the outputs are “reasonable” and implementable. As stated above, when comparing Atlantic Beach parking requirements to those projected for other towns, the total number of parking spaces required is not considered “reasonable.” As evident in Table A7, the peak demand parking space requirements (i.e. spaces/mile) for Atlantic Beach are significantly higher than estimates for other towns within and outside of the study area (i.e. 501 spaces per mile vs. an average of 75 per mile for five other beach communities in NC).

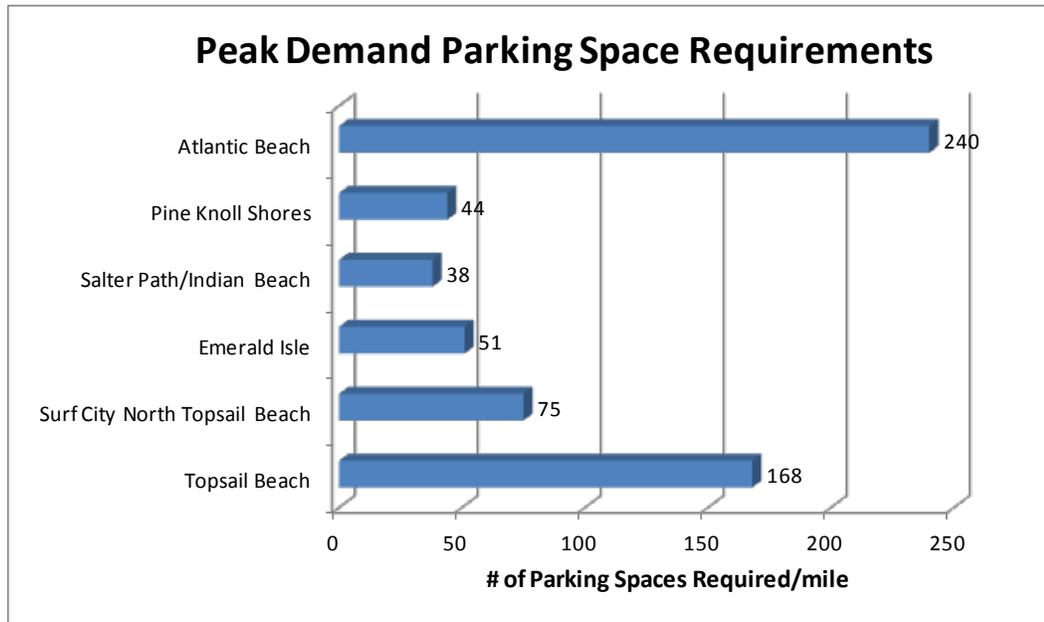
Table A7. Initially-projected peak demand parking space requirements for Atlantic Beach relative to adjacent towns within the Bogue Banks study area as well as two previously approved projects at Topsail Beach and SCNTB.



The Wilmington District then re-coordinated with the model developer regarding the high peak demand parking requirements at Atlantic Beach compared to other Towns. The discrepancy with Atlantic Beach parking numbers is based on the two main variables relative to the surveys that were conducted: STAY TIME and Percentage of overnight visitors relative to day trippers. The difference in STAYTIME across the beaches explained a small amount of the difference in parking space needs (Atlantic Beach has a longer average STAYTIME, and hence its parking spaces do not cycle as quickly as parking spaces in Emerald Isle, but the effect is relatively small). The primary difference is associated with the percentage of day users versus overnight visitors across beaches. From the on-site beach visitor survey data (as opposed to the telephone survey, which only collected day/overnight visitation data by county, rather than by beach), it was found that the percentage of beach visitors staying overnight at Atlantic Beach was only 48% whereas the percentage staying overnight at Emerald Isle was 65.4%. If one takes the predicted number of visits to Atlantic Beach in 2009 (1,084,000 visits) and multiplies by the percentage of day trips (1-0.48), you get 564,096 predicted day trips--these are the trips that need the public parking spaces, because the overnight trips use primarily private condo/cottage/hotel parking lots. Similarly, if one takes the predicted number of visits to Emerald Isle in 2009 (1,228,000 visits) and multiplies by the percentage of day trips (1-0.654), you get 424,753 predicted day trips. So, when one accounts for the difference in the percentages of overnight vs. day trips between the beaches, one finds more day trips taken to Atlantic Beach (even though fewer overall trips) compared to Emerald Isle and, therefore, a larger number of parking spaces needed at Atlantic Beach to accommodate the larger number of day trips.

Wilmington District found that a required geographical distribution of 10 parking spaces within $\frac{1}{4}$ mile of each $\frac{1}{2}$ mile beach access in addition to the 1,011 spaces that already exist, results in a total of ~1100 (~240 spaces per mile) parking spaces to satisfy peak demand requirements. Though reduced from the originally projected total of 2,303 spaces required, this adjusted total number of spaces would still be over three times the average number of parking spaces per mile (~75) based on projections for other Towns. The Wilmington District believes that the Town of Atlantic Beach's commitment to meet the geographic distribution requirement coupled with the existing number of parking spaces would be consistent with requirements for "reasonable" public access and parking for federal participation in CSDR projects pursuant to ER 1105-2-100 and ER 1165-2-130. The Wilmington District will continue to coordinate with the Sponsor regarding parking and access requirements and update project files as additional parking spaces and accesses are obtained leading up to the signing of the PPA.

Table A8. Projected peak demand parking space requirements for Atlantic Beach relative to adjacent towns within the Bogue Banks study area as well as two previously approved projects at Topsail Beach and SCNTB.



To summarize, the number of spaces needed to meet peak demand with the project in place is as follows (previously indicated in Table 1):

Town	Total Parking Spaces Needed for Peak Demand	Current Parking Spaces	Additional Parking Spaces Needed
Emerald Isle	662	529	133
Salter Path/Indian Beach	96	141	0
Pine Knoll Shores	210	180	30
Atlantic Beach	1,100	1,011*	89
Total	2,068	1,861	252

*Includes 594 parking spots available at Fort Macon State Park

Number of parking spaces needed to meet peak parking requirement, and estimated number of current parking spaces.

Given the relative inordinate number of required spaces the Parking and Access model was producing in Atlantic Beach, the district adopted a 'willingness to pay' approach which employed area and user utility to determine requirements. As well, parameters used to define usage throughout Bogue were incorporated to maintain consistency in visitation accounting with other Bogue towns. The methodology used to determine parking and access requirements in Atlantic Beach is defined by the following:

-Optimized utility for beach use is achieved when the user has a 10 ft by 10 ft area, or 100 sq ft.

-Atlantic Beach has a length of 28,692 ft, multiplied by the design template of 50ft throughout the length of the project, producing a total of 1,435,000 square feet of beach. Additionally, Atlantic Beach will have 27 access points, and it is assumed that not all the area around these access points will be used as utilized beach area, as foot travel around them is assumed to be regular. A 30X30 area was assumed to not be utilized for this purpose. With the subtraction of 900 sq ft per access point, the total utilized beach area is 1,410,700 ($900 \times 27 = 24,300$, $1,435,000 - 24,300 = 1,410,700$).

-This 1,410,700 total was then divided by the 100 sq ft area for optimized user utility, which produces the number of users, on Atlantic beach at any given time, which is 14,107.

-The beach recreation study produced by Dr Dumas et al. indicated that 48% of the users on Atlantic beach are overnight visitors and 52% day use visitors. This 52% usage translates to 7,336 day users on the beach ($14,107 \times .52 = 7,336$) that would require parking and access.

-Peak usage is assumed to be weekend and holiday usage. At this time, it is assumed that beach day users will travel with family or friends, at an average of 4 occupants per vehicle. If it is assumed that 7,336 day users are traveling at an average of 4 per automobile, then it is assumed that 1,834 automobiles will be used to transport day users to Atlantic Beach.

-The assumption in the recreation study, and that which was applied to the other beaches on Bogue Banks, is that this value will be only met 60% during the peak demand times, producing a total of 1,100 ($1,834 \times .6 = 1,100$) automobiles used to transport day users on Atlantic Beach. Attachment II, Parking and Access of Appendix B demonstrates this as a consistent approach throughout the study, stating that "Having sufficient parking to meet peak demand 60% of the time at the start of project construction is considered sufficient for satisfying the USACE requirement for accommodating peak demand."

ATTACHMENT 3

SUPPORTING DATA

Bogue Banks Interior Lot Comparisons		
	Structure	Land
El		
9807 Sandy Court	\$644,219	\$737,986
9421 Ocean Drive	\$329,111	\$803,997
9313 Ocean Drive	\$169,732	\$616,355
105 Janell LN	\$577,853	\$621,945
8619 Ocean View Dr	\$667,872	\$649,080
7515 Ocean Dr	\$230,871	\$660,960
7211 Ocean Dr	\$183,327	\$660,960
6205 Ocean Drive	\$170,030	\$649,080
5803 Ocean Drive	\$1,000,923	\$649,080
3107 Ocean Drive	\$1,564,822	\$649,080
Indian Beach		
1829 Salter Path Rd	\$177,000	\$705,280
713 Salter Path Rd	\$300,317	\$636,272
Salter Path		
193 Hoffman Beach Road	\$212,972	\$797,355
127 Sea Isle Dr	\$1,179,847	\$773,258
PKS		
607 Forest Dunes Dr	\$778,136	\$1,111,388
461 Maritime Pl	\$690,081	\$832,200
105 Ocean Shore Ln	\$527,878	\$621,340
115 Dogwood Circle	\$265,510	\$936,709
215 Salter Path Rd	\$1,052,502	\$744,876
13 Pinewood St	\$225,531	\$628,140
AB		

Average Price For Rebuild in 28594 is \$193/sf

Lot values
avg. \$669,852

Average Price For Rebuild in IB is \$274/sf

Lot Values
avg \$670,776

Average Price for Rebuild in SP is \$321/sf

Lot Values
avg \$785,306

Average Price for Rebuild in PKS is \$154/sf

Lot Values
avg \$812,442

1007 Ocean Ridge Dr	\$679,285	\$1,110,037	Average Price for Rebuild in AB is \$137/sf Lot Values avg \$791,513
204 Club Colony Dr	\$223,401	\$642,813	
200 Ocean Blvd	\$493,389	\$621,690	

Summary of Net Benefits, By Alternative, (For Alternative Screening) at 4.125%

Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)	Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)
1	\$94,053	\$33,643	\$5,524	\$28,119	60	\$1,891	\$26,564	\$24,948	\$1,616
2	\$75,627	\$40,007	\$3,892	\$36,115	61	\$22,799	\$34,216	\$24,804	\$9,412
3	\$106,873	\$29,997	\$6,408	\$23,588	62	\$218,802	\$454,227	\$24,015	\$430,213
4	\$108,457	\$50,410	\$5,040	\$45,369	63	\$3,829	\$47,753	\$40,161	\$7,592
5	\$231,654	\$28,324	\$8,668	\$19,655	64	\$5,803	\$14,225	\$10,954	\$3,271
6	\$194,152	\$74,289	\$7,311	\$66,977	65	\$39,412	\$23,034	\$5,028	\$18,005
7	\$83,838	\$25,750	\$11,340	\$14,411	66	\$1,932	\$50,158	\$46,422	\$3,737
8	\$34,277	\$41,113	\$15,745	\$25,368	67	\$204	\$16,438	\$14,891	\$1,547
9	\$51,665	\$27,887	\$13,145	\$14,742	68	\$53,109	\$19,521	\$17,648	\$1,873
10	\$24,965	\$16,300	\$8,582	\$7,718	69	\$117,845	\$61,246	\$46,121	\$15,125
11	\$49,311	\$44,155	\$9,396	\$34,758	70	\$225,447	\$187,538	\$29,666	\$157,872
12	\$56,341	\$73,164	\$14,939	\$58,225	71	\$100,327	\$74,011	\$37,855	\$36,156
13	\$114,164	\$84,290	\$23,531	\$60,759	72	\$65,677	\$59,582	\$33,702	\$25,880
14	\$93,926	\$79,664	\$15,878	\$63,786	73	\$27,884	\$29,883	\$22,591	\$7,293
15	\$247,896	\$123,740	\$15,920	\$107,820	74	\$238	\$40,873	\$38,591	\$2,282
16	\$31,230	\$35,610	\$14,572	\$21,038	75	\$3,783	\$21,090	\$20,778	\$312
17	\$30,183	\$79,132	\$18,883	\$60,249	76	\$15,633	\$66,912	\$7,782	\$59,131
18	\$3,116	\$37,010	\$20,073	\$16,937	77	\$9,524	\$17,678	\$24,815	(\$7,137)
19	\$4,988	\$37,600	\$18,380	\$19,220	78	\$256,956	\$823,541	\$34,444	\$789,097
20	\$7,685	\$55,160	\$17,082	\$38,077	79	\$16,460	\$144,648	\$38,104	\$106,544
21	\$1,181	\$24,744	\$3,463	\$21,281	80	\$267,192	\$91,208	\$21,234	\$69,974
22	\$166,848	\$3,517	\$2,990	\$528	81	\$5,308	\$49,187	\$37,327	\$11,861
23	\$0	\$0	\$2,645	(\$2,645)	82	\$4,208	\$35,032	\$32,902	\$2,130
24	\$2,945	\$4,105	\$2,226	\$1,879	83	\$14,010	\$179,163	\$60,227	\$118,936
25	\$30	\$1,099	\$2,965	(\$1,866)	84	\$12,734	\$144,054	\$58,756	\$85,298
26	\$293	\$947	\$2,304	(\$1,357)	85	\$3,694	\$101,636	\$68,667	\$32,969
27	\$4,626	\$7,211	\$4,253	\$2,958	86	\$26,735	\$79,370	\$76,668	\$2,702
28	\$1,891	\$9,546	\$2,804	\$6,742	87	\$146,458	\$299,945	\$102,160	\$197,785
29	\$234	\$2,531	\$1,645	\$886	88	\$208	\$43,198	\$53,408	(\$10,209)
30	\$8,271	\$15,004	\$6,160	\$8,843	89	\$216,996	\$226,652	\$40,492	\$186,159
31	\$428	\$8,120	\$6,261	\$1,858	90	\$3,691	\$82,827	\$48,522	\$34,305
32	\$1,400	\$11,083	\$6,267	\$4,816	91	\$15,785	\$84,952	\$57,715	\$27,237
33	\$721	\$11,098	\$7,161	\$3,937	92	\$587,952	\$271,195	\$94,080	\$177,115
34	\$344	\$6,732	\$4,843	\$1,889	93	\$393,343	\$993,236	\$50,056	\$943,180
35	\$2,452	\$30,225	\$10,206	\$20,019	94	\$73,221	\$47,728	\$34,696	\$13,032
36	\$5,414	\$6,813	\$4,549	\$2,265	95	\$131,660	\$26,001	\$19,985	\$6,016
37	\$57,390	\$18,559	\$8,336	\$10,223	96	\$115,749	\$24,193	\$16,245	\$7,948
38	\$22,367	\$20,063	\$7,501	\$12,562	97	\$174,293	\$33,508	\$17,120	\$16,388
39	\$31,827	\$21,699	\$5,555	\$16,144	98	\$128,270	\$39,933	\$29,000	\$10,933
40	\$64,438	\$125,138	\$9,880	\$115,257	99	\$106,891	\$28,528	\$18,777	\$9,751
41	\$51,196	\$22,629	\$9,375	\$13,254	100	\$108,541	\$50,601	\$24,471	\$26,130
42	\$9,991	\$19,785	\$8,199	\$11,586	101	\$84,097	\$82,372	\$30,451	\$51,922
43	\$33,102	\$90,552	\$54,741	\$35,811	102	\$82,107	\$33,189	\$23,345	\$9,845
44	\$25,977	\$69,641	\$44,778	\$24,863	103	\$175,400	\$50,821	\$25,420	\$25,401
45	\$4,283	\$103,055	\$72,513	\$30,542	104	\$115,803	\$38,720	\$19,320	\$19,400
46	\$13,875	\$68,193	\$38,969	\$29,224	105	\$61,269	\$24,281	\$16,927	\$7,354
47	\$26,937	\$61,839	\$36,426	\$25,413	106	\$119,705	\$194,042	\$8,062	\$185,980
48	\$12,314	\$49,073	\$35,374	\$13,700	107	\$57,053	\$73,417	\$14,839	\$58,577
49	\$18,477	\$50,283	\$32,619	\$17,664	108	\$73,586	\$27,627	\$19,422	\$8,205
50	\$12,918	\$31,163	\$22,776	\$8,386	109	\$65,211	\$36,187	\$25,517	\$10,670
51	\$0	\$9,083	\$12,311	(\$3,228)	110	\$68,964	\$45,066	\$31,067	\$13,999
52	\$1,406	\$37,264	\$48,123	(\$10,858)	111	\$121,794	\$73,249	\$49,676	\$23,573
53	\$18	\$50,068	\$62,630	(\$12,562)	112	\$121,259	\$94,189	\$86,146	\$8,043
54	\$1,656	\$42,265	\$15,341	\$26,924	113	\$55,102	\$66,686	\$57,885	\$8,801
55	\$2,965	\$73,850	\$39,238	\$34,612	114	\$77,765	\$142,381	\$61,030	\$81,351
56	\$0	\$25,754	\$39,489	(\$13,735)	115	\$168,827	\$424,628	\$65,836	\$358,792
57	\$0	\$8,899	\$13,022	(\$4,123)	116	\$176,006	\$683,338	\$53,686	\$629,651
58	\$0	\$23,526	\$33,383	(\$9,857)	117	\$123,238	\$143,427	\$64,334	\$79,093
59	\$12	\$38,868	\$38,733	\$135	Total	\$7,704,309	\$9,600,177	\$3,173,156	\$6,427,021

Average annual remaining damages, costs and benefits by reach for Alternative 1.

Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)	Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)
1	\$93,839	\$33,857	\$6,205	\$27,653	60	\$1,827	\$26,628	\$27,674	(\$1,046)
2	\$75,599	\$40,035	\$4,381	\$35,654	61	\$20,774	\$36,241	\$27,821	\$8,421
3	\$106,852	\$30,018	\$7,214	\$22,803	62	\$187,296	\$485,733	\$27,312	\$458,421
4	\$108,520	\$50,346	\$5,689	\$44,657	63	\$3,600	\$47,983	\$44,956	\$3,027
5	\$231,522	\$28,456	\$9,686	\$18,770	64	\$6,239	\$13,790	\$12,338	\$1,452
6	\$195,878	\$72,563	\$8,195	\$64,367	65	\$34,406	\$28,039	\$5,642	\$22,397
7	\$83,018	\$26,570	\$13,783	\$12,787	66	\$1,864	\$50,226	\$51,801	(\$1,575)
8	\$33,169	\$42,221	\$18,573	\$23,648	67	\$149	\$16,492	\$16,691	(\$199)
9	\$50,887	\$28,666	\$15,707	\$12,959	68	\$51,666	\$20,964	\$19,697	\$1,268
10	\$24,996	\$16,269	\$10,237	\$6,032	69	\$101,607	\$77,485	\$51,374	\$26,111
11	\$39,645	\$53,821	\$11,844	\$41,977	70	\$198,333	\$214,652	\$33,405	\$181,247
12	\$43,833	\$85,672	\$18,923	\$66,749	71	\$94,756	\$79,582	\$42,253	\$37,329
13	\$100,100	\$98,354	\$28,488	\$69,866	72	\$62,606	\$62,653	\$37,769	\$24,884
14	\$85,418	\$88,172	\$19,932	\$68,240	73	\$26,908	\$30,860	\$25,368	\$5,492
15	\$220,434	\$151,201	\$20,688	\$130,513	74	\$238	\$40,873	\$44,036	(\$3,163)
16	\$28,469	\$38,371	\$16,942	\$21,428	75	\$2,443	\$22,430	\$24,986	(\$2,556)
17	\$25,367	\$83,948	\$22,271	\$61,677	76	\$14,003	\$68,543	\$9,465	\$59,078
18	\$2,308	\$37,818	\$23,891	\$13,926	77	\$9,141	\$18,061	\$29,152	(\$11,091)
19	\$3,495	\$39,093	\$22,003	\$17,090	78	\$232,430	\$848,068	\$38,145	\$809,923
20	\$5,895	\$56,950	\$21,911	\$35,039	79	\$11,880	\$149,229	\$42,482	\$106,746
21	\$684	\$25,241	\$5,901	\$19,340	80	\$253,059	\$105,341	\$23,910	\$81,431
22	\$155,328	\$15,037	\$5,269	\$9,769	81	\$4,777	\$49,719	\$41,666	\$8,053
23	\$0	\$0	\$4,706	(\$4,706)	82	\$3,181	\$36,058	\$36,733	(\$675)
24	\$3,885	\$3,164	\$4,360	(\$1,195)	83	\$10,065	\$183,108	\$66,354	\$116,754
25	\$7	\$1,122	\$5,656	(\$4,534)	84	\$8,796	\$147,991	\$64,707	\$83,284
26	\$534	\$706	\$4,584	(\$3,877)	85	\$3,212	\$102,118	\$74,728	\$27,390
27	\$1,962	\$9,876	\$7,503	\$2,373	86	\$28,683	\$77,421	\$83,269	(\$5,848)
28	\$1,606	\$9,831	\$5,164	\$4,667	87	\$121,419	\$324,985	\$110,474	\$214,510
29	\$0	\$2,765	\$2,982	(\$218)	88	\$364	\$43,042	\$58,238	(\$15,196)
30	\$3,975	\$19,300	\$8,873	\$10,427	89	\$199,113	\$244,534	\$44,160	\$200,374
31	\$0	\$8,547	\$9,208	(\$660)	90	\$4,124	\$82,394	\$52,179	\$30,215
32	\$1,141	\$11,343	\$9,036	\$2,307	91	\$14,610	\$86,126	\$61,575	\$24,551
33	\$0	\$11,819	\$10,687	\$1,132	92	\$606,731	\$252,416	\$101,205	\$151,211
34	\$0	\$7,076	\$7,028	\$48	93	\$339,949	\$1,046,630	\$55,150	\$991,480
35	\$1,424	\$31,254	\$14,322	\$16,932	94	\$68,648	\$52,301	\$39,331	\$12,969
36	\$4,468	\$7,759	\$6,793	\$966	95	\$119,050	\$38,611	\$23,632	\$14,979
37	\$46,848	\$29,100	\$12,002	\$17,098	96	\$105,111	\$34,831	\$19,470	\$15,360
38	\$19,829	\$22,601	\$11,105	\$11,495	97	\$156,605	\$51,195	\$21,007	\$30,188
39	\$31,140	\$22,386	\$8,168	\$14,218	98	\$115,311	\$52,891	\$33,621	\$19,270
40	\$52,921	\$136,655	\$14,273	\$122,382	99	\$93,075	\$42,345	\$21,343	\$21,001
41	\$46,522	\$27,304	\$13,590	\$13,713	100	\$95,779	\$63,362	\$27,671	\$35,691
42	\$9,041	\$20,735	\$11,287	\$9,448	101	\$73,110	\$93,359	\$34,777	\$58,582
43	\$21,525	\$102,128	\$62,739	\$39,389	102	\$74,719	\$40,578	\$26,266	\$14,312
44	\$17,021	\$78,597	\$50,201	\$28,396	103	\$158,543	\$67,678	\$28,792	\$38,887
45	\$2,733	\$104,606	\$79,250	\$25,356	104	\$100,251	\$54,273	\$22,673	\$31,600
46	\$8,324	\$73,745	\$43,402	\$30,343	105	\$54,885	\$30,665	\$19,718	\$10,947
47	\$16,356	\$72,420	\$40,909	\$31,511	106	\$104,763	\$208,984	\$9,544	\$199,441
48	\$8,396	\$52,992	\$39,782	\$13,210	107	\$49,976	\$80,494	\$17,525	\$62,969
49	\$10,445	\$58,316	\$37,045	\$21,270	108	\$66,099	\$35,113	\$22,241	\$12,873
50	\$7,347	\$36,734	\$26,230	\$10,504	109	\$56,091	\$45,308	\$28,334	\$16,973
51	\$0	\$9,083	\$14,419	(\$5,336)	110	\$61,470	\$52,560	\$33,703	\$18,857
52	\$941	\$37,729	\$54,548	(\$16,819)	111	\$121,924	\$73,119	\$49,672	\$23,447
53	\$77	\$50,009	\$69,859	(\$19,850)	112	\$121,259	\$94,189	\$86,137	\$8,052
54	\$1,212	\$42,709	\$17,274	\$25,435	113	\$55,102	\$66,686	\$57,835	\$8,851
55	\$2,575	\$74,240	\$43,829	\$30,411	114	\$77,765	\$142,381	\$61,009	\$81,372
56	\$0	\$25,754	\$43,529	(\$17,775)	115	\$168,827	\$424,628	\$65,813	\$358,814
57	\$0	\$8,899	\$14,826	(\$5,927)	116	\$176,267	\$683,077	\$53,672	\$629,405
58	\$0	\$23,526	\$38,635	(\$15,109)	117	\$123,237	\$143,429	\$64,338	\$79,091
59	\$0	\$38,881	\$43,257	(\$4,377)	Total	\$7,095,623	\$10,208,864	\$3,563,636	\$6,645,228

Average annual remaining damages, costs and benefits by reach for Alternative 2.

Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)	Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)
1	\$43,528	\$84,168	\$9,705	\$74,462	60	\$1,805	\$26,650	\$33,388	(\$6,737)
2	\$34,970	\$80,664	\$6,818	\$73,847	61	\$19,398	\$37,618	\$34,739	\$2,878
3	\$46,606	\$90,264	\$11,222	\$79,042	62	\$165,083	\$507,947	\$34,918	\$473,029
4	\$49,241	\$109,626	\$8,859	\$100,766	63	\$3,715	\$47,868	\$56,001	(\$8,133)
5	\$102,480	\$157,498	\$15,105	\$142,393	64	\$5,817	\$14,211	\$15,559	(\$1,347)
6	\$95,037	\$173,404	\$12,561	\$160,843	65	\$27,534	\$34,911	\$7,083	\$27,829
7	\$39,268	\$70,320	\$27,394	\$42,926	66	\$1,686	\$50,404	\$63,469	(\$13,065)
8	\$18,980	\$56,410	\$31,436	\$24,974	67	\$168	\$16,474	\$20,879	(\$4,405)
9	\$24,422	\$55,131	\$27,875	\$27,256	68	\$50,990	\$21,640	\$24,158	(\$2,518)
10	\$11,245	\$30,019	\$17,941	\$12,078	69	\$89,825	\$89,266	\$62,725	\$26,542
11	\$30,737	\$62,729	\$14,910	\$47,819	70	\$177,451	\$235,535	\$42,145	\$193,389
12	\$35,889	\$93,616	\$23,917	\$69,699	71	\$89,666	\$84,672	\$51,885	\$32,787
13	\$92,242	\$106,212	\$34,783	\$71,429	72	\$62,202	\$63,057	\$47,271	\$15,786
14	\$73,169	\$100,422	\$24,973	\$75,449	73	\$25,453	\$32,315	\$31,853	\$461
15	\$195,437	\$176,199	\$26,836	\$149,363	74	\$238	\$40,873	\$54,971	(\$14,097)
16	\$24,249	\$42,591	\$21,542	\$21,048	75	\$2,049	\$22,824	\$33,471	(\$10,647)
17	\$18,792	\$90,523	\$28,897	\$61,625	76	\$9,948	\$72,597	\$12,861	\$59,736
18	\$1,682	\$38,444	\$31,441	\$7,003	77	\$7,599	\$19,602	\$37,835	(\$18,232)
19	\$2,711	\$39,877	\$29,302	\$10,575	78	\$181,196	\$899,302	\$45,496	\$853,805
20	\$4,449	\$58,396	\$32,690	\$25,706	79	\$10,815	\$150,294	\$51,283	\$99,011
21	\$667	\$25,259	\$11,717	\$13,542	80	\$230,912	\$127,488	\$29,247	\$98,240
22	\$164,052	\$6,313	\$10,874	(\$4,561)	81	\$4,547	\$49,948	\$50,301	(\$353)
23	\$0	\$0	\$9,047	(\$9,047)	82	\$2,653	\$36,587	\$44,385	(\$7,798)
24	\$0	\$7,049	\$8,356	(\$1,306)	83	\$8,729	\$184,444	\$78,499	\$105,945
25	\$7	\$1,122	\$11,013	(\$9,892)	84	\$7,448	\$149,339	\$76,574	\$72,765
26	\$0	\$1,241	\$8,707	(\$7,466)	85	\$2,627	\$102,703	\$86,630	\$16,073
27	\$553	\$11,285	\$15,443	(\$4,158)	86	\$28,351	\$77,754	\$94,939	(\$17,185)
28	\$784	\$10,653	\$10,117	\$536	87	\$116,775	\$329,628	\$125,343	\$204,286
29	\$0	\$2,765	\$5,837	(\$3,073)	88	\$364	\$43,042	\$66,741	(\$23,699)
30	\$2,486	\$20,789	\$16,172	\$4,617	89	\$184,343	\$259,305	\$50,615	\$208,690
31	\$0	\$8,547	\$17,364	(\$8,817)	90	\$3,866	\$82,652	\$58,839	\$23,813
32	\$493	\$11,990	\$16,492	(\$4,502)	91	\$13,384	\$87,353	\$68,602	\$18,750
33	\$0	\$11,819	\$20,655	(\$8,837)	92	\$665,282	\$193,865	\$114,117	\$79,748
34	\$0	\$7,076	\$12,964	(\$5,888)	93	\$306,496	\$1,080,083	\$64,825	\$1,015,258
35	\$1,067	\$31,610	\$25,029	\$6,581	94	\$42,677	\$78,272	\$47,939	\$30,333
36	\$4,141	\$8,087	\$13,130	(\$5,044)	95	\$68,517	\$89,144	\$30,771	\$58,373
37	\$42,852	\$33,097	\$21,841	\$11,256	96	\$61,661	\$78,281	\$25,850	\$52,431
38	\$17,945	\$24,484	\$21,186	\$3,298	97	\$98,937	\$108,864	\$28,776	\$80,088
39	\$32,148	\$21,377	\$15,396	\$5,981	98	\$71,930	\$96,272	\$42,426	\$53,847
40	\$45,563	\$144,012	\$26,093	\$117,919	99	\$50,165	\$85,254	\$26,182	\$59,072
41	\$45,528	\$28,298	\$25,000	\$3,298	100	\$51,318	\$107,824	\$33,742	\$74,082
42	\$8,714	\$21,062	\$19,162	\$1,900	101	\$46,367	\$120,102	\$42,834	\$77,268
43	\$21,145	\$102,509	\$78,203	\$24,306	102	\$43,655	\$71,642	\$31,697	\$39,945
44	\$15,649	\$79,970	\$60,628	\$19,342	103	\$91,881	\$134,340	\$35,068	\$99,272
45	\$2,802	\$104,537	\$92,044	\$12,493	104	\$53,500	\$101,023	\$29,186	\$71,838
46	\$7,570	\$74,498	\$51,912	\$22,586	105	\$29,977	\$55,574	\$25,071	\$30,502
47	\$13,817	\$74,959	\$49,482	\$25,477	106	\$75,363	\$238,384	\$12,453	\$225,931
48	\$7,676	\$53,711	\$48,290	\$5,422	107	\$27,037	\$103,432	\$22,753	\$80,680
49	\$9,192	\$59,568	\$45,571	\$13,997	108	\$38,244	\$62,969	\$27,515	\$35,454
50	\$6,511	\$37,570	\$32,888	\$4,682	109	\$31,027	\$70,371	\$33,604	\$36,767
51	\$0	\$9,083	\$18,477	(\$9,394)	110	\$36,708	\$77,322	\$38,564	\$38,759
52	\$941	\$37,729	\$66,830	(\$29,100)	111	\$127,321	\$67,722	\$54,073	\$13,650
53	\$18	\$50,068	\$83,911	(\$33,842)	112	\$114,854	\$100,594	\$93,128	\$7,465
54	\$932	\$42,989	\$21,046	\$21,943	113	\$54,814	\$66,974	\$62,292	\$4,682
55	\$1,814	\$75,000	\$52,756	\$22,245	114	\$77,060	\$143,086	\$65,161	\$77,925
56	\$0	\$25,754	\$51,361	(\$25,607)	115	\$164,057	\$429,398	\$69,910	\$359,487
57	\$0	\$8,899	\$18,299	(\$9,400)	116	\$172,272	\$687,072	\$56,604	\$630,468
58	\$0	\$23,526	\$48,764	(\$25,238)	117	\$122,346	\$144,319	\$67,227	\$77,092
59	\$39	\$38,841	\$53,222	(\$14,381)	Total	\$119,037,322	\$11,644,144	\$4,427,958	\$7,216,186

Average annual remaining damages, costs and benefits by reach for Alternative 3.

Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)	Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)
1	\$94,018	\$33,678	\$7,421	\$26,256	60	\$1,288	\$27,167	\$44,308	(\$17,141)
2	\$75,627	\$40,007	\$3,896	\$36,111	61	\$18,934	\$38,082	\$48,695	(\$10,614)
3	\$106,873	\$29,997	\$6,415	\$23,582	62	\$171,356	\$501,674	\$51,317	\$450,357
4	\$108,457	\$50,410	\$5,046	\$45,364	63	\$2,687	\$48,896	\$77,996	(\$29,101)
5	\$231,654	\$28,324	\$9,031	\$19,293	64	\$4,005	\$16,024	\$22,290	(\$6,266)
6	\$189,173	\$79,267	\$15,445	\$63,822	65	\$31,919	\$30,526	\$9,987	\$20,539
7	\$76,818	\$32,771	\$34,947	(\$2,176)	66	\$1,246	\$50,843	\$86,165	(\$35,321)
8	\$31,771	\$43,618	\$37,272	\$6,346	67	\$121	\$16,521	\$29,279	(\$12,758)
9	\$51,059	\$28,494	\$33,684	(\$5,191)	68	\$37,331	\$35,298	\$32,881	\$2,417
10	\$23,625	\$17,640	\$21,566	(\$3,926)	69	\$89,609	\$89,482	\$84,570	\$4,912
11	\$41,261	\$52,205	\$27,740	\$24,465	70	\$187,743	\$225,242	\$60,288	\$164,954
12	\$45,449	\$84,056	\$44,794	\$39,262	71	\$83,606	\$90,731	\$70,653	\$20,079
13	\$97,663	\$100,791	\$59,803	\$40,989	72	\$50,037	\$75,222	\$66,359	\$8,863
14	\$83,478	\$90,112	\$45,923	\$44,189	73	\$23,444	\$34,324	\$45,059	(\$10,735)
15	\$217,020	\$154,616	\$52,966	\$101,650	74	\$238	\$40,873	\$77,272	(\$36,399)
16	\$20,699	\$46,141	\$30,644	\$15,498	75	\$2,789	\$22,084	\$51,180	(\$29,096)
17	\$22,113	\$87,202	\$42,097	\$45,104	76	\$15,133	\$67,413	\$19,994	\$47,419
18	\$1,969	\$38,157	\$46,567	(\$8,410)	77	\$9,432	\$17,769	\$55,834	(\$38,064)
19	\$3,003	\$39,585	\$43,945	(\$4,360)	78	\$248,703	\$831,794	\$60,221	\$771,573
20	\$5,038	\$57,807	\$55,479	\$2,328	79	\$12,022	\$149,086	\$68,945	\$80,141
21	\$703	\$25,222	\$27,340	(\$2,118)	80	\$231,325	\$127,075	\$40,034	\$87,041
22	\$161,978	\$8,387	\$27,268	(\$18,881)	81	\$4,397	\$50,098	\$67,679	(\$17,581)
23	\$0	\$0	\$14,919	(\$14,919)	82	\$3,146	\$36,093	\$59,740	(\$23,647)
24	\$5,962	\$1,088	\$16,760	(\$15,672)	83	\$10,944	\$182,229	\$102,639	\$79,591
25	\$33	\$1,096	\$20,991	(\$19,895)	84	\$10,019	\$146,768	\$100,108	\$46,661
26	\$847	\$394	\$17,835	(\$17,440)	85	\$3,093	\$102,237	\$109,862	(\$7,626)
27	\$2,279	\$9,559	\$38,430	(\$28,872)	86	\$26,819	\$79,286	\$120,185	(\$40,899)
28	\$4,809	\$6,628	\$18,521	(\$11,893)	87	\$128,456	\$317,947	\$157,272	\$160,675
29	\$347	\$2,417	\$10,460	(\$8,042)	88	\$239	\$43,167	\$85,078	(\$41,911)
30	\$5,429	\$17,846	\$33,555	(\$15,709)	89	\$197,332	\$246,316	\$64,588	\$181,727
31	\$0	\$8,547	\$37,295	(\$28,748)	90	\$3,159	\$83,360	\$73,059	\$10,301
32	\$493	\$11,990	\$34,245	(\$22,255)	91	\$13,676	\$87,060	\$83,960	\$3,100
33	\$0	\$11,819	\$45,425	(\$33,606)	92	\$556,842	\$302,306	\$141,739	\$160,566
34	\$0	\$7,076	\$27,211	(\$20,135)	93	\$371,757	\$1,014,822	\$85,327	\$929,495
35	\$1,925	\$30,752	\$49,808	(\$19,056)	94	\$56,709	\$64,240	\$66,205	(\$1,965)
36	\$3,770	\$8,457	\$28,898	(\$20,441)	95	\$108,635	\$49,026	\$46,127	\$2,899
37	\$49,837	\$26,111	\$45,199	(\$19,088)	96	\$97,478	\$42,464	\$39,588	\$2,875
38	\$18,882	\$23,548	\$45,952	(\$22,404)	97	\$148,669	\$59,131	\$45,857	\$13,275
39	\$28,706	\$24,819	\$33,014	(\$8,195)	98	\$108,762	\$59,440	\$61,219	(\$1,778)
40	\$57,074	\$132,502	\$54,296	\$78,205	99	\$81,323	\$54,097	\$36,404	\$17,693
41	\$44,253	\$29,573	\$52,309	(\$22,736)	100	\$85,146	\$73,995	\$46,518	\$27,477
42	\$7,565	\$22,211	\$37,053	(\$14,842)	101	\$68,959	\$97,510	\$59,949	\$37,561
43	\$22,551	\$101,102	\$108,552	(\$7,450)	102	\$67,339	\$47,957	\$43,196	\$4,761
44	\$18,288	\$77,330	\$80,774	(\$3,443)	103	\$143,668	\$82,553	\$48,369	\$34,184
45	\$2,802	\$104,537	\$115,881	(\$11,345)	104	\$90,781	\$63,743	\$43,097	\$20,646
46	\$9,177	\$72,891	\$68,203	\$4,688	105	\$47,202	\$38,349	\$36,458	\$1,891
47	\$17,955	\$70,822	\$66,068	\$4,753	106	\$95,168	\$218,580	\$18,660	\$199,920
48	\$8,615	\$52,773	\$64,720	(\$11,947)	107	\$40,872	\$89,598	\$33,991	\$55,606
49	\$11,779	\$56,981	\$62,193	(\$5,212)	108	\$60,997	\$40,216	\$38,696	\$1,520
50	\$8,283	\$35,798	\$45,959	(\$10,162)	109	\$51,531	\$49,868	\$44,798	\$5,070
51	\$0	\$9,083	\$26,518	(\$17,435)	110	\$56,703	\$57,328	\$48,947	\$8,381
52	\$941	\$37,729	\$90,752	(\$53,023)	111	\$119,996	\$75,047	\$63,901	\$11,146
53	\$18	\$50,068	\$105,421	(\$55,353)	112	\$117,111	\$98,337	\$108,915	(\$10,577)
54	\$1,030	\$42,891	\$26,870	\$16,021	113	\$54,276	\$67,511	\$72,393	(\$4,881)
55	\$2,590	\$74,225	\$66,393	\$7,832	114	\$76,990	\$143,157	\$74,654	\$68,503
56	\$0	\$25,754	\$63,119	(\$37,365)	115	\$162,387	\$431,068	\$79,666	\$351,402
57	\$0	\$8,899	\$23,746	(\$14,847)	116	\$169,418	\$689,926	\$63,697	\$626,229
58	\$0	\$23,526	\$64,803	(\$41,277)	117	\$123,004	\$143,661	\$74,591	\$69,070
59	\$0	\$38,881	\$72,724	(\$33,844)	Total	\$6,811,659	\$10,492,828	\$6,144,620	\$4,348,208

Average annual remaining damages, costs and benefits by reach for Alternative 4.

Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)	Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)
1	\$128,995	(\$1,299)	\$872	(\$2,171)	60	\$2,031	\$26,424	\$22,580	\$3,843
2	\$114,527	\$1,107	\$619	\$488	61	\$25,455	\$31,561	\$22,072	\$9,488
3	\$131,901	\$4,969	\$1,019	\$3,950	62	\$231,593	\$441,437	\$20,985	\$420,452
4	\$150,507	\$8,359	\$805	\$7,554	63	\$4,160	\$47,423	\$35,798	\$11,625
5	\$255,070	\$4,908	\$1,362	\$3,546	64	\$8,055	\$11,973	\$9,672	\$2,302
6	\$268,949	(\$508)	\$1,162	(\$1,669)	65	\$40,655	\$21,791	\$4,461	\$17,330
7	\$93,982	\$15,607	\$1,932	\$13,674	66	\$2,404	\$49,686	\$41,846	\$7,841
8	\$50,169	\$25,221	\$5,403	\$19,817	67	\$211	\$16,431	\$13,243	\$3,188
9	\$57,916	\$21,636	\$3,690	\$17,946	68	\$53,009	\$19,621	\$15,884	\$3,736
10	\$27,130	\$14,134	\$2,538	\$11,597	69	\$113,494	\$65,598	\$41,603	\$23,994
11	\$67,808	\$25,658	\$6,796	\$18,862	70	\$232,074	\$180,912	\$26,192	\$154,720
12	\$82,745	\$46,760	\$10,701	\$36,059	71	\$110,492	\$63,846	\$34,050	\$29,796
13	\$135,657	\$62,797	\$18,246	\$44,551	72	\$71,681	\$53,578	\$29,950	\$23,628
14	\$115,699	\$57,892	\$11,592	\$46,300	73	\$29,989	\$27,779	\$20,021	\$7,758
15	\$309,467	\$62,169	\$10,838	\$51,330	74	\$316	\$40,795	\$33,151	\$7,645
16	\$35,314	\$31,526	\$12,522	\$19,004	75	\$5,173	\$19,700	\$16,791	\$2,909
17	\$50,531	\$58,784	\$16,116	\$42,668	76	\$19,093	\$63,453	\$6,219	\$57,234
18	\$5,531	\$34,594	\$16,979	\$17,616	77	\$4,632	\$22,570	\$20,596	\$1,974
19	\$7,935	\$34,653	\$15,443	\$19,211	78	\$336,938	\$743,560	\$30,615	\$712,945
20	\$16,319	\$46,526	\$13,042	\$33,484	79	\$29,255	\$131,853	\$33,592	\$98,261
21	\$5,162	\$20,764	\$1,189	\$19,575	80	\$282,382	\$76,018	\$18,526	\$57,491
22	\$164,160	\$6,205	\$807	\$5,398	81	\$5,968	\$48,527	\$32,900	\$15,628
23	\$0	\$0	\$671	(\$671)	82	\$5,094	\$34,146	\$28,963	\$5,182
24	\$4,854	\$2,196	\$370	\$1,826	83	\$17,707	\$175,466	\$53,801	\$121,665
25	\$658	\$471	\$601	(\$130)	84	\$15,831	\$140,956	\$52,477	\$88,479
26	\$711	\$530	\$351	\$179	85	\$4,524	\$100,806	\$62,221	\$38,585
27	\$9,405	\$2,432	\$1,157	\$1,275	86	\$28,546	\$77,559	\$71,040	\$6,519
28	\$10,224	\$1,213	\$642	\$571	87	\$165,555	\$280,848	\$95,043	\$185,805
29	\$2,287	\$478	\$390	\$88	88	\$462	\$42,944	\$49,304	(\$6,360)
30	\$7,698	\$15,577	\$3,884	\$11,693	89	\$216,501	\$227,147	\$37,376	\$189,771
31	\$1,360	\$7,188	\$3,816	\$3,371	90	\$4,931	\$81,587	\$45,337	\$36,251
32	\$2,050	\$10,433	\$3,950	\$6,483	91	\$18,216	\$82,521	\$54,305	\$28,216
33	\$2,201	\$9,618	\$4,278	\$5,340	92	\$589,873	\$269,274	\$87,901	\$181,373
34	\$1,228	\$5,848	\$3,017	\$2,831	93	\$447,564	\$939,015	\$44,812	\$894,203
35	\$4,522	\$28,155	\$6,700	\$21,455	94	\$75,704	\$45,245	\$30,267	\$14,978
36	\$6,381	\$5,846	\$2,716	\$3,131	95	\$134,215	\$23,446	\$16,628	\$6,819
37	\$60,629	\$15,319	\$5,262	\$10,058	96	\$119,237	\$20,705	\$13,264	\$7,441
38	\$27,850	\$14,580	\$4,519	\$10,062	97	\$184,198	\$23,603	\$13,657	\$9,946
39	\$33,234	\$20,291	\$3,386	\$16,906	98	\$129,904	\$38,299	\$24,627	\$13,672
40	\$72,020	\$117,555	\$6,203	\$111,353	99	\$111,514	\$23,905	\$16,317	\$7,588
41	\$53,012	\$20,814	\$5,849	\$14,965	100	\$117,262	\$41,880	\$21,343	\$20,537
42	\$10,598	\$19,179	\$5,536	\$13,643	101	\$92,153	\$74,317	\$26,418	\$47,899
43	\$44,076	\$79,577	\$46,300	\$33,277	102	\$85,792	\$29,504	\$20,477	\$9,027
44	\$33,971	\$61,648	\$38,781	\$22,866	103	\$187,229	\$38,992	\$22,205	\$16,787
45	\$9,293	\$98,045	\$64,646	\$33,399	104	\$121,543	\$32,981	\$16,217	\$16,764
46	\$20,104	\$61,964	\$34,024	\$27,940	105	\$64,220	\$21,330	\$14,295	\$7,035
47	\$33,206	\$55,570	\$31,580	\$23,990	106	\$155,912	\$157,835	\$6,688	\$151,147
48	\$16,945	\$44,442	\$30,642	\$13,800	107	\$60,837	\$69,633	\$12,355	\$57,278
49	\$23,277	\$45,484	\$27,881	\$17,603	108	\$78,147	\$23,066	\$16,752	\$6,314
50	\$16,254	\$27,827	\$19,186	\$8,640	109	\$67,201	\$34,198	\$22,690	\$11,507
51	\$0	\$9,083	\$10,172	(\$1,089)	110	\$69,928	\$44,102	\$28,444	\$15,658
52	\$2,964	\$35,706	\$41,302	(\$5,596)	111	\$121,696	\$73,347	\$45,049	\$28,298
53	\$18	\$50,068	\$55,050	(\$4,981)	112	\$126,501	\$88,947	\$78,752	\$10,195
54	\$2,858	\$41,063	\$13,351	\$27,712	113	\$55,511	\$66,276	\$53,121	\$13,155
55	\$3,659	\$73,156	\$34,475	\$38,681	114	\$77,724	\$142,422	\$56,506	\$85,916
56	\$0	\$25,754	\$35,164	(\$9,410)	115	\$178,864	\$414,591	\$61,187	\$353,404
57	\$0	\$8,899	\$11,203	(\$2,304)	116	\$179,774	\$679,570	\$50,326	\$629,244
58	\$0	\$23,526	\$28,179	(\$4,653)	117	\$125,759	\$140,906	\$60,787	\$80,119
59	\$7	\$38,874	\$34,806	\$4,068	Total	\$8,637,710	\$8,666,776	\$2,715,409	\$5,951,367

Average annual remaining damages, costs and benefits by reach for Alternative 5.

Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)	Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)
1	\$128,993	(\$1,297)	\$872	(\$2,169)	60	\$1,713	\$26,742	\$32,234	(\$5,491)
2	\$114,615	\$1,019	\$619	\$400	61	\$22,620	\$34,395	\$33,349	\$1,047
3	\$131,899	\$4,972	\$1,020	\$3,952	62	\$193,521	\$479,509	\$33,410	\$446,099
4	\$150,501	\$8,365	\$806	\$7,560	63	\$2,975	\$48,607	\$53,823	(\$5,216)
5	\$255,070	\$4,908	\$1,363	\$3,545	64	\$4,984	\$15,045	\$14,943	\$102
6	\$268,694	(\$253)	\$1,170	(\$1,423)	65	\$36,503	\$25,943	\$6,790	\$19,153
7	\$93,741	\$15,848	\$3,306	\$12,542	66	\$1,726	\$50,364	\$61,158	(\$10,794)
8	\$49,034	\$26,356	\$8,476	\$17,880	67	\$133	\$16,509	\$20,033	(\$3,524)
9	\$57,995	\$21,557	\$6,236	\$15,321	68	\$52,806	\$19,824	\$23,284	(\$3,460)
10	\$27,117	\$14,147	\$4,216	\$9,931	69	\$101,716	\$77,376	\$60,422	\$16,954
11	\$65,245	\$28,221	\$10,825	\$17,395	70	\$210,989	\$201,997	\$40,441	\$161,556
12	\$80,083	\$49,422	\$17,207	\$32,215	71	\$96,709	\$77,628	\$49,981	\$27,647
13	\$132,344	\$66,110	\$26,860	\$39,251	72	\$56,973	\$68,286	\$45,382	\$22,904
14	\$112,137	\$61,453	\$18,296	\$43,157	73	\$26,257	\$31,511	\$30,567	\$944
15	\$299,631	\$72,004	\$18,401	\$53,603	74	\$243	\$40,868	\$53,189	(\$12,321)
16	\$27,373	\$39,467	\$20,686	\$18,780	75	\$4,841	\$20,032	\$32,145	(\$12,113)
17	\$41,673	\$67,641	\$27,659	\$39,982	76	\$18,335	\$64,210	\$12,334	\$51,876
18	\$3,573	\$36,553	\$30,002	\$6,551	77	\$4,615	\$22,587	\$36,447	(\$13,860)
19	\$5,840	\$36,748	\$27,925	\$8,824	78	\$319,321	\$761,176	\$44,332	\$716,844
20	\$9,621	\$53,223	\$30,828	\$22,396	79	\$23,906	\$137,202	\$49,885	\$87,317
21	\$4,584	\$21,342	\$7,211	\$14,130	80	\$263,448	\$94,951	\$28,393	\$66,558
22	\$163,538	\$6,828	\$5,553	\$1,275	81	\$5,578	\$48,917	\$48,934	(\$17)
23	\$0	\$0	\$675	(\$675)	82	\$4,724	\$34,515	\$43,162	(\$8,646)
24	\$4,856	\$2,193	\$421	\$1,773	83	\$15,753	\$177,421	\$76,545	\$100,876
25	\$658	\$471	\$647	(\$176)	84	\$14,795	\$141,993	\$74,681	\$67,312
26	\$712	\$528	\$411	\$117	85	\$4,069	\$101,261	\$84,682	\$16,579
27	\$9,182	\$2,655	\$8,093	(\$5,437)	86	\$27,750	\$78,355	\$93,013	(\$14,658)
28	\$10,225	\$1,212	\$668	\$544	87	\$161,494	\$284,909	\$122,962	\$161,948
29	\$2,287	\$478	\$402	\$76	88	\$261	\$43,145	\$65,340	(\$22,196)
30	\$6,209	\$17,066	\$15,115	\$1,951	89	\$221,132	\$222,515	\$49,552	\$172,963
31	\$635	\$7,913	\$16,174	(\$8,261)	90	\$4,142	\$82,376	\$57,725	\$24,651
32	\$1,533	\$10,950	\$15,414	(\$4,464)	91	\$16,867	\$83,869	\$67,517	\$16,352
33	\$891	\$10,927	\$19,167	(\$8,240)	92	\$578,584	\$280,563	\$111,981	\$168,582
34	\$495	\$6,581	\$12,104	(\$5,523)	93	\$425,120	\$961,459	\$63,308	\$898,151
35	\$2,994	\$29,684	\$23,501	\$6,183	94	\$74,266	\$46,683	\$46,577	\$106
36	\$5,747	\$6,480	\$12,191	(\$5,711)	95	\$132,977	\$24,684	\$29,554	(\$4,870)
37	\$57,471	\$18,477	\$20,421	(\$1,944)	96	\$119,310	\$20,632	\$24,740	(\$4,108)
38	\$25,177	\$17,253	\$19,691	(\$2,438)	97	\$179,295	\$28,506	\$27,493	\$1,012
39	\$31,301	\$22,225	\$14,337	\$7,888	98	\$128,576	\$39,627	\$40,925	(\$1,298)
40	\$68,427	\$121,148	\$24,404	\$96,744	99	\$109,005	\$26,415	\$25,397	\$1,017
41	\$50,382	\$23,444	\$23,356	\$88	100	\$115,223	\$43,918	\$32,756	\$11,162
42	\$9,690	\$20,086	\$18,053	\$2,033	101	\$91,530	\$74,939	\$41,508	\$33,431
43	\$38,820	\$84,833	\$75,106	\$9,728	102	\$85,322	\$29,975	\$30,824	(\$849)
44	\$29,078	\$66,540	\$58,642	\$7,898	103	\$185,763	\$40,458	\$34,034	\$6,424
45	\$6,305	\$101,033	\$89,631	\$11,402	104	\$121,108	\$33,415	\$28,120	\$5,295
46	\$17,494	\$64,574	\$50,304	\$14,270	105	\$64,820	\$20,730	\$24,165	(\$3,434)
47	\$29,308	\$59,469	\$47,837	\$11,631	106	\$135,019	\$178,728	\$11,940	\$166,788
48	\$14,297	\$47,090	\$46,670	\$420	107	\$58,428	\$72,041	\$21,895	\$50,146
49	\$21,125	\$47,635	\$43,869	\$3,767	108	\$77,981	\$23,232	\$26,665	(\$3,433)
50	\$14,341	\$29,740	\$31,563	(\$1,823)	109	\$65,240	\$36,158	\$32,804	\$3,354
51	\$0	\$9,083	\$17,655	(\$8,572)	110	\$69,995	\$44,035	\$37,779	\$6,256
52	\$1,974	\$36,696	\$64,464	(\$27,768)	111	\$116,654	\$78,389	\$53,116	\$25,274
53	\$18	\$50,068	\$77,904	(\$27,835)	112	\$124,397	\$91,050	\$91,648	(\$597)
54	\$2,101	\$41,820	\$19,449	\$22,372	113	\$54,858	\$66,930	\$61,397	\$5,532
55	\$3,381	\$73,433	\$48,959	\$24,474	114	\$77,377	\$142,769	\$64,350	\$78,419
56	\$0	\$25,754	\$48,013	(\$22,259)	115	\$170,170	\$423,285	\$69,123	\$354,162
57	\$0	\$8,899	\$16,831	(\$7,932)	116	\$175,964	\$683,380	\$55,982	\$627,398
58	\$0	\$23,526	\$44,471	(\$20,946)	117	\$125,055	\$141,610	\$66,465	\$75,145
59	\$0	\$38,881	\$51,231	(\$12,350)	Total	\$8,273,352	\$9,031,134	\$4,048,578	\$4,982,556

Average annual remaining damages, costs and benefits by reach for Alternative 6.

Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)	Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)
1	\$35,883	\$91,813	\$11,908	\$79,905	60	\$1,805	\$26,650	\$33,388	(\$6,737)
2	\$29,170	\$86,464	\$8,401	\$78,063	61	\$19,398	\$37,618	\$34,739	\$2,878
3	\$36,663	\$100,207	\$13,851	\$86,356	62	\$165,083	\$507,947	\$34,918	\$473,029
4	\$40,163	\$118,703	\$10,916	\$107,787	63	\$3,715	\$47,868	\$56,001	(\$8,133)
5	\$76,838	\$183,140	\$18,498	\$164,642	64	\$5,817	\$14,211	\$15,559	(\$1,347)
6	\$74,165	\$194,276	\$18,182	\$176,094	65	\$27,534	\$34,911	\$7,083	\$27,829
7	\$25,677	\$83,912	\$38,073	\$45,839	66	\$1,686	\$50,404	\$63,469	(\$13,065)
8	\$14,697	\$60,692	\$40,257	\$20,435	67	\$168	\$16,474	\$20,879	(\$4,405)
9	\$16,214	\$63,339	\$36,492	\$26,846	68	\$50,990	\$21,640	\$24,158	(\$2,518)
10	\$7,574	\$33,691	\$23,372	\$10,319	69	\$89,825	\$89,266	\$62,725	\$26,542
11	\$30,065	\$63,401	\$16,433	\$46,968	70	\$177,451	\$235,535	\$42,145	\$193,389
12	\$35,238	\$94,267	\$26,346	\$67,922	71	\$89,666	\$84,672	\$51,885	\$32,787
13	\$88,727	\$109,728	\$37,873	\$71,854	72	\$62,202	\$63,057	\$47,271	\$15,786
14	\$72,171	\$101,419	\$27,459	\$73,960	73	\$25,453	\$32,315	\$31,853	\$461
15	\$192,937	\$178,699	\$29,751	\$148,947	74	\$238	\$40,873	\$54,971	(\$14,097)
16	\$24,249	\$42,591	\$21,542	\$21,048	75	\$2,049	\$22,824	\$33,471	(\$10,647)
17	\$18,792	\$90,523	\$28,897	\$61,625	76	\$9,948	\$72,597	\$12,861	\$59,736
18	\$1,682	\$38,444	\$31,441	\$7,003	77	\$7,599	\$19,602	\$37,835	(\$18,232)
19	\$2,711	\$39,877	\$29,302	\$10,575	78	\$181,196	\$899,302	\$45,496	\$853,805
20	\$4,449	\$58,396	\$32,690	\$25,706	79	\$10,815	\$150,294	\$51,283	\$99,011
21	\$667	\$25,259	\$11,717	\$13,542	80	\$230,912	\$127,488	\$29,247	\$98,240
22	\$164,052	\$6,313	\$10,874	(\$4,561)	81	\$4,547	\$49,948	\$50,301	(\$353)
23	\$0	\$0	\$9,047	(\$9,047)	82	\$2,653	\$36,587	\$44,385	(\$7,798)
24	\$0	\$7,049	\$8,356	(\$1,306)	83	\$8,729	\$184,444	\$78,499	\$105,945
25	\$7	\$1,122	\$11,013	(\$9,892)	84	\$7,448	\$149,339	\$76,574	\$72,765
26	\$0	\$1,241	\$8,707	(\$7,466)	85	\$2,627	\$102,703	\$86,630	\$16,073
27	\$553	\$11,285	\$15,443	(\$4,158)	86	\$28,351	\$77,754	\$94,939	(\$17,185)
28	\$784	\$10,653	\$10,117	\$536	87	\$116,775	\$329,628	\$125,343	\$204,286
29	\$0	\$2,765	\$5,837	(\$3,073)	88	\$364	\$43,042	\$66,741	(\$23,699)
30	\$2,486	\$20,789	\$16,172	\$4,617	89	\$184,343	\$259,305	\$50,615	\$208,690
31	\$0	\$8,547	\$17,364	(\$8,817)	90	\$3,866	\$82,652	\$58,839	\$23,813
32	\$493	\$11,990	\$16,492	(\$4,502)	91	\$13,384	\$87,353	\$68,602	\$18,750
33	\$0	\$11,819	\$20,655	(\$8,837)	92	\$665,282	\$193,865	\$114,117	\$79,748
34	\$0	\$7,076	\$12,964	(\$5,888)	93	\$284,497	\$1,102,082	\$72,959	\$1,029,123
35	\$1,067	\$31,610	\$25,029	\$6,581	94	\$29,854	\$91,095	\$55,560	\$35,535
36	\$4,141	\$8,087	\$13,130	(\$5,044)	95	\$49,325	\$108,336	\$37,487	\$70,849
37	\$42,852	\$33,097	\$21,841	\$11,256	96	\$46,342	\$93,600	\$31,881	\$61,719
38	\$17,945	\$24,484	\$21,186	\$3,298	97	\$78,336	\$129,465	\$36,389	\$93,076
39	\$32,148	\$21,377	\$15,396	\$5,981	98	\$55,365	\$112,838	\$50,436	\$62,402
40	\$45,563	\$144,012	\$26,093	\$117,919	99	\$35,004	\$100,416	\$30,454	\$69,961
41	\$45,528	\$28,298	\$25,000	\$3,298	100	\$37,751	\$121,390	\$39,076	\$82,314
42	\$8,714	\$21,062	\$19,162	\$1,900	101	\$34,833	\$131,636	\$50,005	\$81,631
43	\$21,145	\$102,509	\$78,203	\$24,306	102	\$31,893	\$83,403	\$36,390	\$47,013
44	\$15,649	\$79,970	\$60,628	\$19,342	103	\$65,371	\$160,850	\$40,608	\$120,242
45	\$2,802	\$104,537	\$92,044	\$12,493	104	\$37,815	\$116,709	\$35,181	\$81,528
46	\$7,570	\$74,498	\$51,912	\$22,586	105	\$20,245	\$65,305	\$29,963	\$35,342
47	\$13,817	\$74,959	\$49,482	\$25,477	106	\$59,011	\$254,736	\$15,163	\$239,573
48	\$7,676	\$53,711	\$48,290	\$5,422	107	\$22,298	\$108,172	\$27,664	\$80,508
49	\$9,192	\$59,568	\$45,571	\$13,997	108	\$28,669	\$72,544	\$32,242	\$40,302
50	\$6,511	\$37,570	\$32,888	\$4,682	109	\$22,205	\$79,193	\$38,112	\$41,081
51	\$0	\$9,083	\$18,477	(\$9,394)	110	\$25,628	\$88,402	\$42,493	\$45,909
52	\$941	\$37,729	\$66,830	(\$29,100)	111	\$127,321	\$67,722	\$54,073	\$13,650
53	\$18	\$50,068	\$83,911	(\$33,842)	112	\$114,854	\$100,594	\$93,128	\$7,465
54	\$932	\$42,989	\$21,046	\$21,943	113	\$54,814	\$66,974	\$62,292	\$4,682
55	\$1,814	\$75,000	\$52,756	\$22,245	114	\$77,060	\$143,086	\$65,161	\$77,925
56	\$0	\$25,754	\$51,361	(\$25,607)	115	\$164,057	\$429,398	\$69,910	\$359,487
57	\$0	\$8,899	\$18,299	(\$9,400)	116	\$172,272	\$687,072	\$56,604	\$630,468
58	\$0	\$23,526	\$48,764	(\$25,238)	117	\$122,346	\$144,319	\$67,227	\$77,092
59	\$39	\$38,841	\$53,222	(\$14,381)	Total	\$5,282,257	\$12,022,230	\$4,594,244	\$7,427,985

Average annual remaining damages, costs and benefits by reach for Alternative 7.

Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)	Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)
1	\$35,545	\$92,151	\$17,518	\$74,633	60	\$1,805	\$26,650	\$33,388	(\$6,737)
2	\$29,377	\$86,257	\$10,064	\$76,193	61	\$19,398	\$37,618	\$34,739	\$2,878
3	\$36,679	\$100,192	\$16,593	\$83,599	62	\$165,083	\$507,947	\$34,918	\$473,029
4	\$40,081	\$118,785	\$13,076	\$105,710	63	\$3,715	\$47,868	\$56,001	(\$8,133)
5	\$76,430	\$183,548	\$23,833	\$159,715	64	\$5,817	\$14,211	\$15,559	(\$1,347)
6	\$73,436	\$195,005	\$28,084	\$166,920	65	\$27,534	\$34,911	\$7,083	\$27,829
7	\$25,163	\$84,426	\$48,696	\$35,730	66	\$1,686	\$50,404	\$63,469	(\$13,065)
8	\$14,356	\$61,034	\$48,965	\$12,069	67	\$168	\$16,474	\$20,879	(\$4,405)
9	\$16,069	\$63,483	\$45,015	\$18,468	68	\$50,990	\$21,640	\$24,158	(\$2,518)
10	\$7,569	\$33,696	\$28,732	\$4,964	69	\$89,825	\$89,266	\$62,725	\$26,542
11	\$30,065	\$63,401	\$16,433	\$46,968	70	\$177,451	\$235,535	\$42,145	\$193,389
12	\$35,238	\$94,267	\$26,346	\$67,922	71	\$89,666	\$84,672	\$51,885	\$32,787
13	\$88,727	\$109,728	\$37,873	\$71,854	72	\$62,202	\$63,057	\$47,271	\$15,786
14	\$72,171	\$101,419	\$27,459	\$73,960	73	\$25,453	\$32,315	\$31,853	\$461
15	\$192,937	\$178,699	\$29,751	\$148,947	74	\$238	\$40,873	\$54,971	(\$14,097)
16	\$24,249	\$42,591	\$21,542	\$21,048	75	\$2,049	\$22,824	\$33,471	(\$10,647)
17	\$18,792	\$90,523	\$28,897	\$61,625	76	\$9,948	\$72,597	\$12,861	\$59,736
18	\$1,682	\$38,444	\$31,441	\$7,003	77	\$7,599	\$19,602	\$37,835	(\$18,232)
19	\$2,711	\$39,877	\$29,302	\$10,575	78	\$181,196	\$899,302	\$45,496	\$853,805
20	\$4,449	\$58,396	\$32,690	\$25,706	79	\$10,815	\$150,294	\$51,283	\$99,011
21	\$667	\$25,259	\$11,717	\$13,542	80	\$230,912	\$127,488	\$29,247	\$98,240
22	\$164,052	\$6,313	\$10,874	(\$4,561)	81	\$4,547	\$49,948	\$50,301	(\$353)
23	\$0	\$0	\$9,047	(\$9,047)	82	\$2,653	\$36,587	\$44,385	(\$7,798)
24	\$0	\$7,049	\$8,356	(\$1,306)	83	\$8,729	\$184,444	\$78,499	\$105,945
25	\$7	\$1,122	\$11,013	(\$9,892)	84	\$7,448	\$149,339	\$76,574	\$72,765
26	\$0	\$1,241	\$8,707	(\$7,466)	85	\$2,627	\$102,703	\$86,630	\$16,073
27	\$553	\$11,285	\$15,443	(\$4,158)	86	\$28,351	\$77,754	\$94,939	(\$17,185)
28	\$784	\$10,653	\$10,117	\$536	87	\$116,775	\$329,628	\$125,343	\$204,286
29	\$0	\$2,765	\$5,837	(\$3,073)	88	\$364	\$43,042	\$66,741	(\$23,699)
30	\$2,486	\$20,789	\$16,172	\$4,617	89	\$184,343	\$259,305	\$50,615	\$208,690
31	\$0	\$8,547	\$17,364	(\$8,817)	90	\$3,866	\$82,652	\$58,839	\$23,813
32	\$493	\$11,990	\$16,492	(\$4,502)	91	\$13,384	\$87,353	\$68,602	\$18,750
33	\$0	\$11,819	\$20,655	(\$8,837)	92	\$665,282	\$193,865	\$114,117	\$79,748
34	\$0	\$7,076	\$12,964	(\$5,888)	93	\$251,709	\$1,134,870	\$82,648	\$1,052,222
35	\$1,067	\$31,610	\$25,029	\$6,581	94	\$24,973	\$95,976	\$64,244	\$31,732
36	\$4,141	\$8,087	\$13,130	(\$5,044)	95	\$45,123	\$112,538	\$44,716	\$67,822
37	\$42,852	\$33,097	\$21,841	\$11,256	96	\$41,658	\$98,284	\$38,321	\$59,963
38	\$17,945	\$24,484	\$21,186	\$3,298	97	\$70,667	\$137,134	\$44,411	\$92,723
39	\$32,148	\$21,377	\$15,396	\$5,981	98	\$49,651	\$118,551	\$59,311	\$59,240
40	\$45,563	\$144,012	\$26,093	\$117,919	99	\$33,558	\$101,862	\$35,255	\$66,607
41	\$45,528	\$28,298	\$25,000	\$3,298	100	\$36,730	\$122,412	\$45,124	\$77,287
42	\$8,714	\$21,062	\$19,162	\$1,900	101	\$31,943	\$134,526	\$58,132	\$76,394
43	\$21,145	\$102,509	\$78,203	\$24,306	102	\$28,502	\$86,795	\$41,866	\$44,929
44	\$15,649	\$79,970	\$60,628	\$19,342	103	\$58,630	\$167,591	\$46,903	\$120,688
45	\$2,802	\$104,537	\$92,044	\$12,493	104	\$37,303	\$117,220	\$41,757	\$75,463
46	\$7,570	\$74,498	\$51,912	\$22,586	105	\$19,737	\$65,813	\$35,335	\$30,478
47	\$13,817	\$74,959	\$49,482	\$25,477	106	\$52,830	\$260,918	\$18,094	\$242,824
48	\$7,676	\$53,711	\$48,290	\$5,422	107	\$20,746	\$109,724	\$32,929	\$76,795
49	\$9,192	\$59,568	\$45,571	\$13,997	108	\$25,838	\$75,375	\$37,525	\$37,850
50	\$6,511	\$37,570	\$32,888	\$4,682	109	\$20,919	\$80,480	\$43,384	\$37,095
51	\$0	\$9,083	\$18,477	(\$9,394)	110	\$24,100	\$89,930	\$47,378	\$42,552
52	\$941	\$37,729	\$66,830	(\$29,100)	111	\$127,321	\$67,722	\$54,073	\$13,650
53	\$18	\$50,068	\$83,911	(\$33,842)	112	\$114,854	\$100,594	\$93,128	\$7,465
54	\$932	\$42,989	\$21,046	\$21,943	113	\$54,814	\$66,974	\$62,292	\$4,682
55	\$1,814	\$75,000	\$52,756	\$22,245	114	\$77,060	\$143,086	\$65,161	\$77,925
56	\$0	\$25,754	\$51,361	(\$25,607)	115	\$164,057	\$429,398	\$69,910	\$359,487
57	\$0	\$8,899	\$18,299	(\$9,400)	116	\$172,272	\$687,072	\$56,604	\$630,468
58	\$0	\$23,526	\$48,764	(\$25,238)	117	\$122,346	\$144,319	\$67,227	\$77,092
59	\$39	\$38,841	\$53,222	(\$14,381)	Total	\$5,190,090	\$12,114,396	\$4,770,137	\$7,344,259

Average annual remaining damages, costs and benefits by reach for Alternative 8.

Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)	Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)
1	\$35,883	\$91,813	\$11,908	\$79,905	60	\$2,031	\$26,424	\$22,580	\$3,843
2	\$29,170	\$86,464	\$8,401	\$78,063	61	\$25,455	\$31,561	\$22,072	\$9,488
3	\$36,663	\$100,207	\$13,851	\$86,356	62	\$231,593	\$441,437	\$20,985	\$420,452
4	\$40,163	\$118,703	\$10,916	\$107,787	63	\$4,160	\$47,423	\$35,798	\$11,625
5	\$76,838	\$183,140	\$18,498	\$164,642	64	\$8,055	\$11,973	\$9,672	\$2,302
6	\$74,165	\$194,276	\$18,182	\$176,094	65	\$40,655	\$21,791	\$4,461	\$17,330
7	\$25,677	\$83,912	\$38,073	\$45,839	66	\$2,404	\$49,686	\$41,846	\$7,841
8	\$14,697	\$60,692	\$40,257	\$20,435	67	\$211	\$16,431	\$13,243	\$3,188
9	\$16,214	\$63,339	\$36,492	\$26,846	68	\$53,009	\$19,621	\$15,884	\$3,736
10	\$7,574	\$33,691	\$23,372	\$10,319	69	\$113,494	\$65,598	\$41,603	\$23,994
11	\$30,737	\$62,729	\$14,910	\$47,819	70	\$232,074	\$180,912	\$26,192	\$154,720
12	\$35,889	\$93,616	\$23,917	\$69,699	71	\$110,492	\$63,846	\$34,050	\$29,796
13	\$92,242	\$106,212	\$34,783	\$71,429	72	\$71,681	\$63,578	\$29,950	\$23,628
14	\$73,169	\$100,422	\$24,973	\$75,449	73	\$29,989	\$27,779	\$20,021	\$7,758
15	\$195,437	\$176,199	\$26,836	\$149,363	74	\$316	\$40,795	\$33,151	\$7,645
16	\$31,230	\$35,610	\$14,572	\$21,038	75	\$5,173	\$19,700	\$16,791	\$2,909
17	\$30,183	\$79,132	\$18,883	\$60,249	76	\$19,093	\$63,453	\$6,219	\$57,234
18	\$3,116	\$37,010	\$20,073	\$16,937	77	\$4,632	\$22,570	\$20,596	\$1,974
19	\$4,988	\$37,600	\$18,380	\$19,220	78	\$336,938	\$743,560	\$30,615	\$712,945
20	\$7,685	\$55,160	\$17,082	\$38,077	79	\$29,255	\$131,853	\$33,592	\$98,261
21	\$5,162	\$20,764	\$1,189	\$19,575	80	\$282,382	\$76,018	\$18,526	\$57,491
22	\$164,160	\$6,205	\$807	\$5,398	81	\$5,968	\$48,527	\$32,900	\$15,628
23	\$0	\$0	\$671	(\$671)	82	\$5,094	\$34,146	\$28,963	\$5,182
24	\$4,854	\$2,196	\$370	\$1,826	83	\$17,707	\$175,466	\$53,801	\$121,665
25	\$658	\$471	\$601	(\$130)	84	\$15,831	\$140,956	\$52,477	\$88,479
26	\$711	\$530	\$351	\$179	85	\$4,524	\$100,806	\$62,221	\$38,585
27	\$9,405	\$2,432	\$1,157	\$1,275	86	\$28,546	\$77,559	\$71,040	\$6,519
28	\$10,224	\$1,213	\$642	\$571	87	\$165,555	\$280,848	\$95,043	\$185,805
29	\$2,287	\$478	\$390	\$88	88	\$462	\$42,944	\$49,304	(\$6,360)
30	\$7,698	\$15,577	\$3,884	\$11,693	89	\$216,501	\$227,147	\$37,376	\$189,771
31	\$1,360	\$7,188	\$3,816	\$3,371	90	\$4,931	\$81,587	\$45,337	\$36,251
32	\$2,050	\$10,433	\$3,950	\$6,483	91	\$18,216	\$82,521	\$54,305	\$28,216
33	\$2,201	\$9,618	\$4,278	\$5,340	92	\$589,873	\$269,274	\$87,901	\$181,373
34	\$1,228	\$5,848	\$3,017	\$2,831	93	\$284,497	\$1,102,082	\$72,959	\$1,029,123
35	\$4,522	\$28,155	\$6,700	\$21,455	94	\$29,854	\$91,095	\$55,560	\$35,535
36	\$6,381	\$5,846	\$2,716	\$3,131	95	\$49,325	\$108,336	\$37,487	\$70,849
37	\$60,629	\$15,319	\$5,262	\$10,058	96	\$46,342	\$93,600	\$31,881	\$61,719
38	\$27,850	\$14,580	\$4,519	\$10,062	97	\$78,336	\$129,465	\$36,389	\$93,076
39	\$33,234	\$20,291	\$3,386	\$16,906	98	\$55,365	\$112,838	\$50,436	\$62,402
40	\$72,020	\$117,555	\$6,203	\$111,353	99	\$35,004	\$100,416	\$30,454	\$69,961
41	\$53,012	\$20,814	\$5,849	\$14,965	100	\$37,751	\$121,390	\$39,076	\$82,314
42	\$10,598	\$19,179	\$5,536	\$13,643	101	\$34,833	\$131,636	\$50,005	\$81,631
43	\$44,076	\$79,577	\$46,300	\$33,277	102	\$31,893	\$83,403	\$36,390	\$47,013
44	\$33,971	\$61,648	\$38,781	\$22,866	103	\$65,371	\$160,850	\$40,608	\$120,242
45	\$9,293	\$98,045	\$64,646	\$33,399	104	\$37,815	\$116,709	\$35,181	\$81,528
46	\$20,104	\$61,964	\$34,024	\$27,940	105	\$20,245	\$65,305	\$29,963	\$35,342
47	\$33,206	\$55,570	\$31,580	\$23,990	106	\$59,011	\$254,736	\$15,163	\$239,573
48	\$16,945	\$44,442	\$30,642	\$13,800	107	\$22,298	\$108,172	\$27,664	\$80,508
49	\$23,277	\$45,484	\$27,881	\$17,603	108	\$28,669	\$72,544	\$32,242	\$40,302
50	\$16,254	\$27,827	\$19,186	\$8,640	109	\$22,205	\$79,193	\$38,112	\$41,081
51	\$0	\$9,083	\$10,172	(\$1,089)	110	\$25,628	\$88,402	\$42,493	\$45,909
52	\$2,964	\$35,706	\$41,302	(\$5,596)	111	\$121,696	\$73,347	\$45,049	\$28,298
53	\$18	\$50,068	\$55,050	(\$4,981)	112	\$126,501	\$88,947	\$78,752	\$10,195
54	\$2,858	\$41,063	\$13,351	\$27,712	113	\$55,511	\$66,276	\$53,121	\$13,155
55	\$3,659	\$73,156	\$34,475	\$38,681	114	\$77,724	\$142,422	\$56,506	\$85,916
56	\$0	\$25,754	\$35,164	(\$9,410)	115	\$178,864	\$414,591	\$61,187	\$353,404
57	\$0	\$8,899	\$11,203	(\$2,304)	116	\$179,774	\$679,570	\$50,326	\$629,244
58	\$0	\$23,526	\$28,179	(\$4,653)	117	\$125,759	\$140,906	\$60,787	\$80,119
59	\$7	\$38,874	\$34,806	\$4,068	Total	\$6,055,161	\$11,249,325	\$3,332,701	\$7,916,625

Average annual remaining damages, costs and benefits by reach for Alternative 9.

Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)	Reach	Total Damages (AA)	Total Benefits (AA)	Total Cost (AA)	Net Benefits (AA)
1	\$65,325	\$62,371	\$310,983	(\$248,613)	60	\$548	\$4,123	\$89,985	(\$85,863)
2	\$40,550	\$75,084	\$221,112	(\$146,028)	61	\$186	\$31,623	\$341,454	(\$309,831)
3	\$71,876	\$64,994	\$454,277	(\$389,283)	62	\$275	\$647,254	\$779,096	(\$131,843)
4	\$60,463	\$98,404	\$334,379	(\$235,975)	63	\$0	\$11,527	\$463,451	(\$451,924)
5	\$115,210	\$144,768	\$553,494	(\$408,726)	64	\$73	\$8,709	\$243,880	(\$235,170)
6	\$50,764	\$217,676	\$497,859	(\$280,182)	65	\$792	\$56,555	\$202,624	(\$146,069)
7	\$20,537	\$71,895	\$396,005	(\$324,109)	66	\$454	\$6,474	\$47,703	(\$41,229)
8	\$10,142	\$41,292	\$125,535	(\$84,242)	67	\$126	\$1,523	\$217,574	(\$216,051)
9	\$11,887	\$47,102	\$336,043	(\$288,941)	68	\$288	\$55,167	\$348,929	(\$293,762)
10	\$17,817	\$10,080	\$175,463	(\$165,383)	69	\$506	\$136,094	\$647,102	(\$511,008)
11	\$39,677	\$29,243	\$364,906	(\$335,663)	70	\$2,129	\$381,771	\$701,731	(\$319,961)
12	\$24,784	\$65,216	\$552,067	(\$486,851)	71	\$50	\$139,088	\$714,897	(\$575,808)
13	\$38,843	\$105,242	\$572,609	(\$467,367)	72	\$649	\$92,189	\$679,432	(\$587,244)
14	\$54,006	\$78,602	\$730,954	(\$652,351)	73	\$0	\$35,853	\$316,690	(\$280,837)
15	\$84,673	\$241,266	\$767,302	(\$526,035)	74	\$642	\$12,465	\$603,650	(\$591,185)
16	\$0	\$48,539	\$102,710	(\$54,171)	75	\$587	\$7,718	\$330,841	(\$323,123)
17	\$0	\$85,042	\$269,614	(\$184,572)	76	\$27	\$76,183	\$313,466	(\$237,283)
18	\$0	\$13,685	\$226,191	(\$212,506)	77	\$70	\$8,196	\$561,767	(\$553,571)
19	\$0	\$18,131	\$321,340	(\$303,209)	78	\$6,464	\$1,049,971	\$449,300	\$600,672
20	\$0	\$36,401	\$911,767	(\$875,366)	79	\$14,901	\$119,467	\$679,599	(\$560,131)
21	\$12,214	\$356	\$721,068	(\$720,712)	80	\$12,557	\$330,551	\$569,699	(\$239,148)
22	\$0	\$166,937	\$412,253	(\$245,315)	81	\$8,093	\$19,792	\$426,932	(\$407,140)
23	\$0	\$0	\$854,336	(\$854,336)	82	\$844	\$14,959	\$362,396	(\$347,437)
24	\$0	\$7,049	\$777,366	(\$770,317)	83	\$0	\$150,663	\$706,874	(\$556,211)
25	\$0	\$1,129	\$910,533	(\$909,403)	84	\$0	\$115,311	\$547,616	(\$432,305)
26	\$0	\$1,241	\$718,229	(\$716,989)	85	\$5,331	\$50,787	\$654,207	(\$603,419)
27	\$0	\$9,735	\$913,571	(\$903,836)	86	\$18,098	\$37,161	\$268,701	(\$231,540)
28	\$0	\$11,437	\$946,417	(\$934,980)	87	\$139	\$378,827	\$197,717	\$181,110
29	\$0	\$2,765	\$613,180	(\$610,415)	88	\$0	\$7,856	\$117,831	(\$109,975)
30	\$532	\$18,923	\$641,368	(\$622,445)	89	\$0	\$415,324	\$358,725	\$56,599
31	\$416	\$4,812	\$750,469	(\$745,656)	90	\$7,028	\$46,039	\$410,638	(\$364,600)
32	\$1,580	\$8,717	\$622,309	(\$613,593)	91	\$203	\$61,104	\$476,454	(\$415,350)
33	\$483	\$8,213	\$1,013,920	(\$1,005,707)	92	\$0	\$794,196	\$1,499,568	(\$705,372)
34	\$48	\$5,586	\$571,354	(\$565,767)	93	\$0	\$1,343,668	\$602,909	\$740,760
35	\$297	\$21,025	\$943,621	(\$922,596)	94	\$8,971	\$79,374	\$856,317	(\$776,943)
36	\$447	\$11,250	\$473,608	(\$462,357)	95	\$36,334	\$100,007	\$662,937	(\$562,930)
37	\$712	\$68,123	\$892,437	(\$824,314)	96	\$32,933	\$89,011	\$624,249	(\$535,238)
38	\$789	\$38,091	\$862,746	(\$824,655)	97	\$49,823	\$137,966	\$827,216	(\$689,250)
39	\$16,386	\$34,316	\$231,526	(\$197,210)	98	\$38,420	\$100,821	\$708,015	(\$607,194)
40	\$4,058	\$177,163	\$1,015,689	(\$838,526)	99	\$25,127	\$92,523	\$516,404	(\$423,881)
41	\$3,039	\$55,760	\$950,525	(\$894,765)	100	\$44,758	\$91,192	\$644,392	(\$553,200)
42	\$2,276	\$15,276	\$570,327	(\$555,051)	101	\$16,155	\$121,067	\$509,713	(\$388,646)
43	\$6,573	\$77,601	\$1,125,275	(\$1,047,674)	102	\$19,944	\$73,580	\$1,155,033	(\$1,081,453)
44	\$10,855	\$52,883	\$723,798	(\$670,915)	103	\$70,627	\$131,477	\$677,060	(\$545,582)
45	\$6,412	\$48,738	\$909,898	(\$861,160)	104	\$51,218	\$83,050	\$461,739	(\$378,690)
46	\$2,261	\$51,837	\$540,769	(\$488,932)	105	\$21,075	\$47,139	\$293,694	(\$246,555)
47	\$6,023	\$56,513	\$460,313	(\$403,800)	106	\$51,286	\$253,747	\$145,715	\$108,031
48	\$5,936	\$29,917	\$539,742	(\$509,825)	107	\$115,324	(\$772)	\$0	(\$772)
49	\$2,923	\$42,200	\$580,541	(\$538,341)	108	\$28,190	\$54,170	\$445,819	(\$391,649)
50	\$1,329	\$26,290	\$398,230	(\$371,940)	109	\$28,255	\$50,288	\$435,206	(\$384,918)
51	\$0	\$0	\$0	\$0	110	\$30,359	\$56,888	\$453,437	(\$396,549)
52	\$0	\$4,207	\$576,556	(\$572,349)	111	\$50,837	\$103,863	\$488,387	(\$384,524)
53	\$0	\$7,714	\$722,109	(\$714,395)	112	\$99,193	\$44,469	\$54,151	(\$9,682)
54	\$0	\$33,380	\$81,826	(\$48,446)	113	\$53,781	\$19,654	\$186,590	(\$166,936)
55	\$0	\$50,202	\$1,502,706	(\$1,452,504)	114	\$167,373	\$545	\$0	\$545
56	\$0	\$0	\$0	\$0	115	\$537,540	(\$753)	\$0	(\$753)
57	\$0	\$0	\$0	\$0	116	\$813,632	(\$1,038)	\$0	(\$1,038)
58	\$0	\$0	\$0	\$0	117	\$210,779	(\$478)	\$0	(\$478)
59	\$559	\$2	\$0	\$2	Total	\$3,475,692	\$11,080,401	\$58,872,734	(\$47,792,333)

Average annual remaining damages, costs and benefits by reach for Alternative 10 (Non-Structural).

Summary of Interest During Construction, NED Plan, 3.5%

Interest During Construction				
Input Data			Monthly Interest Rate (i_m)	
Construction Period (months)	4		$i_m = 1 - (1 + i)^{1/12}$	0.287%
Total Construction Cost	\$37,327,000			
Middle of Month Uniform Payments	\$9,331,750			
Annual Interest Rate(i)	3.500%			
Interest During Construction ($\sum P_m [(1+i)^{n-1} - 1]$)			Total IDC	\$161,051
$n =$ # of periods in months	$P_m =$ the m th monthly payment		$i_m =$ monthly interest rate	
Month	Payment	Interest Factor	Interest	
1	\$9,331,750	0.008637	\$80,602	
2	\$9,331,750	0.005750	\$53,658	
3	\$9,331,750	0.002871	\$26,791	
4	\$9,331,750	0.000000	\$0	

NED Plan Dimensions

Reaches	Length (ft)	Landward Dune Slope (X:1)	Max Dune Elevation (ft)	Dune Width (ft)	Seaward Dune Slope (X:1)	Berm Height (ft)	Berm Width (ft)	Berm Seaward Slope (X:1)
4-10	4,876	4	16	95	-4	5.5	50	-15
11-15	5,633	4	15	45	-4	7	50	-15
16-21	6,891	4	20	10	-4	7	50	-15
22-92	82,053	4	x	x	-4	7	50	-15
93-110	15,274	4	18	40	-4	5.5	50	-15
111-117	4,943	4	x	x	-4	5.5	50	-15

PUBLIC PARKING AND ACCESS MAPS

ATTACHMENT 4

ADDENDUM 1 AND ADDENDUM 2

Addendum 1, Section 4.0-Coastal Storm Damages Without Project and Table B-3

The affected structures in reaches 15, 70, 78, 87, 89, 92, 93, 106, 114, and 116 can be described as mostly multilevel multifamily structures that are mainly “slab on grade” construction. Also, included in this inventory are larger, “slab on grade” hotels, and commercial entities, which include a “second row” post office and church and large fishing pier.

By reach, the structures of note are as follows:

- Reach 15: High density condominiums on Pebble Beach Rd and Queen Ct.
- Reach 70: High density condominium developments (Forest Dunes and Coral Shores), Clam Digger Inn
- Reach 78: High density condominium developments and Whaler Inn Beach Club
- Reach 87: High density condominium development
- Reach 89: High density condominium development (Ocean Sands), Windjammer Inn and Seahawk Inn and Villas
- Reach 92: High density condominium development (Coral Bay Club)
- Reach 93: Post office and Bogue Banks Baptist Church, both on “second row” of inventory
- Reach 106: High density condominium development (Dunes Club), Oceana Fishing Pier
- Reach 114: High density condominium development (A Place at The Beach, phases I-III)
- Reach 116: High density condominium development (A Place at The Beach, phases I-III and Tar Landing)

Addendum 2, 6.03-Combined Structural/Non-Structural Alternative Evaluation

Nonstructural measures considered were regulatory (building codes, construction setbacks and floodplain regulations) and physical modifications to reduce damages (removal). Most regulatory measures have already been implanted at the local level. These measures were considered as part of the existing and future without project conditions, and are an integral part of any alternatives considered.

Based on an initial screening, no action, non-structural (regulatory measures and removal), and beach fill structural measure were forwarded in the plan formulation process and considered for more detailed evaluation.

The Economics Appendix (Section 6.03) and the Main Report (Section 5.07.2) discuss only one non-structural alternative which was the removal of all first row structures, but that is because it was the only non-structural alternative that made

it through the screening process. This screening process is further described in section 5.05 of the Main Report.

Section 5.07.3 of the Main Report describes the combined structural/non-structural alternative evaluation. A combined structural/non-structural alternative would involve structure removal in parts of a study area, and beach fill in other parts. Generally, in a combined plan, the non-structural aspects would be implemented at the “ends” of a project or within stretches of beach the structural alternative is implemented.

The non-structural analysis showed 5 reaches that had positive net benefits – reaches 78, 89, 93, 106 and 114. However, these reaches are all separated from one another by a good distance, plus the net benefits from the structural plans at these reaches are even higher. Therefore, there was not a viable combined structural/non-structural alternative, and such a plan was screened from further consideration.

A combined structural/non-structural plan where specific reaches are implemented as non-structural would have 1000 foot sections where the dune and berms would not be constructed and/or maintained. These gaps are unsustainable and would eventually permit erosion and flanking of the adjacent structural area and reduce benefits there.
