MONTAUK POINT, N.Y. - ECONOMICS <u>APPENDIX 4</u>

General

1.   The feasibility study is being conducted under the following study authority: 15 May 1991:

"Resolved by the Committee on Environment and Public Works of the United States Senate, that the Secretary of the Army is hereby requested to review the report of the Chief of Engineers on Fire Island to Montauk Point, New York, published as House Document Number 86-425, 86th Congress, 2nd session, and other pertinent reports, to determine whether modifications of the recommendations contained therein are advisable at the present time, with a view to preserving, restoring, and protecting Montauk Point and vicinity, including the historic Montauk Lighthouse and associated facilities, from erosion, environmental degradation, and coastal storm damage."

2.   In addition, Section 110 of the National Historic Preservation Act of 1966, as amended, imposes a responsibility to maintain and protect historic properties. At the present time this responsibility is borne directly by the Montauk Point Historical Society, the current owners of the Montauk Point Lighthouse. However, through the operation of a revisionary interest, as provided for in the land transfer (a quitclaim dated 18 September 1998 from the U.S. Coast Guard to the Montauk Point Historical Society), this responsibility would fall back on the federal government.

3.   When originally proposed, the transfer of the property from the U.S. Coast Guard to the Montauk Historical Society would have had an adverse impact on the property because the Montauk Historical Society, as a non-federal entity, would not have been required to adhere to the National Historic Preservation Act. To avoid this adverse impact, the U.S. Coast Guard included a condition in the transfer agreement that required the Montauk Historical Society to maintain and preserve the property in accordance with the National Historic Preservation Act.   The Montauk Historical Society is therefore required to act as a federal agency with regards to the preservation of the National Historic Landmark.

4   Alternative ways to follow Section 110 of the NHPA at Montauk Point therefore include:

- Provide mitigation for adverse impacts following a storm event that causes damage to the bluff and other features of the historic property, or

- Take steps now to protect the integrity and significance of the historic property, thereby avoiding the costs of Section 110 compliance that would have been triggered by storm damage.

- Through a combination of Section 110 of the NHPA and the nature of the land conveyance, there is indeed a statutory duty to perform the cultural resources mitigation at Montauk Point. If triggered by coastal storm damage such mitigation would incur a cost; therefore, avoiding that cost should, therefore be counted as a benefit.

5.   If the Federal government is not mandated to follow Section 110 of the NHPA and the nature of the land conveyance, then the most likely future without-project scenario is that the bluff will erode and the historic Montauk Point Lighthouse complex will collapse. The economic analysis that follows below is based on this assumption.

6.   The proxy used to place a depreciated replacement value of the Montauk Point Lighthouse complex is based on the calculations for the costs of historic property mitigation. Moving the Montauk Point Lighthouse complex, a National Historic Landmark, would preserve the structures but allow for the eventual destruction of the bluff and archaeological resources. These archaeological materials, which are contributing elements to the National Historic Landmark, must be documented through data recovery. Prior to moving the structures, each structure, individually, as well as their interrelationship as a complex, would be documented on engineering drawings and through photographs to facilitate their rebuilding on the new site as well as documenting their historic setting. Archaeological excavations would be performed to recover artifacts pertaining to the use of the lighthouse and the bluff as well as identifying any potentially significant sites at the new location. Alternatively, all of these costs could be avoided by protecting the property from storm damage.

Existing Conditions

7.   The lighthouse complex and the surrounding Montauk Point State Park are valued Federal and State properties respectively. Montauk Point Lighthouse complex and the State Park annual attendance figures averaged 76,376 and 833,864 persons, respectively in the 2004-2012 period. The lighthouse complex does not have a parking lot, and visitors must use the state parking lot. The average attendance for the state park only is 757,488 (833,864-76,376). These figures were obtained from Montauk Point Lighthouse and Montauk State Park offices. Recent census data indicate that the populations for Long Island and New York's five boroughs have increased by 2.3% in ten years. The population for the surveyed area increased from 10,762,191 (2000 Census) to 11,008,015 (2010 Census). The economic analysis assumes the lighthouse and state park attendance will remain stable. Tables 1-3 show lighthouse admissions, parks admissions, and state population data.

TABLE 1. Lighthouse Attendance				
Year	Adults	Seniors	Children	Group	Total
2004	54,192	6,851	15,427	4,810	81,280
2005	49,592	6,245	14,450	4,161	74,448
2006	46,699	5,574	13,773	3,645	69,691
2007	50,634	6,518	14,567	4,616	76,335
2008	49,697	6,822	13,885	3,668	74,072
2009	51,618	7,137	14,996	4,369	78,120
2010	51,365	7,410	14,569	4,452	77,796
2011	47,770	6,911	12,812	4,118	71,611
2012	57,579	8,160	14,870	3,422	84,031
Total	459,146	61,628	129,349	37,261	687,384
Avg.	**51,016**	**6,848**	**14,372**	**4,140**	**76,376**

TABLE 2. Montauk State Park	
Year	Attendance
2004	905,950
2005	886,700
2006	898,910
2007	867,045
2008	904,428
2009	863,190
2010	687,830
2011	752,240
2012	738,485
Total	7,504,778
Avg.	**833,864**

TABLE 3. Population Data									
									2000-2010
County	1980		1990		2000		2010*		%Change
Nassau	1,321,582		1,287,348		1,334,544		1,339,532		0.4%
Suffolk	1,284,231		1,321,864		1,419,369		1,493,350		5.2%
Bronx	1,168,972		1,203,789		1,332,650		1,385,108		3.9%
Kings	2,231,028		2,300,664		2,465,326		2,504,700		1.6%
New York	1,428,285		1,487,536		1,537,195		1,585,873		3.2%
Queens	1,891,325		1,951,598		2,229,379		2,230,722		0.1%
Richmond	352,029		378,977		443,728		468,730		5.6%
Total	9,677,452		9,931,776		10,762,191		11,008,015		8.4%
*Source: US Census Bureau, 2010									

Without-Project Conditions

7.   The Montauk Point Lighthouse complex sits on a high bluff underlain with glacial till, approximately 70-feet above Mean Sea Level (MSL). It is estimated that once the upper sections of the revetment that protects the bluff are displaced by a 15-year or greater storm event, the foundation soil underlying the displaced stone will become exposed and subject to subsequent erosion. To determine the extent of this erosion at the toe of the upper bluff above the damaged revetment that would cause significant bluff failure, a slope stability analysis was performed. The results of this analysis determined that for significant bluff failure, the damaged crest elevation of the revetment should degrade to approximately elevation +10 NGVD and the upper bluff toe at this +10 NGVD elevation recede horizontally approximately 10 ft. This is anticipated to cause approximately 26-30 ft. of loss of the bluff crest which will immediately threaten the lighthouse facility at the most critical area to the southeast of the lighthouse.

8.   The period of time estimated for this condition to occur, subsequent to revetment failure, is an additional 10 years of long-term erosion at the upper bluff toe (at el. +10 NGVD). A decision tree analysis was applied to calculate the probability of revetment failure for any given year through the 50-year period of economic analysis due to a 15-year or greater storm event. When revetment failure occurs, the bluff crest will erode at an average rate of 3 feet per year. The lighthouse complex will be immediately threatened after 10 years, or 30 feet of erosion at the bluff crest.

Proxy for Depreciated Replacement Value of Montauk Lighthouse Complex

9.   The proxy used to place an economic value of the National Historic Landmark, Montauk Point Lighthouse complex, is based on the hypothetical calculations for the costs of historic properties mitigation of the site. The economic analysis assumes that the historic properties mitigation of the site will be initiated after the revetment that protects the bluff is displaced. The estimated cost for moving the Montauk Point Lighthouse

complex and complete historic properties mitigation of the complex is $22,693,000[1] (October 2016 price level), as shown in Table 4. This figure takes into account the creation of raised grades landward of the present location of the lighthouse for the move. The raised grade would be necessary to maintain the lighthouse elevation because the existing bluff elevation decreases significantly as one move away from the shorefront. The overall mitigation process would take approximately three years to complete. The cost flows for years 1 through 3 were present valued to the base year. This was done to convert 3 years of expenditures into an equivalent expenditure that will occur in one year. Table 5 shows the calculations for the one-year equivalent value of the lighthouse complex if the upper section of the revetment is displaced in year 2017. Since this expenditure only happens when a 15-year or greater storm occurs, a decision tree analysis was applied to calculate the probability of occurrence throughout the 50-year period of analysis. For example, the probability for the expenditure to occur in year 0 (base year) is $(1/15) = 0.067$; year 1 (base year +1) is $(14/15)*(1/15) = .062$; and so forth up to the fiftieth year. The expected value (sum of the products of the probability of occurrences multiplied by the one-year equivalent cultural mitigation cost) was then amortized using a 2.875 percent discount rate and a 50-year period of analysis to calculate the average annual mitigation cost at an October 2016 price level.

Table 4. Cultural Mitigation Costs of Lighthouse Complex			
Year	Tasks		Costs
1	Public Hearings	$	100,000
	Phase I&II Surveys	$	175,000
	Coordination	$	100,000
2	Phase 3 Archaeological Survey	$	2,000,000
	Coordination	$	60,000
	HABS Work (various)	$	750,000.00
	Website, Publications, etc.	$	500,000.00
	Coordination	$	60,000.00
	Public Hearings	$	100,000.00
Subtotal Archaeological Work		$	3,845,000
3	Moving Lighthouse	$	18,473,000
	Archaeological Monitoring	$	375,000
Subtotal Moving the Lighthouse		$	18,848,000
	Total	$	22,693,000

---

[1] The Cape Hatteras Lighthouse was relocated at a cost of $12 million in 1999. This is equivalent to approximately $20.5 million at 2017 price levels (Civil Works Construction Cost Index). Unlike the Cape Hatteras Lighthouse, which rested on a relatively flat, level surface, the Montauk Point Lighthouse rests upon a hill on top of the bluff. Raised grades would have to be built to raise the level of the ground west of the bluff up to the lighthouse grade to ensure a stable move.

Table 5. Montauk Point Lighthouse Complex - Calculation for one-year equivalent value (October 2016 P.L. 2.875% discount rate)				
Year		Present Value Factor	Mitigation Cost	Expected Value
2016	BY-4	1.1200551		$ -
2017	BY-3	1.0887535	$ 375,000	$ 408,283
2018	BY-2	1.0583266	$ 3,470,000	$ 3,672,393
2019	BY-1	1.0287500	$ 18,848,000	$ 19,389,880
2020	BY	1.0000000		$ -
		Total		$ 23,471,000

10.   Table 6 shows the expected annual cultural mitigation costs and lighthouse relocation costs that would be incurred in the without-project condition when the revetment fails and bluff erosion begins. This calculation is the proxy for the depreciated replacement value of the Montauk Lighthouse complex. The year 1994 was used to initiate the probability calculations for revetment failure because 1993 was the most recent occurrence of a 15-year or greater storm event.

Table 6. Proxy for Depreciated Replacement Value of Lighthouse Complex - without-project (October 2016 P.L., 2.875% discount rate)

	End of year n	Probability that armor stone will be there at end of year n	Probability that armor stone won't be there at end of year n	Present Value of Lighthouse Complex in Year n	Prob. Of Damage in Year n	Expected Damage in Year n
1994	1	0.9333333	0.0666667			
1995	2	0.8711111	0.1288889			
1996	3	0.8130370	0.1869630			
1997	4	0.7588346	0.2411654			
1998	5	0.7082456	0.2917544			
1999	6	0.6610292	0.3389708			
2000	7	0.6169606	0.3830394			
2001	8	0.5758299	0.4241701			
2002	9	0.5374412	0.4625588			
2003	10	0.5016118	0.4983882			
2004	11	0.4681710	0.5318290			
2005	12	0.4369596	0.5630404			
2006	13	0.4078290	0.5921710			
2007	14	0.3806404	0.6193596			
2008	15	0.3552644	0.6447356			
2009	16	0.3315801	0.6684199			
2010	17	0.3094747	0.6905253			
2011	18	0.2888431	0.7111569			
2012	19	0.2695869	0.7304131			
2013	20	0.2516144	0.7483856			
2014	21	0.2348401	0.7651599			
2015	22	0.2191841	0.7808159			
2016	23	0.2045718	0.7954282			
2017	24	0.1909337	0.8090663			
2018	25	0.1782048	0.8217952			
2019	26	0.1663245	0.8336755			
2020	27	0.1552362	0.8447638	$23,470,556	0.067	$1,321,805
2021	28	0.1448871	0.8551129	$22,814,635	0.062	$1,213,899
2022	29	0.1352280	0.8647720	$22,177,045	0.058	$1,113,75
2023	30	0.1262128	0.8737872	$21,557,273	0.054	$1,020,983
2024	31	0.1177986	0.8822014	$20,954,822	0.051	$935,207
2025	32	0.1099453	0.8900547	$20,369,207	0.047	$856,019
2026	33	0.1026157	0.8973843	$19,799,959	0.044	$783,019
2027	34	0.0957746	0.9042254	$19,246,618	0.041	$715,809
2028	35	0.0893896	0.9106104	$18,708,742	0.038	$654,004
2029	36	0.0834303	0.9165697	$18,185,897	0.036	$597,228
2030	37	0.0778683	0.9221317	$17,677,665	0.033	$545,123
2031	38	0.0726771	0.9273229	$17,183,635	0.031	$497,347
2032	39	0.0678319	0.9321681	$16,703,412	0.029	$453,575
2033	40	0.0633098	0.9366902	$16,236,609	0.027	$413,503
2034	41	0.0590892	0.9409108	$15,782,852	0.025	$376,841
2035	42	0.0551499	0.9448501	$15,341,776	0.024	$343,320
2036	43	0.0514732	0.9485268	$14,913,027	0.022	$312,689
2037	44	0.0480417	0.9519583	$14,496,259	0.021	$284,713
2038	45	0.0448389	0.9551611	$14,091,139	0.019	$259,175
2039	46	0.0418496	0.9581504	$13,697,341	0.018	$235,873
2040	47	0.0390597	0.9609403	$13,314,547	0.017	$214,618
2041	48	0.0364557	0.9635443	$12,942,452	0.016	$195,240
2042	49	0.0340253	0.9659747	$12,580,755	0.015	$177,57
2043	50	0.0317570	0.9682430	$12,229,167	0.014	$161,486
2044	51	0.0296398	0.9703602	$11,887,404	0.013	$146,829
2045	52	0.0276638	0.9723362	$11,555,192	0.012	$133,482
2046	53	0.0258196	0.9741804	$11,232,264	0.011	$121,331
2047	54	0.0240983	0.9759017	$10,918,362	0.010	$110,272
2048	55	0.0224917	0.9775083	$10,613,231	0.010	$100,209
2049	56	0.0209923	0.9790077	$10,316,628	0.009	$91,054
2050	57	0.0195928	0.9804072	$10,028,314	0.008	$82,727
2051	58	0.0182866	0.9817134	$9,748,057	0.008	$75,154
2052	59	0.0170675	0.9829325	$9,475,633	0.007	$68,268
2053	60	0.0159297	0.9840703	$9,210,822	0.007	$62,008
2054	61	0.0148677	0.9851323	$8,953,411	0.006	$56,317
2055	62	0.0138765	0.9861235	$8,703,194	0.006	$51,14
2056	63	0.0129514	0.9870486	$8,459,970	0.006	$46,445
2057	64	0.0120880	0.9879120	$8,223,543	0.005	$42,174
2058	65	0.0112821	0.9887179	$7,993,724	0.005	$38,294
2059	66	0.0105300	0.9894700	$7,770,327	0.005	$34,768
2060	67	0.0098280	0.9901720	$7,553,173	0.004	$31,566
2061	68	0.0091728	0.9908272	$7,342,088	0.004	$28,657
2062	69	0.0085613	0.9914387	$7,136,902	0.004	$26,015
2063	70	0.0079905	0.9920095	$6,937,451	0.003	$23,616
2064	71	0.0074578	0.9925422	$6,743,573	0.003	$21,437
2065	72	0.0069606	0.9930394	$6,555,113	0.003	$19,459
2066	73	0.0064966	0.9935034	$6,371,921	0.003	$17,662
2067	74	0.0060635	0.9939365	$6,193,847	0.003	$16,031
2068	75	0.0056592	0.9943408	$6,020,751	0.002	$14,550
2069	76	0.0052820	0.9947180	$5,852,492	0.002	$13,205
						$15,155,47
					Annual Damages	$575,12

Local Costs Forgone

11.   The lighthouse complex is situated on 3 acres of land, specifically a bluff that has an appraised value of $18.2 million[2].   It is estimated that the top of the bluff will erode at a rate of 3 feet per year when the revetment fails. Because of the complexity of actually replacing the bluff surface, a prorated amount of the appraised value of land lost was used as a proxy for the local costs forgone for this loss in the without-project condition. The local costs forgone for this land value due to long-term erosion are calculated to be $131,200 per year. The average annual local costs forgone are $126,700 as shown in Table 7. The two numbers differ because the average annual costs take into account the probability that revetment failure will not occur immediately.

---

[2] The land was appraised for $12 million in 2004. The land value has been adjusted to October 2016 price levels using CPI rent for primary residences, (374.891/246.9) x $12 million = $18.2 million

	End of year n	Probability that armor	Probability that armor			
	n	stone will be there at	stone won't be there at			
		end of year n	end of year n	Present Value Factor		

Table 7. Local Costs Forgone (October 2016 P.L. 2.875% discount rate)

Year	n	Prob. armor will be there	Prob. armor won't be there	Present Value Factor	Value	Result
1994	1	0.9333333	0.0666667			
1995	2	0.8711111	0.1288889			
1996	3	0.8130370	0.1869630			
1997	4	0.7588346	0.2411654			
1998	5	0.7082456	0.2917544			
1999	6	0.6610292	0.3389708			
2000	7	0.6169606	0.3830394			
2001	8	0.5758299	0.4241701			
2002	9	0.5374412	0.4625588			
2003	10	0.5016118	0.4983882			
2004	11	0.4681710	0.5318290			
2005	12	0.4369596	0.5630404			
2006	13	0.4078290	0.5921710			
2007	14	0.3806404	0.6193596			
2008	15	0.3552644	0.6447356			
2009	16	0.3315801	0.6684199			
2010	17	0.3094747	0.6905253			
2011	18	0.2888431	0.7111569			
2012	19	0.2695869	0.7304131			
2013	20	0.2516144	0.7483856			
2014	21	0.2348401	0.7651599			
2015	22	0.2191841	0.7808159			
2016	23	0.2045718	0.7954282			
2017	24	0.1909337	0.8090663			
2018	25	0.1782048	0.8217952			
2019	26	0.1663245	0.8336755			
2020	27	0.1552362	0.8447638	1.0000000	$131,200	$110,833
2021	28	0.1448871	0.8551129	0.9720535	$131,200	$109,055
2022	29	0.1352280	0.8647720	0.9448879	$131,200	$107,205
2023	30	0.1262128	0.8737872	0.9184816	$131,200	$105,296
2024	31	0.1177986	0.8822014	0.8928132	$131,200	$103,339
2025	32	0.1099453	0.8900547	0.8678622	$131,200	$101,345
2026	33	0.1026157	0.8973843	0.8436084	$131,200	$99,324
2027	34	0.0957746	0.9042254	0.8200325	$131,200	$97,284
2028	35	0.0893896	0.9106104	0.7971154	$131,200	$95,233
2029	36	0.0834303	0.9165697	0.7748388	$131,200	$93,177
2030	37	0.0778683	0.9221317	0.7531847	$131,200	$91,123
2031	38	0.0726771	0.9273229	0.7321358	$131,200	$89,075
2032	39	0.0678319	0.9321681	0.7116752	$131,200	$87,038
2033	40	0.0633098	0.9366902	0.6917863	$131,200	$85,016
2034	41	0.0590892	0.9409108	0.6724533	$131,200	$83,013
2035	42	0.0551499	0.9448501	0.6536606	$131,200	$81,031
2036	43	0.0514732	0.9485268	0.6353930	$131,200	$79,073
2037	44	0.0480417	0.9519583	0.6176360	$131,200	$77,141
2038	45	0.0448389	0.9551611	0.6003752	$131,200	$75,237
2039	46	0.0418496	0.9581504	0.5835968	$131,200	$73,364
2040	47	0.0390597	0.9609403	0.5672873	$131,200	$71,521
2041	48	0.0364557	0.9635443	0.5514336	$131,200	$69,711
2042	49	0.0340253	0.9659747	0.5360229	$131,200	$67,933
2043	50	0.0317570	0.9682430	0.5210429	$131,200	$66,190
2044	51	0.0296398	0.9703602	0.5064816	$131,200	$64,481
2045	52	0.0276638	0.9723362	0.4923272	$131,200	$62,806
2046	53	0.0258196	0.9741804	0.4785683	$131,200	$61,167
2047	54	0.0240983	0.9759017	0.4651940	$131,200	$59,563
2048	55	0.0224917	0.9775083	0.4521934	$131,200	$57,993
2049	56	0.0209923	0.9790077	0.4395562	$131,200	$56,459
2050	57	0.0195928	0.9804072	0.4272721	$131,200	$54,960
2051	58	0.0182866	0.9817134	0.4153313	$131,200	$53,495
2052	59	0.0170675	0.9829325	0.4037243	$131,200	$52,065
2053	60	0.0159297	0.9840703	0.3924416	$131,200	$50,668
2054	61	0.0148677	0.9851323	0.3814742	$131,200	$49,305
2055	62	0.0138765	0.9861235	0.3708133	$131,200	$47,976
2056	63	0.0129514	0.9870486	0.3604504	$131,200	$46,679
2057	64	0.0120880	0.9879120	0.3503770	$131,200	$45,414
2058	65	0.0112821	0.9887179	0.3405852	$131,200	$44,181
2059	66	0.0105300	0.9894700	0.3310670	$131,200	$42,979
2060	67	0.0098280	0.9901720	0.3218148	$131,200	$41,807
2061	68	0.0091728	0.9908272	0.3128212	$131,200	$40,666
2062	69	0.0085613	0.9914387	0.3040790	$131,200	$39,554
2063	70	0.0079905	0.9920095	0.2955810	$131,200	$38,470
2064	71	0.0074578	0.9925422	0.2873205	$131,200	$37,415
2065	72	0.0069606	0.9930394	0.2792909	$131,200	$36,388
2066	73	0.0064966	0.9935034	0.2714857	$131,200	$35,388
2067	74	0.0060635	0.9939365	0.2638986	$131,200	$34,414
2068	75	0.0056592	0.9943408	0.2565236	$131,200	$33,465
2069	76	0.0052820	0.9947180	0.2493546	$131,200	$32,543
						$3,338,854
					Annual Damages	$126,703

<u>Recreation Loss</u>

12.	Another without-project consequence of storm damage to the bluff would be loss visitations to the lighthouse. Visitation losses associated with the lighthouse's closure were assessed using the Travel Cost Estimate of Willingness to Pay. The lighthouse has a log in which visitors indicate the places where they are traveling from to visit. A recent sample from the log was used to estimate the round-trip distance from each origin. The values of losses are the costs in cents per mile to operate an automobile, plus the opportunity costs of time spent in travel and on site. Surveys were conducted to determine the number of visitors that make the trip to Montauk, NY exclusively to visit the lighthouse. Based on the survey, 47% of the people sampled indicated that visiting the Montauk Lighthouse complex was the reason they drove to Montauk, New York. The remaining 53% of the people indicated that visiting the Montauk Lighthouse complex was part of their itinerary on their visit to Long Island, New York. The travel costs attributed to this category were prorated at 25% of their total travel costs.

13.	A rate of $0.535 per mile[3] was used for calculating the operating costs per car. Costs per person were calculated using state park figures of 3.5 persons per car. The opportunity cost of time is 1/3 and 1/12 the average wage rate for adults and children, respectively. The hourly wage rate is $20.47[4]. The estimated car driving speed is 40 mph. Tables 8 and 9 show the calculations for the Travel Cost Method. As a result, $2,651,600 in annual visitation losses have been projected for all visitors to the Montauk Point Lighthouse complex including admissions fees.

---

[3] IRS mileage rate for 2016.
[4] The estimated average payroll tax rate for the region is 30%. The current hourly wage rate is $28.84 (US Dept. of Labor, May 2015) multiplied by the CPI factor to bring the price level to October 2016 (264.738/261.066). The after-tax hourly wage rate is 0.7 x $28.84 (264.738/261.066) = $20.47.

Table 8. Montauk Point Lighthouse Travel Cost Method												
Mean Hourly Wage	Oct-16		Adult time cost/hr		Child time cost/hr			Annual Admission Fees				
NY&NJ metropolitan area	$20.47		$6.82		$1.71			$515,093				
Cost per mile	0.535		Avg. time spent									
Round Trip Factor	2		at lighthouse		1 hour							
People per car	3.5		No. Adults per year	59589								
Avg. driving speed	40		No. Children per year	16787								

Residence	No. of people sampled	Multiply Factor	No. of Adults	No. of Children	Miles to Montauk	Travel Cost Per Car	Car Travel Cost per Person	Total Car Travel Cost	Travel time cost per adult	Travel time cost per child	Total travel time cost	Total time cost spent at lighthouse
E. Hampton	40	0.022	1339	377	16	$17.12	$4.89	8,395	$5.46	$1.36	$7,824	$9,780
So. Hampton(1)	6	0.003	201	57	31	$33.17	$9.48	2,440	$10.58	$2.64	$2,274	$1,467
So. Hampton(2)	7	0.004	234	66	45	$48.15	$13.76	4,132	$15.35	$3.84	$3,851	$1,712
Southhold	11	0.006	368	104	42	$44.94	$12.84	6,060	$14.33	$3.58	$5,648	$2,690
Riverhead	10	0.006	335	94	48	$51.36	$14.67	6,296	$16.38	$4.09	$5,868	$2,445
Brookhaven(1)	73	0.041	2444	688	61	$65.27	$18.65	58,412	$20.81	$5.20	$54,441	$17,849
Brookhaven(2)	74	0.042	2477	698	67	$71.69	$20.48	65,037	$22.86	$5.71	$60,614	$18,094
Islip	100	0.056	3348	943	74	$79.18	$22.62	97,070	$25.25	$6.31	$90,469	$24,451
Smithtown	16	0.009	536	151	76	$81.32	$23.23	15,951	$25.93	$6.48	$14,866	$3,912
Babylon	83	0.047	2779	783	83	$88.81	$25.37	90,367	$28.32	$7.08	$84,222	$20,294
Huntington	48	0.027	1607	453	88	$94.16	$26.90	55,409	$30.02	$7.51	$51,641	$11,737
Oyster Bay	21	0.012	703	198	95	$101.65	$29.04	26,170	$32.41	$8.10	$24,390	$5,135
So. Oyster Bay	21	0.012	703	198	90	$96.30	$27.51	24,792	$30.71	$7.68	$23,106	$5,135
Hempstead	143	0.080	4787	1349	100	$107.00	$30.57	187,581	$34.12	$8.53	$174,826	$34,965
No. Hempstead	19	0.011	636	179	103	$110.21	$31.49	25,671	$35.14	$8.79	$23,925	$4,646
Queens	99	0.056	3314	934	115	$123.05	$35.16	149,343	$39.23	$9.81	$139,188	$24,207
Brooklyn	40	0.022	1339	377	115	$123.05	$35.16	60,341	$39.23	$9.81	$56,238	$9,780
Manhattan	106	0.060	3549	1000	116	$124.12	$35.46	161,293	$39.58	$9.89	$150,326	$25,918
Bronx	24	0.013	803	226	120	$128.40	$36.69	37,779	$40.94	$10.24	$35,210	$5,868
Staten Island	12	0.007	402	113	120	$128.40	$36.69	18,889	$40.94	$10.24	$17,605	$2,934
Others	827	0.465	27685	7799	20	$21.40	$6.11	216,964	$6.82	$1.71	$202,211	$202,211
Total	1780	1	59589	16787				1,318,392			$1,228,744	$435,231
Prorated Travel Cost								$880,575			$820,697	$435,231

Table 9. Summary of Travel Cost Method (October 2016 P.L.)		
Prorated Car Travel Cost	$	880,575
Prorated Travel Time Cost	$	820,697
Time Spent at Lighthouse Cost	$	435,231
Admissions Cost	$	515,093
Total	$	2,651,595

14.   Lighthouse visitations will be lost when the existing revetment is damaged by a 15-year or greater storm event, followed by 10 years of erosion to the bluff. If the revetment is damaged in year 2017, the lighthouse visitations will be lost starting in year 2027. Since the base year is 2020, the lighthouse visitations will be lost from 2027 through 2069. The $2,651,600 per year of lighthouse visitations from 2027 through 2069 is discounted to the first year that visitations are lost, year 2027. This was done to convert 43 years of lost visitations into a one-year equivalent loss that will occur in 2027. Similar calculations converted the lost visitations into one-year equivalents losses that will occur in years 2028 through 2069. These results are shown in Table 10. The average annual lighthouse visitations are calculated to be $1,182,200 as shown in Table 11.

		Lighthouse Visitations in year n	Lighthouse Visitations Present Value	Lighthouse Visitations 1-yr equivalent value in year n
Table 10. Montauk Point Lighthouse Visitations - Calculation for one-year equivalent value in year n (October 2016 P.L., 2.875% discount rate)				
Year	Present Value Factor			
2020	1			
2021	0.972053463			
2022	0.944887935			
2023	0.918481589			
2024	0.892813209			
2025	0.867862172			
2026	0.84360843			
2027	0.820032495	$2,651,595	$2,174,394	$54,807,673
2028	0.797115427	$2,651,595	$2,113,628	$52,633,279
2029	0.774838811	$2,651,595	$2,054,559	$50,519,651
2030	0.753184749	$2,651,595	$1,997,141	$48,465,092
2031	0.732135844	$2,651,595	$1,941,328	$46,467,951
2032	0.711675182	$2,651,595	$1,887,075	$44,526,623
2033	0.691786326	$2,651,595	$1,834,337	$42,639,548
2034	0.672453293	$2,651,595	$1,783,074	$40,805,211
2035	0.653660553	$2,651,595	$1,733,243	$39,022,137
2036	0.635393004	$2,651,595	$1,684,805	$37,288,894
2037	0.61763597	$2,651,595	$1,637,721	$35,604,089
2038	0.600375183	$2,651,595	$1,591,952	$33,966,368
2039	0.583596776	$2,651,595	$1,547,462	$32,374,416
2040	0.567287267	$2,651,595	$1,504,216	$30,826,953
2041	0.551433552	$2,651,595	$1,462,179	$29,322,737
2042	0.536022894	$2,651,595	$1,421,316	$27,860,558
2043	0.52104291	$2,651,595	$1,381,595	$26,439,243
2044	0.506481565	$2,651,595	$1,342,984	$25,057,648
2045	0.492327159	$2,651,595	$1,305,452	$23,714,664
2046	0.47856832	$2,651,595	$1,268,970	$22,409,211
2047	0.465193993	$2,651,595	$1,233,506	$21,140,242
2048	0.452193432	$2,651,595	$1,199,034	$19,906,735
2049	0.439556191	$2,651,595	$1,165,525	$18,707,701
2050	0.427272118	$2,651,595	$1,132,953	$17,542,176
2051	0.415331342	$2,651,595	$1,101,291	$16,409,224
2052	0.403724269	$2,651,595	$1,070,513	$15,307,933
2053	0.392441574	$2,651,595	$1,040,596	$14,237,420
2054	0.381474191	$2,651,595	$1,011,515	$13,196,823
2055	0.370813308	$2,651,595	$983,247	$12,185,308
2056	0.36045036	$2,651,595	$955,768	$11,202,061
2057	0.350377021	$2,651,595	$929,058	$10,246,293
2058	0.340585197	$2,651,595	$903,094	$9,317,235
2059	0.33106702	$2,651,595	$877,856	$8,414,141
2060	0.321814843	$2,651,595	$853,323	$7,536,285
2061	0.312821233	$2,651,595	$829,475	$6,682,962
2062	0.304078962	$2,651,595	$806,294	$5,853,487
2063	0.295581008	$2,651,595	$783,761	$5,047,192
2064	0.287320543	$2,651,595	$761,858	$4,263,431
2065	0.279290929	$2,651,595	$740,567	$3,501,573
2066	0.271485714	$2,651,595	$719,870	$2,761,007
2067	0.263898629	$2,651,595	$699,752	$2,041,137
2068	0.256523576	$2,651,595	$680,197	$1,341,384
2069	0.24935463	$2,651,595	$661,188	$661,188

Table 11. Lighthouse Visitations Damages - without-project
(October 2016 P.L., 2.875% discount rate)

	End of year n	Probability that armor stone will be there at end of year n	Probability that armor stone won't be there at end of year n	Present Value of Visitaions for Year n	Prob. Of Damage in Year n	Expected Damage in Year n
	n					
1994	1	0.9333333	0.0666667			
1995	2	0.8711111	0.1288889			
1996	3	0.8130370	0.1869630			
1997	4	0.7588346	0.2411654			
1998	5	0.7082456	0.2917544			
1999	6	0.6610292	0.3389708			
2000	7	0.6169606	0.3830394			
2001	8	0.5758299	0.4241701			
2002	9	0.5374412	0.4625588			
2003	10	0.5016118	0.4983882			
2004	11	0.4681710	0.5318290			
2005	12	0.4369596	0.5630404			
2006	13	0.4078290	0.5921710			
2007	14	0.3806404	0.6193596			
2008	15	0.3552644	0.6447356			
2009	16	0.3315801	0.6684199			
2010	17	0.3094747	0.6905253			
2011	18	0.2888431	0.7111569			
2012	19	0.2695869	0.7304131			
2013	20	0.2516144	0.7483856			
2014	21	0.2348401	0.7651599			
2015	22	0.2191841	0.7808159			
2016	23	0.2045718	0.7954282			
2017	24	0.1909337	0.8090663			
2018	25	0.1782048	0.8217952			
2019	26	0.1663245	0.8336755			
2020	27	0.1552362	0.8447638			
2021	28	0.1448871	0.8551129			
2022	29	0.1352280	0.8647720			
2023	30	0.1262128	0.8737872			
2024	31	0.1177986	0.8822014			
2025	32	0.1099453	0.8900547			
2026	33	0.1026157	0.8973843			
2027	34	0.0957746	0.9042254	$54,807,673	0.067	$3,303,899
2028	35	0.0893896	0.9106104	$52,633,279	0.062	$2,982,212
2029	36	0.0834303	0.9165697	$50,519,651	0.058	$2,689,107
2030	37	0.0778683	0.9221317	$48,465,092	0.054	$2,422,373
2031	38	0.0726771	0.9273229	$46,467,951	0.051	$2,179,919
2032	39	0.0678319	0.9321681	$44,526,623	0.047	$1,959,777
2033	40	0.0633098	0.9366902	$42,639,548	0.044	$1,760,103
2034	41	0.0590892	0.9409108	$40,805,211	0.041	$1,579,17
2035	42	0.0551499	0.9448501	$39,022,137	0.038	$1,415,393
2036	43	0.0514732	0.9485268	$37,288,894	0.036	$1,267,269
2037	44	0.0480417	0.9519583	$35,604,089	0.033	$1,133,429
2038	45	0.0448389	0.9551611	$33,966,368	0.031	$1,012,603
2039	46	0.0418496	0.9581504	$32,374,416	0.029	$903,620
2040	47	0.0390597	0.9609403	$30,826,953	0.027	$805,404
2041	48	0.0364557	0.9635443	$29,322,737	0.025	$716,968
2042	49	0.0340253	0.9659747	$27,860,558	0.024	$637,406
2043	50	0.0317570	0.9682430	$26,439,243	0.022	$565,888
2044	51	0.0296398	0.9703602	$25,057,648	0.021	$501,657
2045	52	0.0276638	0.9723362	$23,714,664	0.019	$444,022
2046	53	0.0258196	0.9741804	$22,409,211	0.018	$392,350
2047	54	0.0240983	0.9759017	$21,140,242	0.017	$346,067
2048	55	0.0224917	0.9775083	$19,906,735	0.016	$304,650
2049	56	0.0209923	0.9790077	$18,707,701	0.015	$267,624
2050	57	0.0195928	0.9804072	$17,542,176	0.014	$234,555
2051	58	0.0182866	0.9817134	$16,409,224	0.013	$205,052
2052	59	0.0170675	0.9829325	$15,307,933	0.012	$178,759
2053	60	0.0159297	0.9840703	$14,237,420	0.011	$155,354
2054	61	0.0148677	0.9851323	$13,196,823	0.010	$134,544
2055	62	0.0138765	0.9861235	$12,185,308	0.010	$116,066
2056	63	0.0129514	0.9870486	$11,202,061	0.009	$99,681
2057	64	0.0120880	0.9879120	$10,246,293	0.008	$85,172
2058	65	0.0112821	0.9887179	$9,317,235	0.008	$72,345
2059	66	0.0105300	0.9894700	$8,414,141	0.007	$61,024
2060	67	0.0098280	0.9901720	$7,536,285	0.007	$51,049
2061	68	0.0091728	0.9908272	$6,682,962	0.006	$42,279
2062	69	0.0085613	0.9914387	$5,853,487	0.006	$34,584
2063	70	0.0079905	0.9920095	$5,047,192	0.006	$27,848
2064	71	0.0074578	0.9925422	$4,263,431	0.005	$21,967
2065	72	0.0069606	0.9930394	$3,501,573	0.005	$16,848
2066	73	0.0064966	0.9935034	$2,761,007	0.005	$12,405
2067	74	0.0060635	0.9939365	$2,041,137	0.004	$8,563
2068	75	0.0056592	0.9943408	$1,341,384	0.004	$5,254
2069	76	0.0052820	0.9947180	$661,188	0.004	$2,418
						$31,154,263
					Annual Damages	$1,182,245

15.   The Montauk Point Lighthouse complex resides within the Montauk Point State Park. The Montauk Point Lighthouse complex offers a unique experience that is not found elsewhere in the New York metropolitan area. Part of the state park experience is its connection with the lighthouse complex. There will be a reduction to the overall aesthetics and recreational value of the state park visitations if the lighthouse complex did not exist. Per ER 1105-2-100, Planning Guidance Notebook, the Unit Day Value method was used to assign visitation values to the state park for the with-project and without-project conditions. It is estimated that the current value for the recreational experience is $8.79. Without the lighthouse complex, the recreational experience is reduced to an estimate of $7.63. The annual benefits lost from state park visitations experience are $870,000 based on 750,000 visitations[5]. Table 12 shows the calculations for the state park recreation values based on Unit Day Value calculations. The two criteria that differ from the without-project versus with-project conditions are the recreation experience and the availability of opportunity. The recreation experience with the project in place will preserve the lighthouse and therefore, have one high quality value activity, the ability to visit the lighthouse. The assigned recreation experience value with the project in place is 15 points versus 10 points in the without-project condition. The availability of opportunity value is also increased with preserving the lighthouse. There is no recreation area that has a historic lighthouse within an hour's drive of Montauk Point State Park[6]. The assigned availability of opportunity value with the project in place is 14 points versus 6 points in the without-project condition. The average annual reduced state park usage values will be incurred when the existing revetment is damaged by a 15-year or greater storm event, and after 10 years of long-term erosion have occurred to the bluff. Tables 13 shows the one-year equivalent reduced state park visitation usages for years 2027 through 2069 and Table 14 shows calculations for the average annual reduced state park recreational experience to be $387,900.

---

[5] Unit Day Value was used due to study cost considerations. The difference in state park usage value is $1.16 per visit. 750,000 visitations x $1.15 = $870,000 (Oct. 2016 P.L.). Although the average annual visitations to the State Park are 833,900, the method of using Unit Day Value to evaluate recreation usage imposes an annual visitation cap of 750,000 persons.

[6] Montauk Point Lighthouse is the oldest lighthouse in New York State. The lighthouse was authorized by the Second Congress, under President George Washington, in 1792. This National Historic Landmark is the fourth oldest active lighthouse in the United States.

Table 12: State Park Visitations, Guidelines for Assigning Points for General Recreation - Unit Day Values (FY 2017)

Criteria	Judgment Factors					Points Assigned Without Project	Points Assigned With Project
Recreation experience[1]	Two general activities[2]	Several general activities	Several general activities; one high quality value activity[3]	Several general activities; more than one high quality value activity	Numerous high quality value activities; some general activities		
Total Points: 30							
Point Value:	0-4	5-10	11-16	17-23	24-30	**10**	**15**
Availability of opportunity[4]	Several within 1 hr. travel time; a few within 30 min. travel time	Several within 1 hr. travel time; none within 30 min. travel time	One or two within 1 hr. travel time; none within 45 min. travel time	None within 1 hr. travel time	None within 2 hr. travel time		
Total Points: 18							
Point Value:	0-3	4-6	7-10	11-14	15-18	**6**	**14**
Carrying Capacity[5]	Minimum facility for development for public health and safety	Basic facility to conduct activity(ies)	Adequate facilities to conduct without deterioration of the resource or activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative		
Total Points: 14							
Point Value:	0-2	3-5	6-8	9-11	12-14	**6**	**6**
Accessibility	Limited access by any means to site or within site	Fair access, poor quality roads to site; limited access within site	Fair access, fair road to site; fair access, good roads within site	Good access, good roads to site; fair access, good roads within site	Good access, high standard road to site; good access within site		
Total Points: 18							
Point Value:	0-3	4-6	7-10	11-14	15-18	**10**	**10**
Environmental	Low esthetic factors[6] that significantly lower quality[7]	Average esthetic quality; factors exist that lower quality to minor degree	Above average esthetic quality; any limiting factors can be reasonably rectified	High esthetic quality; no factors exist that lower quality	Outstanding esthetic quality; no factors exist that lower quality		
Total Points: 20							
Point Value:	0-2	3-6	7-10	11-15	16-20	**10**	**10**
					Total Points	42	55
					Unit Day Value	$7.63	$8.79

[1]Value for water-oriented activities should be adjusted if significant seasonal water level changes occur.

[2]General activities include those that are common to the region and that are usually of normal quality. This includes picnicking, camping, hiking, riding, cycling, and fishing and hunting of normal quality.

[3]High quality value activities include those that are not common to the region and/or Nation, and that are usually of high quality.

[4]Likelihood of success are fishing and hunting.

[5]Value should be adjusted for overuse.

[6]Major aesthetic qualities to be considered include geology and topography, water, and vegetation.

[7]Factors to be considered to lowering quality include air and water pollution, pests, poor climate, and unsightly adjacent areas.

Table 13. Montauk Point State Park Visitations - Calculation for one-year equivalent value in year n (October 2016 P.L., 2.875% discount rate)

Year	Present Value Factor	State Park Visitations in year n	State Park Visitations Present Value	State Park Visitations 1-yr equivalent value in year n
2020	1			
2021	0.972053463			
2022	0.944887935			
2023	0.918481589			
2024	0.892813209			
2025	0.867862172			
2026	0.84360843			
2027	0.820032495	$870,000	$713,428	$17,982,637
2028	0.797115427	$870,000	$693,490	$17,269,208
2029	0.774838811	$870,000	$674,110	$16,575,71
2030	0.753184749	$870,000	$655,271	$15,901,608
2031	0.732135844	$870,000	$636,958	$15,246,338
2032	0.711675182	$870,000	$619,157	$14,609,379
2033	0.691786326	$870,000	$601,854	$13,990,222
2034	0.672453293	$870,000	$585,034	$13,388,368
2035	0.653660553	$870,000	$568,685	$12,803,333
2036	0.635393004	$870,000	$552,792	$12,234,649
2037	0.61763597	$870,000	$537,343	$11,681,85
2038	0.600375183	$870,000	$522,326	$11,144,51
2039	0.583596776	$870,000	$507,729	$10,622,187
2040	0.567287267	$870,000	$493,540	$10,114,45
2041	0.551433552	$870,000	$479,747	$9,620,918
2042	0.536022894	$870,000	$466,340	$9,141,17
2043	0.52104291	$870,000	$453,307	$8,674,831
2044	0.506481565	$870,000	$440,639	$8,221,524
2045	0.492327159	$870,000	$428,325	$7,780,885
2046	0.47856832	$870,000	$416,354	$7,352,560
2047	0.465193993	$870,000	$404,719	$6,936,206
2048	0.452193432	$870,000	$393,408	$6,531,487
2049	0.439556191	$870,000	$382,414	$6,138,079
2050	0.427272118	$870,000	$371,727	$5,755,665
2051	0.415331342	$870,000	$361,338	$5,383,938
2052	0.403724269	$870,000	$351,240	$5,022,600
2053	0.392441574	$870,000	$341,424	$4,671,360
2054	0.381474191	$870,000	$331,883	$4,329,935
2055	0.370813308	$870,000	$322,608	$3,998,053
2056	0.36045036	$870,000	$313,592	$3,675,445
2057	0.350377021	$870,000	$304,828	$3,361,853
2058	0.340585197	$870,000	$296,309	$3,057,025
2059	0.33106702	$870,000	$288,028	$2,760,716
2060	0.321814843	$870,000	$279,979	$2,472,688
2061	0.312821233	$870,000	$272,154	$2,192,709
2062	0.304078962	$870,000	$264,549	$1,920,555
2063	0.295581008	$870,000	$257,155	$1,656,006
2064	0.287320543	$870,000	$249,969	$1,398,850
2065	0.279290929	$870,000	$242,983	$1,148,882
2066	0.271485714	$870,000	$236,193	$905,898
2067	0.263898629	$870,000	$229,592	$669,706
2068	0.256523576	$870,000	$223,176	$440,114
2069	0.24935463	$870,000	$216,939	$216,939

		Table 14. Park Visitation Damages - without-project design				
		(October 2016 P.L., 2.875% discount rate)				
	End of year n	Probability that armor stone will be there at end of year n	Probability that armor stone won't be there at end of year n	Present Value of Visitaions for Year n	Prob. Of Damage in Year n	Expected Damage in Year n
	n					
1994	1	0.9333333	0.0666667			
1995	2	0.8711111	0.1288889			
1996	3	0.8130370	0.1869630			
1997	4	0.7588346	0.2411654			
1998	5	0.7082456	0.2917544			
1999	6	0.6610292	0.3389708			
2000	7	0.6169606	0.3830394			
2001	8	0.5758299	0.4241701			
2002	9	0.5374412	0.4625588			
2003	10	0.5016118	0.4983882			
2004	11	0.4681710	0.5318290			
2005	12	0.4369596	0.5630404			
2006	13	0.4078290	0.5921710			
2007	14	0.3806404	0.6193596			
2008	15	0.3552644	0.6447356			
2009	16	0.3315801	0.6684199			
2010	17	0.3094747	0.6905253			
2011	18	0.2888431	0.7111569			
2012	19	0.2695869	0.7304131			
2013	20	0.2516144	0.7483856			
2014	21	0.2348401	0.7651599			
2015	22	0.2191841	0.7808159			
2016	23	0.2045718	0.7954282			
2017	24	0.1909337	0.8090663			
2018	25	0.1782048	0.8217952			
2019	26	0.1663245	0.8336755			
2020	27	0.1552362	0.8447638			
2021	28	0.1448871	0.8551129			
2022	29	0.1352280	0.8647720			
2023	30	0.1262128	0.8737872			
2024	31	0.1177986	0.8822014			
2025	32	0.1099453	0.8900547			
2026	33	0.1026157	0.8973843			
2027	34	0.0957746	0.9042254	$17,982,637	0.067	$1,084,024
2028	35	0.0893896	0.9106104	$17,269,208	0.062	$978,477
2029	36	0.0834303	0.9165697	$16,575,718	0.058	$882,308
2030	37	0.0778683	0.9221317	$15,901,608	0.054	$794,791
2031	38	0.0726771	0.9273229	$15,246,338	0.051	$715,241
2032	39	0.0678319	0.9321681	$14,609,379	0.047	$643,011
2033	40	0.0633098	0.9366902	$13,990,222	0.044	$577,497
2034	41	0.0590892	0.9409108	$13,388,368	0.041	$518,134
2035	42	0.0551499	0.9448501	$12,803,333	0.038	$464,396
2036	43	0.0514732	0.9485268	$12,234,649	0.036	$415,797
2037	44	0.0480417	0.9519583	$11,681,857	0.033	$371,883
2038	45	0.0448389	0.9551611	$11,144,514	0.031	$332,239
2039	46	0.0418496	0.9581504	$10,622,187	0.029	$296,482
2040	47	0.0390597	0.9609403	$10,114,458	0.027	$264,257
2041	48	0.0364557	0.9635443	$9,620,918	0.025	$235,240
2042	49	0.0340253	0.9659747	$9,141,171	0.024	$209,136
2043	50	0.0317570	0.9682430	$8,674,831	0.022	$185,670
2044	51	0.0296398	0.9703602	$8,221,524	0.021	$164,596
2045	52	0.0276638	0.9723362	$7,780,885	0.019	$145,685
2046	53	0.0258196	0.9741804	$7,352,560	0.018	$128,732
2047	54	0.0240983	0.9759017	$6,936,206	0.017	$113,546
2048	55	0.0224917	0.9775083	$6,531,487	0.016	$99,591
2049	56	0.0209923	0.9790077	$6,138,079	0.015	$87,808
2050	57	0.0195928	0.9804072	$5,755,665	0.014	$76,958
2051	58	0.0182866	0.9817134	$5,383,938	0.013	$67,278
2052	59	0.0170675	0.9829325	$5,022,600	0.012	$58,652
2053	60	0.0159297	0.9840703	$4,671,360	0.011	$50,972
2054	61	0.0148677	0.9851323	$4,329,935	0.010	$44,145
2055	62	0.0138765	0.9861235	$3,998,053	0.010	$38,082
2056	63	0.0129514	0.9870486	$3,675,445	0.009	$32,706
2057	64	0.0120880	0.9879120	$3,361,853	0.008	$27,945
2058	65	0.0112821	0.9887179	$3,057,025	0.008	$23,737
2059	66	0.0105300	0.9894700	$2,760,716	0.007	$20,022
2060	67	0.0098280	0.9901720	$2,472,688	0.007	$16,750
2061	68	0.0091728	0.9908272	$2,192,709	0.006	$13,872
2062	69	0.0085613	0.9914387	$1,920,555	0.006	$11,347
2063	70	0.0079905	0.9920095	$1,656,006	0.006	$9,137
2064	71	0.0074578	0.9925422	$1,398,850	0.005	$7,208
2065	72	0.0069606	0.9930394	$1,148,882	0.005	$5,528
2066	73	0.0064966	0.9935034	$905,898	0.005	$4,070
2067	74	0.0060635	0.9939365	$669,706	0.004	$2,809
2068	75	0.0056592	0.9943408	$440,114	0.004	$1,724
2069	76	0.0052820	0.9947180	$216,939	0.004	$793
						$10,222,643
					Annual Damages	$387,930

With-Project Conditions

Authorized Plan

16.   The Stone Revetment Plan (73-year storm design) was identified as the most feasible alternative both economically and environmentally in providing protection to Montauk Point and its vicinity. This alternative will provide protection to the Montauk Point Lighthouse complex until a 125-year storm exceedance would cause the upper part of the stone revetment to be displaced, thereby exposing the bluff to erosion.

17.   The existing revetment has been in place since 1994. In the with-project condition, construction will commence in 2018 and will be completed by 2019. With-project damages were calculated for the following storm damage categories: Storm damage to the lighthouse complex, and local costs forgone for the land loss values due to erosion. With-project damages were also calculated for two recreation loss categories: lost lighthouse visitations, and lost state park visitations benefits.

Montauk Point Lighthouse Complex

18.   Table 15 shows the residual damages that occur to the lighthouse complex under the with-project conditions for the 73-year storm design stone revetment alternative.

Local Costs Forgone

19.   Local costs forgone for loss of land value were calculated based on the probability that the stone revetment will be displaced in 2020, thereby exposing the bluff to erosion. The long-term erosion rate that is used is three feet per year. Table 16 shows the residual damages for local costs forgone for loss of land value.

Recreation Loss

20.   Residual loss of Montauk Point Lighthouse visitation benefits was calculated based on the probability that the stone revetment will be displaced in 2020, thereby exposing the bluff to erosion. The long-term erosion rate that is used is three feet per year. Therefore, by the tenth year after the upper sections of the revetment that protects the bluff are displaced the lighthouse will be immediately threatened and closed to the public. Table 17 shows the residual lost visitations benefits.

21.   Similarly, residual losses of the Montauk Point State Park visitations benefits were calculated and are shown in Table 18.

.

Table 15.   Lighthouse Complex - 73yr storm design Residual Damages
(October 2016 P.L., 2.875% discount rate)

	End of year n	Probability that armor stone will be there at end of year n	Probability that armor stone won't be there at end of year n	Present Value of Lighthouse Complex in Year n	Prob. Of Damage in Year n	Expected Damage in Year n
2020	1	0.9920000	0.0080000	$23,470,556	0.008	$1,502
2021	2	0.9840640	0.0159360	$22,814,635	0.007936	$2,885
2022	3	0.9761915	0.0238085	$22,177,045	0.007872512	$4,157
2023	4	0.9683820	0.0316180	$21,557,273	0.007809532	$5,323
2024	5	0.9606349	0.0393651	$20,954,822	0.007747056	$6,390
2025	6	0.9529498	0.0470502	$20,369,207	0.007685079	$7,365
2026	7	0.9453262	0.0546738	$19,799,959	0.007623599	$8,253
2027	8	0.9377636	0.0622364	$19,246,618	0.00756261	$9,059
2028	9	0.9302615	0.0697385	$18,708,742	0.007502109	$9,788
2029	10	0.9228194	0.0771806	$18,185,897	0.007442092	$10,446
2030	11	0.9154369	0.0845631	$17,677,665	0.007382555	$11,036
2031	12	0.9081134	0.0918866	$17,183,635	0.007323495	$11,563
2032	13	0.9008485	0.0991515	$16,703,412	0.007264907	$12,032
2033	14	0.8936417	0.1063583	$16,236,609	0.007206788	$12,445
2034	15	0.8864925	0.1135075	$15,782,852	0.007149133	$12,807
2035	16	0.8794006	0.1205994	$15,341,776	0.00709194	$13,122
2036	17	0.8723654	0.1276346	$14,913,027	0.007035205	$13,391
2037	18	0.8653865	0.1346135	$14,496,259	0.006978923	$13,619
2038	19	0.8584634	0.1415366	$14,091,139	0.006923092	$13,807
2039	20	0.8515957	0.1484043	$13,697,341	0.006867707	$13,960
2040	21	0.8447829	0.1552171	$13,314,547	0.006812765	$14,080
2041	22	0.8380246	0.1619754	$12,942,452	0.006758263	$14,168
2042	23	0.8313204	0.1686796	$12,580,755	0.006704197	$14,227
2043	24	0.8246699	0.1753301	$12,229,167	0.006650564	$14,260
2044	25	0.8180725	0.1819275	$11,887,404	0.006597359	$14,268
2045	26	0.8115279	0.1884721	$11,555,192	0.00654458	$14,253
2046	27	0.8050357	0.1949643	$11,232,264	0.006492224	$14,217
2047	28	0.7985954	0.2014046	$10,918,362	0.006440286	$14,162
2048	29	0.7922067	0.2077933	$10,613,231	0.006388763	$14,090
2049	30	0.7858690	0.2141310	$10,316,628	0.006337653	$14,001
2050	31	0.7795821	0.2204179	$10,028,314	0.006286952	$13,897
2051	32	0.7733454	0.2266546	$9,748,057	0.006236656	$13,780
2052	33	0.7671586	0.2328414	$9,475,633	0.006186763	$13,650
2053	34	0.7610214	0.2389786	$9,210,822	0.006137269	$13,509
2054	35	0.7549332	0.2450668	$8,953,411	0.006088171	$13,359
2055	36	0.7488937	0.2511063	$8,703,194	0.006039466	$13,199
2056	37	0.7429026	0.2570974	$8,459,970	0.00599115	$13,031
2057	38	0.7369594	0.2630406	$8,223,543	0.005943221	$12,856
2058	39	0.7310637	0.2689363	$7,993,724	0.005895675	$12,675
2059	40	0.7252152	0.2747848	$7,770,327	0.00584861	$12,488
2060	41	0.7194135	0.2805865	$7,553,173	0.005801721	$12,296
2061	42	0.7136582	0.2863418	$7,342,088	0.005755308	$12,100
2062	43	0.7079489	0.2920511	$7,136,902	0.005709265	$11,900
2063	44	0.7022853	0.2977147	$6,937,451	0.005663591	$11,697
2064	45	0.6966670	0.3033330	$6,743,573	0.005618282	$11,492
2065	46	0.6910937	0.3089063	$6,555,113	0.005573336	$11,286
2066	47	0.6855649	0.3144351	$6,371,921	0.005528749	$11,077
2067	48	0.6800804	0.3199196	$6,193,847	0.005484519	$10,868
2068	49	0.6746398	0.3253602	$6,020,751	0.005440643	$10,658
2069	50	0.6692426	0.3307574	$5,852,492	0.005397118	$10,447
						$580,939
					Annual Damages	$22,046

Table 16. Local Costs Forgone - 73yr storm design Residual Damages
(October 2016 P.L., 2.875% discount rate)

	End of year n	Probability that armor stone will be there at end of year n	Probability that armor stone won't be there at end of year n	Present Value Factor		
2020	1	0.9920000	0.0080000	1.0000000	$131,200	$1,050
2021	2	0.9840640	0.0159360	0.9720535	$131,200	$2,032
2022	3	0.9761915	0.0238085	0.9448879	$131,200	$2,952
2023	4	0.9683820	0.0316180	0.9184816	$131,200	$3,810
2024	5	0.9606349	0.0393651	0.8928132	$131,200	$4,611
2025	6	0.9529498	0.0470502	0.8678622	$131,200	$5,357
2026	7	0.9453262	0.0546738	0.8436084	$131,200	$6,051
2027	8	0.9377636	0.0622364	0.8200325	$131,200	$6,696
2028	9	0.9302615	0.0697385	0.7971154	$131,200	$7,293
2029	10	0.9228194	0.0771806	0.7748388	$131,200	$7,846
2030	11	0.9154369	0.0845631	0.7531847	$131,200	$8,356
2031	12	0.9081134	0.0918866	0.7321358	$131,200	$8,826
2032	13	0.9008485	0.0991515	0.7116752	$131,200	$9,258
2033	14	0.8936417	0.1063583	0.6917863	$131,200	$9,653
2034	15	0.8864925	0.1135075	0.6724533	$131,200	$10,014
2035	16	0.8794006	0.1205994	0.6536606	$131,200	$10,343
2036	17	0.8723654	0.1276346	0.6353930	$131,200	$10,640
2037	18	0.8653865	0.1346135	0.6176360	$131,200	$10,908
2038	19	0.8584634	0.1415366	0.6003752	$131,200	$11,149
2039	20	0.8515957	0.1484043	0.5835968	$131,200	$11,363
2040	21	0.8447829	0.155217	0.5672873	$131,200	$11,553
2041	22	0.8380246	0.1619754	0.5514336	$131,200	$11,719
2042	23	0.8313204	0.1686796	0.5360229	$131,200	$11,863
2043	24	0.8246699	0.1753301	0.5210429	$131,200	$11,986
2044	25	0.8180725	0.1819275	0.5064816	$131,200	$12,089
2045	26	0.8115279	0.1884721	0.4923272	$131,200	$12,174
2046	27	0.8050357	0.1949643	0.4785683	$131,200	$12,241
2047	28	0.7985954	0.2014046	0.4651940	$131,200	$12,292
2048	29	0.7922067	0.2077933	0.4521934	$131,200	$12,328
2049	30	0.7858690	0.2141310	0.4395562	$131,200	$12,349
2050	31	0.7795821	0.2204179	0.4272721	$131,200	$12,356
2051	32	0.7733454	0.2266546	0.4153313	$131,200	$12,351
2052	33	0.7671586	0.2328414	0.4037243	$131,200	$12,333
2053	34	0.7610214	0.2389786	0.3924416	$131,200	$12,305
2054	35	0.7549332	0.2450668	0.3814742	$131,200	$12,265
2055	36	0.7488937	0.2511063	0.3708133	$131,200	$12,216
2056	37	0.7429026	0.2570974	0.3604504	$131,200	$12,158
2057	38	0.7369594	0.2630406	0.3503770	$131,200	$12,092
2058	39	0.7310637	0.2689363	0.3405852	$131,200	$12,017
2059	40	0.7252152	0.2747848	0.3310670	$131,200	$11,936
2060	41	0.7194135	0.2805865	0.3218148	$131,200	$11,847
2061	42	0.7136582	0.2863418	0.3128212	$131,200	$11,752
2062	43	0.7079489	0.2920511	0.3040790	$131,200	$11,651
2063	44	0.7022853	0.2977147	0.2955810	$131,200	$11,545
2064	45	0.6966670	0.3033330	0.2873205	$131,200	$11,435
2065	46	0.6910937	0.3089063	0.2792909	$131,200	$11,319
2066	47	0.6855649	0.3144351	0.2714857	$131,200	$11,200
2067	48	0.6800804	0.3199196	0.2638986	$131,200	$11,077
2068	49	0.6746398	0.3253602	0.2565236	$131,200	$10,950
2069	50	0.6692426	0.3307574	0.2493546	$131,200	$10,821
						$504,430
					Annual Damages	$19,142

	End of year n	Probability that armor stone will be there at end of year n	Probability that armor stone won't be there at end of year n	Present Value of Visitaions for Year n	Prob. Of Damage in Year n	Expected Damage in Year n
	n					
2020	1	0.9920000	0.0080000			
2021	2	0.9840640	0.0159360			
2022	3	0.9761915	0.0238085			
2023	4	0.9683820	0.0316180			
2024	5	0.9606349	0.0393651			
2025	6	0.9529498	0.0470502			
2026	7	0.9453262	0.0546738			
2027	8	0.9377636	0.0622364			
2028	9	0.9302615	0.0697385			
2029	10	0.9228194	0.0771806			
2030	11	0.9154369	0.0845631	$48,465,092	0.008	$32,787
2031	12	0.9081134	0.0918866	$46,467,951	0.007936	$33,885
2032	13	0.9008485	0.0991515	$44,526,623	0.007872512	$34,756
2033	14	0.8936417	0.1063583	$42,639,548	0.007809532	$35,417
2034	15	0.8864925	0.1135075	$40,805,211	0.007747056	$35,882
2035	16	0.8794006	0.1205994	$39,022,137	0.007685079	$36,166
2036	17	0.8723654	0.1276346	$37,288,894	0.007623599	$36,283
2037	18	0.8653865	0.1346135	$35,604,089	0.00756261	$36,246
2038	19	0.8584634	0.1415366	$33,966,368	0.007502109	$36,066
2039	20	0.8515957	0.1484043	$32,374,416	0.007442092	$35,756
2040	21	0.8447829	0.1552171	$30,826,953	0.007382555	$35,325
2041	22	0.8380246	0.1619754	$29,322,737	0.007323495	$34,783
2042	23	0.8313204	0.1686796	$27,860,558	0.007264907	$34,141
2043	24	0.8246699	0.1753301	$26,439,243	0.007206788	$33,408
2044	25	0.8180725	0.1819275	$25,057,648	0.007149133	$32,591
2045	26	0.8115279	0.1884721	$23,714,664	0.00709194	$31,698
2046	27	0.8050357	0.1949643	$22,409,211	0.007035205	$30,737
2047	28	0.7985954	0.2014046	$21,140,242	0.006978923	$29,714
2048	29	0.7922067	0.2077933	$19,906,735	0.006923092	$28,637
2049	30	0.7858690	0.2141310	$18,707,701	0.006867707	$27,51
2050	31	0.7795821	0.2204179	$17,542,176	0.006812765	$26,342
2051	32	0.7733454	0.2266546	$16,409,224	0.006758263	$25,136
2052	33	0.7671586	0.2328414	$15,307,933	0.006704197	$23,896
2053	34	0.7610214	0.2389786	$14,237,420	0.006650564	$22,628
2054	35	0.7549332	0.2450668	$13,196,823	0.006597359	$21,337
2055	36	0.7488937	0.2511063	$12,185,308	0.00654458	$20,025
2056	37	0.7429026	0.2570974	$11,202,061	0.006492224	$18,698
2057	38	0.7369594	0.2630406	$10,246,293	0.006440286	$17,358
2058	39	0.7310637	0.2689363	$9,317,235	0.006388763	$16,009
2059	40	0.7252152	0.2747848	$8,414,141	0.006337653	$14,653
2060	41	0.7194135	0.2805865	$7,536,285	0.006286952	$13,294
2061	42	0.7136582	0.2863418	$6,682,962	0.006236656	$11,935
2062	43	0.7079489	0.2920511	$5,853,487	0.006186763	$10,576
2063	44	0.7022853	0.2977147	$5,047,192	0.006137269	$9,222
2064	45	0.6966670	0.3033330	$4,263,431	0.006088171	$7,873
2065	46	0.6910937	0.3089063	$3,501,573	0.006039466	$6,533
2066	47	0.6855649	0.3144351	$2,761,007	0.00599115	$5,201
2067	48	0.6800804	0.3199196	$2,041,137	0.005943221	$3,881
2068	49	0.6746398	0.3253602	$1,341,384	0.005895675	$2,573
2069	50	0.6692426	0.3307574	$661,188	0.00584851	$1,279
						$950,238
					Annual Damages	$36,060

Table 17. Lighthouse Visitations Damages - 73yr with-project design Residual Damages (October 2016 P.L., 2.875% discount rate)

	End of year n	Probability that armor stone will be there at end of year n	Probability that armor stone won't be there at end of year n	Present Value of Visitaions for Year n	Prob. Of Damage in Year n	Expected Damage in Year n
	n					
2020	1	0.9920000	0.0080000			
2021	2	0.9840640	0.0159360			
2022	3	0.9761915	0.0238085			
2023	4	0.9683820	0.0316180			
2024	5	0.9606349	0.0393651			
2025	6	0.9529498	0.0470502			
2026	7	0.9453262	0.0546738			
2027	8	0.9377636	0.0622364			
2028	9	0.9302615	0.0697385			
2029	10	0.9228194	0.0771806			
2030	11	0.9154369	0.0845631	$15,901,608	0.008	$10,758
2031	12	0.9081134	0.0918866	$15,246,338	0.007936	$11,11
2032	13	0.9008485	0.0991515	$14,609,379	0.007872512	$11,404
2033	14	0.8936417	0.1063583	$13,990,222	0.007809532	$11,620
2034	15	0.8864925	0.1135075	$13,388,368	0.007747056	$11,77
2035	16	0.8794006	0.1205994	$12,803,333	0.007685079	$11,866
2036	17	0.8723654	0.1276346	$12,234,649	0.007623599	$11,905
2037	18	0.8653865	0.1346135	$11,681,857	0.00756261	$11,892
2038	19	0.8584634	0.1415366	$11,144,514	0.007502109	$11,834
2039	20	0.8515957	0.1484043	$10,622,187	0.007442092	$11,732
2040	21	0.8447829	0.1552171	$10,114,458	0.007382555	$11,590
2041	22	0.8380246	0.1619754	$9,620,918	0.007323495	$11,413
2042	23	0.8313204	0.1686796	$9,141,171	0.007264907	$11,202
2043	24	0.8246699	0.1753301	$8,674,831	0.007206788	$10,961
2044	25	0.8180725	0.1819275	$8,221,524	0.007149133	$10,693
2045	26	0.8115279	0.1884721	$7,780,885	0.00709194	$10,400
2046	27	0.8050357	0.1949643	$7,352,560	0.007035205	$10,085
2047	28	0.7985954	0.2014046	$6,936,206	0.006978923	$9,749
2048	29	0.7922067	0.2077933	$6,531,487	0.006923092	$9,396
2049	30	0.7858690	0.2141310	$6,138,079	0.006867707	$9,027
2050	31	0.7795821	0.2204179	$5,755,665	0.006812765	$8,643
2051	32	0.7733454	0.2266546	$5,383,938	0.006758263	$8,247
2052	33	0.7671586	0.2328414	$5,022,600	0.006704197	$7,840
2053	34	0.7610214	0.2389786	$4,671,360	0.006650564	$7,424
2054	35	0.7549332	0.2450668	$4,329,935	0.006597359	$7,001
2055	36	0.7488937	0.2511063	$3,998,053	0.00654458	$6,570
2056	37	0.7429026	0.2570974	$3,675,445	0.006492224	$6,135
2057	38	0.7369594	0.2630406	$3,361,853	0.006440286	$5,695
2058	39	0.7310637	0.2689363	$3,057,025	0.006388763	$5,252
2059	40	0.7252152	0.2747848	$2,760,716	0.006337653	$4,808
2060	41	0.7194135	0.2805865	$2,472,688	0.006286952	$4,362
2061	42	0.7136582	0.2863418	$2,192,709	0.006236656	$3,916
2062	43	0.7079489	0.2920511	$1,920,555	0.006186763	$3,470
2063	44	0.7022853	0.2977147	$1,656,006	0.006137269	$3,026
2064	45	0.6966670	0.3033330	$1,398,850	0.006088171	$2,583
2065	46	0.6910937	0.3089063	$1,148,882	0.006039466	$2,143
2066	47	0.6855649	0.3144351	$905,898	0.00599115	$1,707
2067	48	0.6800804	0.3199196	$669,706	0.005943221	$1,273
2068	49	0.6746398	0.3253602	$440,114	0.005895675	$844
2069	50	0.6692426	0.3307574	$216,939	0.00584851	$420
						$311,77
					Annual Damages	$11,83

Table 18.   Park Visitation - 73yr level of protection design Residual Damages
(October 2016 P.L., 2.875% discount rate)

Benefits

22.   Benefits are estimated to be annual damages in the without-project condition minus any residual damages in the with-project condition. The benefits claimed are avoided storm damage costs when compared to the existing condition, specifically avoided loss of the lighthouse complex and its associated costs for the preservation of artifacts, prevented local costs forgone for loss of land values, avoided lost visitation benefits to the lighthouse and to the State Park. The project benefits for the 73-year

storm design stone revetment are summarized in Table 19 below. All benefits are discounted using a 2.875 percent interest rate and amortized over the 50-year period of analysis. Table 20 summarizes the annual cost for the stone revetment.

Table 19. Benefit Summary (Oct. 2016 P.L., 2.875% discount rate)			
Description	Without-Project Damages	Residual Damages - 73yr storm design	Benefits - 73yr storm design
Storm Damage Reduction			
Lighthouse Complex	$575,121	$22,046	$553,075
Land Loss	$126,703	$19,142	$107,561
Subtotal	$701,800	$41,200	$661,000
Recreation			
Lighthouse Visitation	$1,182,245	$36,060	$1,146,185
Park Visitation	$387,930	$11,831	$376,099
Subtotal	$1,570,200	$47,900	$1,522,000

Table 20. Cost Summary (Oct. 2016 P.L., 2.875% discount rate)	
Description	73yr storm design
Total First Cost	$22,885,000
Interest During Construction	$493,500
Total Investment Cost	$23,378,500
Annual Investment Cost	$887,000
Annual Revetment Maintenance Cost	$58,900
Total Annual Cost	$946,000

Summary

23.   The Planning Guidance Notebook, ER 1105-2-100, 22 April 2000, Chapter 3-4b(4)(a), reads in pertinent part,

 "The Corps participates in single purpose projects formulated exclusively for hurricane and storm damage reduction, with economic benefits equal to or exceeding the costs, based solely on damage reduction benefits, or a combination of damage reduction benefits and recreation benefits. Under current policy, 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 federal participation project cost sharing is met, then all recreation benefits are included in the benefit to cost analysis."

24.   Federal participation in this recreation benefit generating shore protection project is warranted since the recreation benefits are incidental, and when combined with and limited to an equivalent amount of primary hurricane and storm damage reduction benefits, they produce an economically justified project. The incidental recreation benefits are limited because the storm damage reduction benefits must be at least 50

percent of the total benefits used for project evaluation. Table 21 shows the 73-year design cost-benefit analysis based on storm damage reduction benefits and an equivalent amount of recreation benefits. All recreation benefits are included in the final benefit cost ratio (BCR) because the criterion for federal participation project cost sharing with limited recreation benefits has been met.

Table 21. Cost-Benefit Summary (Oct. 2016 P.L., 2.875% discount rate)	
Description	**73yr Storm Design**
Annual Storm Damage Benefits	$661,000
Annual Recreation Benefits	$1,522,000
Annual Recreation Benefits Used for Project Justification	$661,000
Total Benefits Used for Project Justification	$1,322,000
Annual Costs	$946,000
Net Benefits	$376,000
BCR	1.4
Total Benefits	$2,183,000
Total Net Benefits	$1,237,000
Final BCR	2.3