

# **Appendix E – Economics**

## **Galveston Island Coastal Erosion, City of Galveston, Galveston County, Texas Section 204 Final Integrated Detailed Project Report and Environmental Assessment**

**February 2023**



**US Army Corps  
of Engineers**

Galveston District

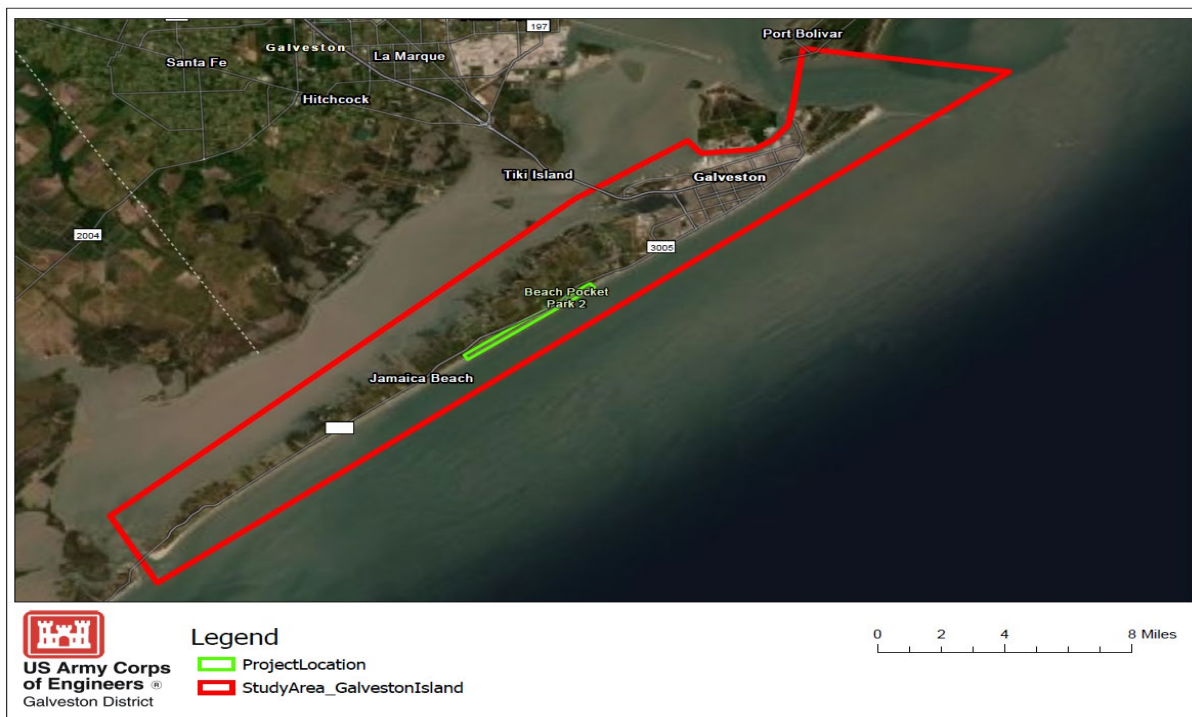
# 1 Introduction

This report presents the economic analysis of using dredged material from the Federal Navigation Project for Galveston TX Harbor to provide coastal storm risk reduction measures on the West End Beach of Galveston Island TX. The analyses follow the U. S. Army Corps of Engineers (USACE) guidance for conducting economic evaluations as contained in EP 1105-2-58 dated 01 March 2019.

The economic benefits of providing coastal storm damage protection through beneficial use of dredged material are calculated in two steps. First, the projected Future Without Project Conditions (FWOPC) are compared to the Future With Project Conditions (FWPC). Then, the least-cost disposal plan associated with the Navigation maintenance dredging (base plan) is compared to the cost of providing the coastal storm damage protection. This analysis was conducted using the Fiscal Year 2023 Federal interest rate for water resources projects of 2.5%. A twenty-four (24) year period of analysis is used, based upon the period of protection determined by engineering erosion analysis.

# 2 Description of Study Area

The project location is situated in the center of Galveston Island, running parallel to FM 3005 stretching from 8 Mile Road southwest to Thirteen Mile Road.





Galveston Island is a barrier island on the Texas shoreline of the Gulf of Mexico. The island sits approximately 50 miles southeast of Houston. The study area/potential project site lies on the west side of the island, beyond the western terminus of the Galveston Seawall. The area is generally identified as west of 61<sup>st</sup> Street and is primarily a residential area with a smattering of commercial businesses. The end of the study area is where the Galveston Island State Park property begins, traveling southwest along the Gulf Coast.

The proposed project will use the dredged material from the Federal Navigation Project for Galveston Harbor as beach-fill on a stretch of beach located on the West End of Galveston. Selected economic characteristics from the 2019 American Community Survey report the following:

- 1) Total Population of 8,556 with a median age of 51.3 years
- 2) The work force numbers approximately 4,200 with a white/blue collar split of 84%/16%
- 3) Total households number 3,744 with an average persons per household at 2.
- 4) Average household income is roughly \$114,000 accompanied with a median income of \$75,300
- 5) There are approximately 559 persons living below the poverty level of income.
- 6) Of the approximately 10,052 housing units, 37% are occupied and roughly 67% are owner-occupied.

<https://www.point2homes.com/US/Neighborhood/TX/Galveston-Bolivar-Peninsula/West-End-Galveston-Demographics.html>

(<https://data.census.gov>).

A more in-depth socio-economics section can be found in Chapter 4, Section 4.3 “Socioeconomics/Economics”. Environmental Justice (EJ) is also addressed in more detail in the environmental appendix. Overall, however, this community is a rather affluent section of Galveston Island. Most of the homes in the study area serve as vacation or second homes. They have been built on stilts to withstand coastal storms. The process of essentially placing dredge material along a relatively small stretch of beach will have minimal EJ effects.

### **3 Benefit Methodology**

The benefits to beach placement are determined by estimating the value of the erosion losses and damages that would occur without beneficial placement and comparing them to the erosion losses and damages that would occur with beneficial placement. The benefits equal the degree to which erosion losses and damages are reduced. For this analysis, the long-term erosion rate of 1.25 feet per year was used for both the FWOPC and FWPC based on hydraulic analyses. If protective measures are not implemented, it is anticipated that long-term erosion will continue at the current rate and eventually threaten shorefront structures along the beach. This location on the beach provides storm damage protection to residential properties, improves recreation benefits, and delays land erosion.

Thus, this economic analysis primarily follows practices of the PCX-CSRSM pertaining to littoral erosion problems. The avoided damages are not related to depth-damage relationships nor a set of probabilistic storm events. Benefits are derived from delaying the inevitable encroachment upon the properties that would cause safety and/or legal issues that

would arise as the private properties became part of the public beach/coastline. The PCX-CSRM was consulted at the start of this study to determine how to estimate benefits in an efficient manner for the CAP 204 program. Subsequently, New England District shared a similar study (Newbury Port Harbor, Plum Island North Point, Newbury Port, Massachusetts) as a go-by. Initially, per the coastal storm risk management economics technical guidance, no land loss damages prevented were included as benefits (littoral erosion land loss not policy compliant as NED benefits). Subsequently, engineering analysis indicated that approximately 15% of the erosion could be attributable to Gulf storm events and a modest amount of land loss damage prevented is now reflected in the benefits.

### **3.1 Future Without Project Condition (FWOPC)**

The study evaluated 155 residential structures at risk of being undermined due to coastal erosion from 2023 to 2037. The value of each structure was determined using 2021 tax assessment records available from Galveston County Assessor Office, which stipulates in its methods of assessment that depreciated replacement costs are used for assessment and taxing purposes. Damages were analyzed for the FWOPC using ArcMap Geographic Information Systems (GIS) to overlay the erosion contours onto aerial photographs containing geo-referenced parcel maps. The hydraulic analysis estimated that the structures closest to the dune line would be impacted as early as 2023. The erosion contours were then advanced landward in annual increments at the 1.25 feet per year erosion rate. A structure was considered damaged when the erosion line reached the seaward edge of the parcel. The present value of the structure was determined for that same year using the current 2023 Fiscal Year Federal Discount Rate of 2.5%. The structure was considered a total loss and was not rebuilt once this occurred. Structure values totaling \$150,053,000 for the FWOP condition are presented in Table E-2 below.

The local ability to respond to this erosion problem in the future is not known but likely limited. As homes start to erode, political pressure may force regulatory change as has happened historically in other locations along the Texas Gulf Coast.

### **3.2 Future With Project Condition (FWPC)**

The FWPC assumes the placement of dredged material on the beaches within the study area. Coastal engineering analysis determined that the amount of material to be dredged will provide a beach fill with a berm length of approximately 1.7 miles linear feet that will last approximately 8-10 years, although several properties are expected to have some protection for up to 24 years. In the with-project condition, it was assumed that the erosion rate would remain at 1.25 feet per year, but the structures would be damaged up to 24 years later than in the FWOP condition. This is a onetime placement with no plans for renourishment. Therefore, while the project life is 8-10 years, the impact of the placement will last beyond those years. The present value was determined for structures in with-project condition based on the additional length of time before erosion undermined the structure. Structure values for the with-project condition are also presented in Table E-2.

Table E-2: Structure Valuation for FWOP and FWP Conditions									
Structure ID	2021 Depreciated Replacement Values	FWOP CONDITIONS				ALT 2 FWP CONDITIONS			
		Year Damaged	Study Year	Present Value Factor	Present Value	Year Damaged	Study Year	Present Value Factor	Present Value
0	1,682,930	2029	6	0.862297	1,451,185	2034	11	0.762145	1,282,636
1	96,360	2035	12	0.743556	71,649	2041	18	0.641166	61,783
2	1,151,140	2023	0	1	1,151,140	2023	0	1.000000	1,151,140
3	387,520	2023	0	1	387,520	2023	0	1.000000	387,520
5	174,530	2036	13	0.72542	126,608	2041	18	0.641166	111,903
6	285,650	2036	13	0.72542	207,216	2041	18	0.641166	183,149
8	175,430	2023	0	1	175,430	2023	0	1.000000	175,430
11	426,110	2023	0	1	426,110	2023	0	1.000000	426,110
17	1,390,830	2023	0	1	1,390,830	2023	0	1.000000	1,390,830
18	1,334,980	2023	0	1	1,334,980	2023	0	1.000000	1,334,980
19	739,640	2036	13	0.72542	536,550	2043	20	0.610271	451,381
22	479,680	2038	15	0.690466	331,203	2046	23	0.566697	271,833
23	695,670	2025	2	0.951814	662,149	2034	11	0.762145	530,201
24	602,350	2038	15	0.690466	415,902	2044	21	0.595386	358,631
25	718,350	2023	0	1	718,350	2023	0	1.000000	718,350
26	1,109,670	2025	2	0.951814	1,056,200	2033	10	0.781198	866,872
28	701,790	2038	15	0.690466	484,562	2045	22	0.580865	407,645
29	506,360	2028	5	0.883854	447,548	2035	12	0.743556	376,507
30	490,640	2037	14	0.707727	347,239	2043	20	0.610271	299,423
32	361,910	2027	4	0.905951	327,873	2034	11	0.762145	275,828
35	700,950	2029	6	0.862297	604,427	2036	13	0.725420	508,483
37	619,520	2035	12	0.743556	460,648	2041	18	0.641166	397,215
38	679,840	2023	0	1	679,840	2031	8	0.820747	557,976

Table E-2 (Continued): Structure Valuation for FWOP and FWP Conditions									
		FWOP PROJECT CONDITIONS				ALT 2 FWP CONDITIONS			
Structure ID	2021 Depreciated Replacement Values	Year Damaged	Study Year	Present Value Factor	Present Value	Year Damaged	Study Year	Present Value Factor	Present Value
41	684,880	2035	12	0.743556	509,247	2042	19	0.625528	428,411
42	1,175,820	2023	0	1	1,175,820	2023	0	1.000000	1,175,820
43	589,240	2028	5	0.883854	520,802	2035	12	0.743556	438,133
44	708,550	2023	0	1	708,550	2023	0	1.000000	708,550
46	308,170	2030	7	0.841265	259,253	2037	14	0.707727	218,100
49	986,860	2026	3	0.928599	916,398	2033	10	0.781198	770,933
51	562,110	2033	10	0.781198	439,119	2039	16	0.673625	378,651
55	1,051,210	2023	0	1	1,051,210	2023	0	1.000000	1,051,210
59	958,900	2031	8	0.820747	787,014	2038	15	0.690466	662,087
61	460,280	2036	13	0.72542	333,896	2044	21	0.595386	274,044
63	743,260	2026	3	0.928599	690,191	2033	10	0.781198	580,634
68	348,370	2024	1	0.97561	339,873	2031	8	0.820747	285,923
69	442,790	2034	11	0.762145	337,470	2042	19	0.625528	276,977
76	503,780	2033	10	0.781198	393,552	2040	17	0.657195	331,082
77	952,150	2023	0	1	952,150	2023	0	1.000000	952,150
79	865,520	2030	7	0.841265	728,132	2037	14	0.707727	612,552
80	512,360	2023	0	1	512,360	2023	0	1.000000	512,360
82	926,600	2031	8	0.820747	760,504	2037	14	0.707727	655,780
83	712,170	2038	15	0.690466	491,729	2044	21	0.595386	424,016
86	781,370	2033	10	0.781198	610,405	2039	16	0.673625	526,350
88	698,510	2035	12	0.743556	519,381	2040	17	0.657195	459,057
89	1,240,200	2023	0	1	1,240,200	2023	0	1.000000	1,240,200
90	542,140	2029	6	0.862297	467,486	2035	12	0.743556	403,111
91	1,291,010	2033	10	0.781198	1,008,535	2041	18	0.641166	827,752

Table E-2 (Continued): Structure Valuation for FWOP and FWP Conditions									
		FWOP CONDITIONS				ALT 2 FWP CONDITIONS			
Structure ID	2021 Depreciated Replacement Values	Year Damaged	Study Year	Present Value Factor	Present Value	Year Damaged	Study Year	Present Value Factor	Present Value
92	1,218,350	2023	0	1	1,218,350	2023	0	1.000000	1,218,350
95	1,054,340	2033	10	0.781198	823,649	2038	15	0.690466	727,985
97	549,920	2034	11	0.762145	419,119	2039	16	0.673625	370,440
98	1,513,160	2023	0	1	1,513,160	2023	0	1.000000	1,513,160
99	308,120	2035	12	0.743556	229,104	2041	18	0.641166	197,556
103	443,100	2038	15	0.690466	305,945	2043	20	0.610271	270,411
106	324,080	2035	12	0.743556	240,972	2040	17	0.657195	212,984
107	1,064,680	2034	11	0.762145	811,440	2039	16	0.673625	717,195
110	161,650	2035	12	0.743556	120,196	2040	17	0.657195	106,236
113	446,990	2033	10	0.781198	349,188	2038	15	0.690466	308,631
119	255,190	2032	9	0.800728	204,338	2038	15	0.690466	176,200
121	959,230	2023	0	1	959,230	2023	0	1.000000	959,230
122	1,338,400	2023	0	1	1,338,400	2023	0	1.000000	1,338,400
125	891,650	2025	2	0.951814	848,685	2029	6	0.862297	768,867
126	1,077,500	2027	4	0.905951	976,162	2032	9	0.800728	862,785
128	1,040,050	2026	3	0.928599	965,790	2030	7	0.841265	874,958
129	1,659,730	2028	5	0.883854	1,466,959	2033	10	0.781198	1,296,578
130	1,872,050	2028	5	0.883854	1,654,619	2033	10	0.781198	1,462,442
135	1,079,330	2023	0	1	1,079,330	2029	6	0.862297	930,703
138	1,233,200	2023	0	1	1,233,200	2027	4	0.905951	1,117,218
139	1,974,030	2023	0	1	1,974,030	2027	4	0.905951	1,788,374
140	959,700	2023	0	1	959,700	2029	6	0.862297	827,546
143	518,070	2036	13	0.72542	375,819	2043	20	0.610271	316,163
146	762,210	2038	15	0.690466	526,280	2045	22	0.580865	442,741



Table E-2 (Continued): Structure Valuation for FWOP and FWP Conditions									
		FWOP CONDITIONS				ALT 2 FWP CONDITIONS			
Structure ID	2021 Depreciated Replacement Values	Year Damaged	Study Year	Present Value Factor	Present Value	Year Damaged	Study Year	Present Value Factor	Present Value
148	600,220	2038	15	0.690466	414,431	2045	22	0.580865	348,647
155	861,920	2023	0	1	861,920	2024	1	0.975610	840,898
156	1,018,280	2032	9	0.800728	815,366	2040	17	0.657195	669,209
160	469,130	2037	14	0.707727	332,016	2044	21	0.595386	279,314
161	248,470	2030	7	0.841265	209,029	2038	15	0.690466	171,560
165	433,330	2025	2	0.951814	412,450	2034	11	0.762145	330,260
167	683,000	2031	8	0.820747	560,570	2039	16	0.673625	460,086
168	506,830	2036	13	0.72542	367,665	2043	20	0.610271	309,304
182	371,030	2038	15	0.690466	256,183	2045	22	0.580865	215,518
184	1,000,870	2033	10	0.781198	781,878	2040	17	0.657195	657,767
186	733,560	2027	4	0.905951	664,569	2036	13	0.725420	532,139
187	491,840	2037	14	0.707727	348,089	2043	20	0.610271	300,156
193	537,610	2030	7	0.841265	452,273	2038	15	0.690466	371,201
197	601,400	2023	0	1	601,400	2031	8	0.820747	493,597
199	304,160	2030	7	0.841265	255,879	2038	15	0.690466	210,012
201	205,170	2030	7	0.841265	172,602	2038	15	0.690466	141,663
203	300,930	2031	8	0.820747	246,987	2038	15	0.690466	207,782
205	51,000	2031	8	0.820747	41,858	2038	15	0.690466	35,214
207	228,760	2030	7	0.841265	192,448	2038	15	0.690466	157,951
212	498,040	2029	6	0.862297	429,458	2037	14	0.707727	352,476
223	332,210	2033	10	0.781198	259,522	2040	17	0.657195	218,327
231	283,200	2032	9	0.800728	226,766	2040	17	0.657195	186,118
233	382,780	2033	10	0.781198	299,027	2040	17	0.657195	251,561
234	304,500	2032	9	0.800728	243,822	2040	17	0.657195	200,116
236	462,040	2032	9	0.800728	369,969	2040	17	0.657195	303,650

Table E-2 (Continued): Structure Valuation for FWOP and FWP Conditions									
		FWOP CONDITIONS				ALT 2 FWP CONDITIONS			
Structure ID	2021 Depreciated Replacement Values	Year Damaged	Study Year	Present Value Factor	Present Value	Year Damaged	Study Year	Present Value Factor	Present Value
237	327,120	2033	10	0.781198	255,546	2040	17	0.657195	214,982
239	267,980	2033	10	0.781198	209,346	2040	17	0.657195	176,115
242	279,680	2033	10	0.781198	218,486	2040	17	0.657195	183,804
244	324,080	2033	10	0.781198	253,171	2040	17	0.657195	212,984
246	412,900	2033	10	0.781198	322,557	2040	17	0.657195	271,356
248	430,030	2034	11	0.762145	327,745	2041	18	0.641166	275,721
252	407,800	2035	12	0.743556	303,222	2041	18	0.641166	261,467
254	293,910	2033	10	0.781198	229,602	2041	18	0.641166	188,445
256	446,610	2033	10	0.781198	348,891	2041	18	0.641166	286,351
258	573,500	2035	12	0.743556	426,429	2042	19	0.625528	358,740
259	218,460	2035	12	0.743556	162,437	2042	19	0.625528	136,653
261	231,110	2035	12	0.743556	171,843	2042	19	0.625528	144,566
267	362,300	2035	12	0.743556	269,390	2042	19	0.625528	226,629
268	444,410	2036	13	0.72542	322,384	2043	20	0.610271	271,211
271	291,540	2036	13	0.72542	211,489	2043	20	0.610271	177,918
273	487,920	2036	13	0.72542	353,947	2043	20	0.610271	297,763
275	477,640	2037	14	0.707727	338,039	2043	20	0.610271	291,490
278	275,730	2037	14	0.707727	195,142	2043	20	0.610271	168,270
280	376,150	2036	13	0.72542	272,867	2043	20	0.610271	229,553
283	127,960	2023	0	1	127,960	2023	0	1.000000	127,960
287	280,250	2038	15	0.690466	193,503	2044	21	0.595386	166,857
289	397,140	2038	15	0.690466	274,211	2044	21	0.595386	236,452
291	697,730	2038	15	0.690466	481,759	2044	21	0.595386	415,419
293	778,330	2038	15	0.690466	537,410	2045	22	0.580865	452,104

Table E-2 (Continued): Structure Valuation for FWOP and FWP Conditions									
		FWOP CONDITIONS				ALT 2 FWP CONDITIONS			
Structure ID	2021 Depreciated Replacement Values	Year Damaged	Study Year	Present Value Factor	Present Value	Year Damaged	Study Year	Present Value Factor	Present Value
295	628,300	2037	14	0.707727	444,665	2043	20	0.610271	383,433
299	520,800	2023	0	1	520,800	2023	0	1	520,800
315	1,604,500	2033	10	0.781198	1,253,433	2045	22	0.580865	931,997
316	1,567,530	2029	6	0.862297	1,351,676	2041	18	0.641166	1,005,047
320	1,515,540	2025	2	0.951814	1,442,513	2039	16	0.673625	1,020,906
321	1,142,340	2023	0	1	1,142,340	2037	14	0.707727	808,465
322	1,605,360	2023	0	1	1,605,360	2037	14	0.707727	1,136,157
323	1,670,850	2023	0	1	1,670,850	2025	2	0.951814	1,590,339
324	1,298,970	2025	2	0.951814	1,236,378	2039	16	0.673625	875,019
325	1,782,120	2027	4	0.905951	1,614,513	2041	18	0.641166	1,142,635
326	1,315,530	2029	6	0.862297	1,134,377	2042	19	0.625528	822,900
328	932,010	2028	5	0.883854	823,761	2041	18	0.641166	597,573
329	2,223,130	2027	4	0.905951	2,014,046	2041	18	0.641166	1,425,395
333	1,166,520	2027	4	0.905951	1,056,810	2041	18	0.641166	747,933
334	1,495,390	2024	1	0.97561	1,458,917	2039	16	0.673625	1,007,332
337	1,565,380	2025	2	0.951814	1,489,951	2039	16	0.673625	1,054,479
340	1,152,110	2024	1	0.97561	1,124,010	2038	15	0.690466	795,492
342	23,576,360	2023	0	1	23,576,360	2023	0	1	23,576,360
344	1,824,270	2023	0	1	1,824,270	2037	14	0.707727	1,291,085
345	91,000	2024	1	0.97561	88,780	2037	14	0.707727	64,403
346	1,149,750	2023	0	1	1,149,750	2037	14	0.707727	813,709
348	427,940	2023	0	1	427,940	2023	0	1	427,940
350	1,230,570	2023	0	1	1,230,570	2027	4	0.905951	1,114,836
352	926,910	2023	0	1	926,910	2026	3	0.928599	860,728

Table E-2 (Continued): Structure Valuation for FWOP and FWP Conditions									
		FWOP CONDITIONS				ALT 2 FWP CONDITIONS			
Structure ID	2021 Depreciated Replacement Values	Year Damaged	Study Year	Present Value Factor	Present Value	Year Damaged	Study Year	Present Value Factor	Present Value
354	970,540	2023	0	1	970,540	2026	3	0.928599	901,243
355	1,598,040	2023	0	1	1,598,040	2023	0	1	1,598,040
356	900,510	2023	0	1	900,510	2023	0	1	900,510
358	659,710	2023	0	1	659,710	2025	2	0.951814	627,921
359	736,140	2023	0	1	736,140	2025	2	0.951814	700,669
360	765,200	2023	0	1	765,200	2025	2	0.951814	728,328
361	670,040	2023	0	1	670,040	2024	1	0.97561	653,698
363	966,780	2023	0	1	966,780	2024	1	0.97561	943,200
365	1,000,490	2023	0	1	1,000,490	2025	2	0.951814	952,281
366	858,470	2023	0	1	858,470	2025	2	0.951814	817,104
367	1,239,180	2023	0	1	1,239,180	2024	1	0.97561	1,208,956
368	7,915,290	2027	4	0.905951	7,170,862	2030	7	0.841265	6,658,858
369	7,587,360	2023	0	1	7,587,360	2026	3	0.928599	7,045,618
370	6,389,370	2023	0	1	6,389,370	2026	3	0.928599	5,933,165

Table E-2 (Continued): Structure Valuation for FWOP and FWP Conditions									
		FWOP CONDITIONS				ALT 3 FWP CONDITIONS			
Structure ID	2021 Depreciated Replacement Values	Year Damaged	Study Year	Present Value Factor	Present Value	Year Damaged	Study Year	Present Value Factor	Present Value
0	1,682,930	2029	6	0.862297	1,451,185	2035	12	0.743556	1,251,353
1	96,360	2035	12	0.743556	71,649	2041	18	0.641166	61,783
2	1,151,140	2023	0	1	1,151,140	2023	0	1	1,151,140
3	387,520	2023	0	1	387,520	2023	0	1	387,520
5	174,530	2036	13	0.72542	126,608	2042	19	0.625528	109,173
6	285,650	2036	13	0.72542	207,216	2042	19	0.625528	178,682
8	175,430	2023	0	1	175,430	2023	0	1	175,430
11	426,110	2023	0	1	426,110	2023	0	1	426,110
17	1,390,830	2023	0	1	1,390,830	2023	0	1	1,390,830
18	1,334,980	2023	0	1	1,334,980	2023	0	1	1,334,980
19	739,640	2036	13	0.72542	536,550	2043	20	0.610271	451,381
22	479,680	2038	15	0.690466	331,203	2046	23	0.566697	271,833
23	695,670	2025	2	0.951814	662,149	2034	11	0.762145	530,201
24	602,350	2038	15	0.690466	415,902	2045	22	0.580865	349,884
25	718,350	2023	0	1	718,350	2023	0	1	718,350
26	1,109,670	2025	2	0.951814	1,056,200	2034	11	0.762145	845,729
28	701,790	2038	15	0.690466	484,562	2045	22	0.580865	407,645
29	506,360	2028	5	0.883854	447,548	2036	13	0.72542	367,324
30	490,640	2037	14	0.707727	347,239	2044	21	0.595386	292,120
32	361,910	2027	4	0.905951	327,873	2035	12	0.743556	269,100
35	700,950	2029	6	0.862297	604,427	2037	14	0.707727	496,081
37	619,520	2035	12	0.743556	460,648	2042	19	0.625528	387,527
38	679,840	2023	0	1	679,840	2032	9	0.800728	544,367

Table E-2 (Continued): Structure Valuation for FWOP and FWP Conditions									
		FWOP CONDITIONS				ALT 3 FWP CONDITIONS			
Structure ID	2021 Depreciated Replacement Values	Year Damaged	Study Year	Present Value Factor	Present Value	Year Damaged	Study Year	Present Value Factor	Present Value
41	684,880	2035	12	0.743556	509,247	2042	19	0.625528	428,411
42	1,175,820	2023	0	1	1,175,820	2023	0	1	1,175,820
43	589,240	2028	5	0.883854	520,802	2036	13	0.72542	427,447
44	708,550	2023	0	1	708,550	2028	5	0.883854	626,255
46	308,170	2030	7	0.841265	259,253	2038	15	0.690466	212,781
49	986,860	2026	3	0.928599	916,398	2034	11	0.762145	752,130
51	562,110	2033	10	0.781198	439,119	2040	17	0.657195	369,416
55	1,051,210	2023	0	1	1,051,210	2031	8	0.820747	862,777
59	958,900	2031	8	0.820747	787,014	2039	16	0.673625	645,939
61	460,280	2036	13	0.72542	333,896	2045	22	0.580865	267,360
63	743,260	2026	3	0.928599	690,191	2034	11	0.762145	566,472
68	348,370	2024	1	0.97561	339,873	2033	10	0.781198	272,146
69	442,790	2034	11	0.762145	337,470	2043	20	0.610271	270,222
76	503,780	2033	10	0.781198	393,552	2040	17	0.657195	331,082
77	952,150	2023	0	1	952,150	2031	8	0.820747	781,474
79	865,520	2030	7	0.841265	728,132	2037	14	0.707727	612,552
80	512,360	2023	0	1	512,360	2023	0	1	512,360
82	926,600	2031	8	0.820747	760,504	2038	15	0.690466	639,785
83	712,170	2038	15	0.690466	491,729	2045	22	0.580865	413,674
86	781,370	2033	10	0.781198	610,405	2040	17	0.657195	513,513
88	698,510	2035	12	0.743556	519,381	2041	18	0.641166	447,861
89	1,240,200	2023	0	1	1,240,200	2023	0	1	1,240,200
90	542,140	2029	6	0.862297	467,486	2036	13	0.72542	393,279
91	1,291,010	2033	10	0.80051	1,033,467	2041	18	0.669978	864,948

Table E-2 (Continued): Structure Valuation for FWOP and FWP Conditions									
		FWOP CONDITIONS				ALT 3 FWP CONDITIONS			
Structure ID	2021 Depreciated Replacement Values	Year Damaged	Study Year	Present Value Factor	Present Value	Year Damaged	Study Year	Present Value Factor	Present Value
92	1,218,350	2023	0	1	1,218,350	2023	0	1	1,218,350
95	1,054,340	2033	10	0.781198	823,649	2039	16	0.673625	710,230
97	549,920	2034	11	0.762145	419,119	2040	17	0.657195	361,405
98	1,513,160	2023	0	1	1,513,160	2023	0	1	1,513,160
99	308,120	2035	12	0.743556	229,104	2041	18	0.641166	197,556
103	443,100	2038	15	0.690466	305,945	2044	21	0.595386	263,816
106	324,080	2035	12	0.743556	240,972	2041	18	0.641166	207,789
107	1,064,680	2034	11	0.762145	811,440	2040	17	0.657195	699,702
110	161,650	2035	12	0.743556	120,196	2041	18	0.641166	103,644
113	446,990	2033	10	0.781198	349,188	2039	16	0.673625	301,104
119	255,190	2032	9	0.800728	204,338	2038	15	0.690466	176,200
121	959,230	2023	0	1	959,230	2023	0	1	959,230
122	1,338,400	2023	0	1	1,338,400	2023	0	1	1,338,400
125	891,650	2025	2	0.951814	848,685	2031	8	0.820747	731,819
126	1,077,500	2027	4	0.905951	976,162	2033	10	0.781198	841,741
128	1,040,050	2026	3	0.928599	965,790	2032	9	0.800728	832,798
129	1,659,730	2028	5	0.883854	1,466,959	2034	11	0.762145	1,264,955
130	1,872,050	2028	5	0.883854	1,654,619	2034	11	0.762145	1,426,773
135	1,079,330	2023	0	1	1,079,330	2028	5	0.883854	953,970
138	1,233,200	2023	0	1	1,233,200	2026	3	0.928599	1,145,149
139	1,974,030	2023	0	1	1,974,030	2023	0	1	1,974,030
140	959,700	2023	0	1	959,700	2028	5	0.883854	848,235
143	518,070	2036	13	0.72542	375,819	2043	20	0.610271	316,163
146	762,210	2038	15	0.690466	526,280	2045	22	0.580865	442,741

Table E-2 (Continued): Structure Valuation for FWOP and FWP Conditions									
		FWOP CONDITIONS				ALT 3 FWP CONDITIONS			
Structure ID	2021 Depreciated Replacement Values	Year Damaged	Study Year	Present Value Factor	Present Value	Year Damaged	Study Year	Present Value Factor	Present Value
148	600,220	2038	15	0.690466	414,431	2045	22	0.580865	348,647
155	861,920	2023	0	1	861,920	2023	0	1	861,920
156	1,018,280	2032	9	0.800728	815,366	2040	17	0.657195	669,209
160	469,130	2037	14	0.707727	332,016	2043	20	0.610271	286,296
161	248,470	2030	7	0.841265	209,029	2038	15	0.690466	171,560
165	433,330	2025	2	0.951814	412,450	2034	11	0.762145	330,260
167	683,000	2031	8	0.820747	560,570	2038	15	0.690466	471,588
168	506,830	2036	13	0.72542	367,665	2043	20	0.610271	309,304
182	371,030	2038	15	0.690466	256,183	2044	21	0.595386	220,906
184	1,000,870	2033	10	0.781198	781,878	2040	17	0.657195	657,767
186	733,560	2027	4	0.905951	664,569	2035	12	0.743556	545,443
187	491,840	2037	14	0.707727	348,089	2043	20	0.610271	300,156
193	537,610	2030	7	0.841265	452,273	2038	15	0.690466	371,201
197	601,400	2023	0	1	601,400	2031	8	0.820747	493,597
199	304,160	2030	7	0.841265	255,879	2038	15	0.690466	210,012
201	205,170	2030	7	0.841265	172,602	2038	15	0.690466	141,663
203	300,930	2031	8	0.820747	246,987	2038	15	0.690466	207,782
205	51,000	2031	8	0.820747	41,858	2038	15	0.690466	35,214
207	228,760	2030	7	0.841265	192,448	2038	15	0.690466	157,951
212	498,040	2029	6	0.862297	429,458	2037	14	0.707727	352,476
223	332,210	2033	10	0.781198	259,522	2040	17	0.657195	218,327
231	283,200	2032	9	0.800728	226,766	2040	17	0.657195	186,118
233	382,780	2033	10	0.781198	299,027	2040	17	0.657195	251,561
234	304,500	2032	9	0.800728	243,822	2040	17	0.657195	200,116
236	462,040	2032	9	0.800728	369,969	2040	17	0.657195	303,650



Table E-2 (Continued): Structure Valuation for FWOP and FWP Conditions									
		FWOP CONDITIONS				ALT 3 FWP CONDITIONS			
Structure ID	2021 Depreciated Replacement Values	Year Damaged	Study Year	Present Value Factor	Present Value	Year Damaged	Study Year	Present Value Factor	Present Value
237	327,120	2033	10	0.781198	255,546	2040	17	0.657195	214,982
239	267,980	2033	10	0.781198	209,346	2041	18	0.641166	171,820
242	279,680	2033	10	0.781198	218,486	2040	17	0.657195	183,804
244	324,080	2033	10	0.781198	253,171	2040	17	0.657195	212,984
246	412,900	2033	10	0.781198	322,557	2040	17	0.657195	271,356
248	430,030	2034	11	0.762145	327,745	2041	18	0.641166	275,721
252	407,800	2035	12	0.743556	303,222	2042	19	0.625528	255,090
254	293,910	2033	10	0.781198	229,602	2041	18	0.641166	188,445
256	446,610	2033	10	0.781198	348,891	2041	18	0.641166	286,351
258	573,500	2035	12	0.743556	426,429	2042	19	0.625528	358,740
259	218,460	2035	12	0.743556	162,437	2042	19	0.625528	136,653
261	231,110	2035	12	0.743556	171,843	2042	19	0.625528	144,566
267	362,300	2035	12	0.743556	269,390	2042	19	0.625528	226,629
268	444,410	2036	13	0.72542	322,384	2043	20	0.610271	271,211
271	291,540	2036	13	0.72542	211,489	2043	20	0.610271	177,918
273	487,920	2036	13	0.72542	353,947	2043	20	0.610271	297,763
275	477,640	2037	14	0.707727	338,039	2043	20	0.610271	291,490
278	275,730	2037	14	0.707727	195,142	2043	20	0.610271	168,270
280	376,150	2036	13	0.72542	272,867	2043	20	0.610271	229,553
283	127,960	2023	0	1	127,960	2023	0	1	127,960
287	280,250	2038	15	0.690466	193,503	2044	21	0.595386	166,857
289	397,140	2038	15	0.690466	274,211	2044	21	0.595386	236,452
291	697,730	2038	15	0.690466	481,759	2044	21	0.595386	415,419
293	778,330	2038	15	0.690466	537,410	2045	22	0.580865	452,104

Table E-2 (Continued): Structure Valuation for FWOP and FWP Conditions									
		FWOP CONDITIONS				ALT 3 FWP CONDITIONS			
Structure ID	2021 Depreciated Replacement Values	Year Damaged	Study Year	Present Value Factor	Present Value	Year Damaged	Study Year	Present Value Factor	Present Value
295	628,300	2037	14	0.707727	444,665	2044	21	0.595386	374,081
299	520,800	2023	0	1	520,800	2023	0	1	520,800
315	1,604,500	2033	10	0.781198	1,253,433	2044	21	0.595386	955,297
316	1,567,530	2029	6	0.862297	1,351,676	2040	17	0.657195	1,030,173
320	1,515,540	2025	2	0.951814	1,442,513	2037	14	0.707727	1,072,589
321	1,142,340	2023	0	1	1,142,340	2023	0	1	1,142,340
322	1,605,360	2023	0	1	1,605,360	2023	0	1	1,605,360
323	1,670,850	2023	0	1	1,670,850	2023	0	1	1,670,850
324	1,298,970	2025	2	0.951814	1,236,378	2038	15	0.690466	896,894
325	1,782,120	2027	4	0.905951	1,614,513	2039	16	0.673625	1,200,480
326	1,315,530	2029	6	0.862297	1,134,377	2041	18	0.641166	843,473
328	932,010	2028	5	0.883854	823,761	2040	17	0.657195	612,512
329	2,223,130	2027	4	0.905951	2,014,046	2039	16	0.673625	1,497,556
333	1,166,520	2027	4	0.905951	1,056,810	2039	16	0.673625	785,797
334	1,495,390	2024	1	0.97561	1,458,917	2037	14	0.707727	1,058,328
337	1,565,380	2025	2	0.951814	1,489,951	2038	15	0.690466	1,080,841
340	1,152,110	2024	1	0.97561	1,124,010	2036	13	0.72542	835,764
342	23,576,360	2023	0	1	23,576,360	2023	0	1	23,576,360
344	1,824,270	2023	0	1	1,824,270	2023	0	1	1,824,270
345	91,000	2024	1	0.97561	88,780	2023	0	1	91,000
346	1,149,750	2023	0	1	1,149,750	2023	0	1	1,149,750
348	427,940	2023	0	1	427,940	2023	0	1	427,940
350	1,230,570	2023	0	1	1,230,570	2023	0	1	1,230,570
352	926,910	2023	0	1	926,910	2023	0	1	926,910

Table E-2 (Continued): Structure Valuation for FWOP and FWP Conditions									
		FWOP CONDITIONS				ALT 3 FWP CONDITIONS			
Structure ID	2021 Depreciated Replacement Values	Year Damaged	Study Year	Present Value Factor	Present Value	Year Damaged	Study Year	Present Value Factor	Present Value
354	970,540	2023	0	1	970,540	2023	0	1	970,540
355	1,598,040	2023	0	1	1,598,040	2023	0	1	1,598,040
356	900,510	2023	0	1	900,510	2023	0	1	900,510
358	659,710	2023	0	1	659,710	2023	0	1	659,710
359	736,140	2023	0	1	736,140	2023	0	1	736,140
360	765,200	2023	0	1	765,200	2023	0	1	765,200
361	670,040	2023	0	1	670,040	2023	0	1	670,040
363	966,780	2023	0	1	966,780	2023	0	1	966,780
365	1,000,490	2023	0	1	1,000,490	2023	0	1	1,000,490
366	858,470	2023	0	1	858,470	2023	0	1	858,470
367	1,239,180	2023	0	1	1,239,180	2023	0	1	1,239,180
368	7,915,290	2027	4	0.905951	7,170,862	2027	4	0.905951	7,170,862
369	7,587,360	2023	0	1	7,587,360	2023	0	1	7,587,360
370	6,389,370	2023	0	1	6,389,370	2023	0	1	6,389,370

## 4 Project Benefits

### 5.1 Coastal Storm Damage Reduction

The benefit of providing measures to manage the risk of coastal storm damage in the study area is equal to the reduction in annual damages between the FWOPC and FWPC.

The value of structure damages in the FWOPC is approximately \$148.9 million compared to \$133.2 million under Alternative 2 and \$136.8 million under Alternative 3. Annual damages, presented in Table E-3, were calculated using the current 2023 Fiscal Year Federal Discount Rate of 2.5% for the 24-year life of the project. A total of 158 residential structures are expected to be damaged due to coastal erosion from 2023 to 2037 if risk reduction measures are not implemented.

Engineering analysis determined that not all the damaging erosion could be considered littoral; that approximately 15% of the erosion problem was attributable to storm damage. Based upon those parameters, land values obtained from the Galveston County Assessor's Office for 2021 were analyzed for potential land loss avoidance benefits. Based upon those values, the average per acre land value was roughly \$942,000 with a resulting square foot value of \$22.00. Using that last figure with approximately 27,000 linear feet of shoreline impacted and the landward erosion rate of 1.25 feet per year, annual eroded area was roughly 33,700 square feet with an overall value of \$740.5K. Multiplied by 24 years, that resulted in total potential land loss valued at \$17.8M under FWOP conditions and about \$5.9M under FWP conditions, an overall life cycle benefit of \$11.9M. Next, that overall benefit was amortized over an estimated 8 years of land loss delays avoided to arrive at an annual benefit of \$1.6M. Finally, that figure has been multiplied by the 15% engineering portion assigned to storm erosion and a factor of 93% developed land for an overall benefit of just over \$245K per year attributable to either placement site.

**Table E-3: Annual Structure and Land Loss Damages Calculations**

	<b>FWOP</b>	<b>FWP ALT 2</b>	<b>FWP ALT 3</b>
<b>Total Damages over 24 years</b>	\$148,887,000	\$133,227,000	\$136,806,000
<b>Capital Recovery Factor</b>	0.0559	0.0559	0.0559
<b>Annual Damages to Structures</b>	\$8,325,000	\$7,449,000	7,649,000
<b># Structs Delay Dmg over 24 years</b>	0	136	116
<b>Annual Benefit (Structures)</b>		<b>\$875,600</b>	<b>\$675,500</b>
<b>Annual Land Loss Avoided</b>		<b>\$245,200</b>	<b>\$245,200</b>

## 5 Recreation

Beach nourishment provides enhanced recreational benefits based on overall enhanced beach experience. There are a number of beach access points along the stretch of beach under consideration for both Alternative 2 and 3 (see Real Estate Appendix for detailed locations). These facilities basically consist of a paved unlined road off of FM 3005 leading to small unpaved parking lots of sand. The beach activities include typical ones: picnicking and swimming as well as strolling/walking and occasional bicycle riding on the compacted sand near the Gulf water.

Recreation Benefits were estimated using the USACE-approved Unit Day Value Methodology (Economic Guidance Memo 22-03, Oct 2021). Galveston Park Board provided visitation estimates for all areas generally defined as West End Beaches, which contain the overall study areas described earlier. Using cell phone tracking, approximately 53,000 visitors traveled to the West End of Galveston Island (baseline years 2018-2020). Using the study area length of 1.7 miles out of approximately 20 miles of beach overall, approximately 8.5% of visits (4,500) were allocated to the study area. With an average family size of 2.6 persons, that resulted in just over 12,000 person visits per year to the study area beach stretches.

Next, the Unit Day Value criteria were assigned both under FWOPC and FWPC and assigned an appropriate value per the economic guidance memorandum referenced above; the results are presented here:

**Table E-4: Annual Recreation Benefits Calculations**

UDV Criteria	Point Range	FWOPC Project Points	FWP Project Points
Recreation Experience	0-30	4	10
Availability of Opportunity	0-18	3	3
Carrying Capacity	0-14	2	5
Accessibility	0-18	6	6
Environmental Aesthetic	0-20	2	6
Total Points		17	30
Value/User/Day		\$5.94	\$7.28

Next, discussions with the Park Board indicated that under expected erosion conditions forecast, half the visitation would be expected to be lost. Thus, under FWOPC, annual recreation value was estimated at \$35,900 (\$5.94 x 6,000 visitors, rounded). Under FWPC, that same value would be approximately \$87,800 (\$7.28 x 12,000 visitors). Thus, the difference between the two annual values—\$51,900—represents Annual Recreation Benefits for dredge material placement under both alternatives.

## 6 Benefit and Cost Comparison

The benefit of providing protection through beneficial use of dredged material is equal to the reduction in annual damages between the FWOPC and FWPC, plus land loss avoidance and recreation benefits obtained from beach sand nourishment. Benefits are then compared to the incremental cost of sand placement over the least-cost Federal Navigation Base Plan (open water disposal). In this case, the same amount of sand was considered for two different sections of beach on Galveston Island’s West End. Essentially, twenty (20) more structures are protected in the stretch protected by Alternative 2 and is supported by the non-Federal Sponsor. Per policy, it is the National Economic Development (NED) Plan—\$368K vs. \$145K in Net Annual Benefits—and in this case also the Recommended Plan. Table E-5 below presents the two incremental project costs (including Interest During Construction—IDC) as well as the Net Annual Benefits associated with each of the two Alternatives/placement sites analyzed.

**Table E-5: Benefit-Cost Comparison**

<b>Beneficial Use of Dredge Material - §204</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
<b>FY 2023/(Oct '22) Total First Incremental Cost</b>	<b>\$14,427,000</b>	<b>\$14,838,000</b>
IDC - @ 2.5% (5 mos. Construction schedule; IDC charged 3 mos.)	\$30,000	\$31,000
<b>FY 2023 Total Investment</b>	<b>\$14,457,000</b>	<b>\$14,869,000</b>
Capital Recovery Factor—24 years	0.0559	0.0559
<b>FY 2023 Ann. Increment. Costs @ 2.5%; 24-Year Period of Analysis</b>	<b>\$808,000</b>	<b>\$831,000</b>
Annual Land Loss Avoided	\$248,000	\$248,000
Annual Recreation Benefits	\$52,000	\$52,000
Annual Structures Benefits (using Galveston Co Assess Values 2021)	\$876,000	\$676,000
<b>Total Annual Benefits</b>	<b>\$1,176,000</b>	<b>\$976,000</b>
Net Annual Benefits	<b>\$368,000</b>	\$145,000
<b>Benefit-Cost Ratio</b>	<b>1.46</b>	<b>1.17</b>