GREAT CHEBEAGUE ISLAND

MAINE

NAVIGATION IMPROVEMENT PROJECT

APPENDIX D

ECONOMIC ASSESSMENT

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1.0 Introduction

This Economic Assessment evaluates the benefits of providing navigation improvements to the existing town landing at Stone Wharf in the Town of Chebeague Island, Maine. The analysis includes a description of the study area and existing conditions, as well as an examination of future without and with project conditions. Economic benefits of the proposed navigation improvements are estimated by evaluating the difference between the two conditions.

The study was requested by the Town of Chebeague Island and is conducted at a Feasibility level of detail using data provided by benefits as contained in ER 1105-2-100, April 2000, Appendix E, Section II - Navigation. Costs and benefits are based on a 50-year evaluation period, starting in 2020, and presented in annual terms using the FY20 Federal interest rate for water resources projects of 2.75%.

2.0 Description of Study Area

The town of Chebeague Island is a municipality consisting of 17 islands in upper Casco Bay, Cumberland County, Maine, about 10 miles north of Portland. Only two of the islands are inhabited year round, Great Chebeague and Hope Islands. All of the islands are un-bridged, and only Great Chebeague Island has town infrastructure and services. Bates, Ministerial, and Stave islands are privately owned and occupied only in the summer (Town Comprehensive Plan, 2011). Great Chebeague Island is the largest island, approximately 4 miles long and 1.4 miles wide at its widest point. The town of Chebeague Island encompasses 24.6 square miles including 21.0 square miles of ocean (Census Bureau). The 2018 American Community Survey (latest available) reports that 412 people live in the town of Chebeague Island year-round. The population on the island is close to 2,000 during the summer (Town Comprehensive Plan, 2011).

With no bridges from the mainland, Chebeague Island relies on boat travel through a channel at the Stone Wharf to transport all rescue operations and an estimated 157,000 ferry passengers annually, including commuting schoolchildren, residents, police, teachers, and supplies. Navigational improvements are needed to ensure the island maintains its critical public navigational access, which is integral to the economic, educational, and public safety needs of the immediate and surrounding communities.

3.0 Vessel Fleet

The fleet currently consists of 64 commercial vessels registered on Great Chebeague Island. There are 44 vessels licensed for lobstering or fishing (see Table D-1), 14 vessels licensed primarily for freight transport, waste removal and utility services (see Table D-2) and 6 vessels for passenger transportation (see Table D-3).

Table D-1 – Commercial Fishing Vessels						
Last	**First**	**Boat Name**	**Length**	**Beam**	**Draft**	**Type**
Todd	Daniel		66.5	20.5	9	Fishing
Todd	Andrew	Emma Ray	46	16	8	Fishing
Dropping Springs	Stephen Todd	Heidi and Hester	60	18	7	Fishing
Parmenter	Rusty	Patricia Ann	42	15	7	Fishing
Riddle	Gregory	Ocean Hooker	48	17	7	Fishing
Todd	Alex	Jake and Josh	42	16	7	Fishing
Johnson	Stephen	Osprey	38.1	12.8	6.6	Fishing
Whetham	Henri	N.Lights	37	12	7	Fishing
Hamilton	Jeffrey	Andrew and I	35	11.8	6	Fishing
Miller	David	Gail Elaine	36	12	6	Fishing
Nintenner	David	Different Tactics	45	17	6	Fishing
Putnam	Jeff	Captain B	44	15	6	Fishing
Rich	Patricia	Sea Smoke	36	12	6	Fishing
Ross	Gary	Wanderer	35	11.8	5.8	Fishing
Dyer	Williard	Elva Jean	31.9	11.5	5.3	Fishing
Bowman	Lee	Caitlin Marie	28	10	5	Fishing
Doughty	Nathan	Retriever	36	13.2	5	Fishing
Houghton	Winthrop	Miss Ruby	25	9.7	5	Fishing
Olsen	Mark	Woodcutter	43	14	5	Fishing
Rich	Christopher	Stelias	36	11	5	Fishing
Rich	Sherman	Kelly Anne	38	14	5	Fishing
Robinson	Gordan	Enterprise	37	14	5	Fishing
Campbell	David	Amada E.	32.1	10.5	4.8	Fishing
Campbell	Kenneth	Drea Marie	32	10.5	4.8	Fishing
Dyer	Joseph	Amanda J	32	10.4	4.8	Fishing
Rich	Patricia	Resistance	34	11.5	4.5	Fishing
Burgess	Ernest	Susan Adams	32.6	10.4	4	Fishing
Doughty	Amos	jesse james	28	9	4	Fishing
Hamilton	Jason	Alissa J.	35.8	12.3	4	Fishing
Higgins	James		28	11	4	Fishing
Hutchinson	Bruce	Heidi M	30	10	4	Fishing
Rich	David	Miss Robinson	36	12	4	Fishing
Riddle	Barry	Tin Lilly	32	11	4	Fishing
Robinson	Everett	Kitty Hawk	36	12	4	Fishing
Taylor	Mary	Sadi and Eden	28	11	4	Fishing
Doughty	Justin	Frankie B	30	10	3.5	Fishing
Bowman	Mark	Summer Girl	21	7	3	Fishing
Martin			22	10	3	Fishing
Nida	Carleton	DJ	20	6	3	Fishing

Table D-1 Continued						
Tozier	Ron	Keepah	21	9	3	Fishing
Munroe	Ralph	Lobster Skiff	20	6	2	Fishing
Jordan	John	Storm Walker			4	Fishing
Martin	Christopher	Sara Ellen			2	Fishing
Todd	Jacob/Joshua	High Maintenance			4	Fishing

Table D-2 – Commercial Non-Fishing Vessels					
Company	**Boat Name**	**Length**	**Beam**	**Draft**	**Type**
L.P.A.	Lionel Plante	87	28	6	waste
L.P.A.	Ft. Gaines	150	48	6	waste
Hamilton	Greta and Sean	28	10	5.5	
Boat Yard		26	10	5.5	Service boat
CTC		50	24	5	Freight barge
CTC	Dovekie	25.2	14	5	Push Boat
Intercoastal		80	24	5	Freight barge
CMP	High Voltage	42	14	5	Service
Portland Harbor Fuel	Judy Anne 2	36	12	5	Fuel Supply
Ring	Altantic Seal	42	12	5	
Tozier	Blackswan	34	11	4	
BBC		40	14	4	Barge
Telephone Co.	Light Waves	30	11	4	Service
Bohem		28	11	3	Electrical Contractor

Table D-3 – Commercial Passenger					
Company	**Boat Name**	**Length**	**Beam**	**Draft**	**Type**
CTC	Islander	52	18.3	7	Passengers/Freight
CTC	Pied Piper	56	16	7	Passengers/Freight
Water Taxi		30	12	4	
Water Taxi	PHWT	30	5	4	
Water Taxi	Fog BW	27	10	3	
Water Taxi	Bounty	21	5	3	

Two passenger ferries, owned and operated by the municipally-managed Chebeague Transportation Company (CTC), provide passenger and small freight ferry service from Cousins Island (connected to the mainland by causeway) to the Stone Wharf on Chebeague Island 10-12 times throughout the day, seven days per week. The trip is approximately 15 minutes, depending on the tide. A barge and push boat transport vehicles and commercial freight from April 1st (weather permitting) to November 30th each year. Barging originates on Great Chebeague Island, or in Yarmouth at Cousins Island or Yankee Marina. CTC has about 22 employees.

The CTC ferry also provides several significant public services to the town. It holds the contract for transporting island children to school on the mainland. It also provides transportation free of charge at any time of day or night for police and medical rescue services. When an ambulance service brings a patient to the dock the ferry transports the patient to Cousins Island where another ambulance takes the patient to a hospital on the mainland.

4.0 Economic Setting

As of the 2018 American Community Survey, Chebeague Island's racial makeup is 98.2 percent white, and the median age in the town is 62.7 years. Median annual household income for 2020 is projected to be $63,542 which is slightly above Maine's average of $55,425. At approximately 1.5 percent, the unemployment rate is well below Maine's 9.9 percent rate (July. 2020). Educational attainment is relatively high, with 52.1 percent of the population holding a bachelor's degree or higher.

The population is mainly employed in health and education (18 percent), retail (17 percent), finance and professional services (15 percent), fishing (10 percent), and construction (10 percent). For 58 percent of commuters, travel time to work is less than 15 minutes. The average commute time for Chebeague Island residents is 27 minutes, while 24 percent commute for 45 minutes or more.

Chebeague Island counts 535 total housing units, 207 of which are occupied year-round. Much of the island's housing stock is used during summer months when tourism peaks. Roughly 34 percent of the Town's citizens moved into their current homes prior to 1989.

In the past, Chebeague Island's economy mostly relied on shipbuilding and later commercial fishing. Chebeague Island is home to several lobsterman who fish the waters of Casco Bay, and from 2014 to 2018 between 531,961 and 1,094,072 pounds of lobster and other species were landed at Chebeague at a value of $2,241,333 to $4,437,760 (communication with National Marine Fisheries Service, April 2019). In 2011 1,465,030 pounds of lobster and other commercial marine species were reported for Chebeague with a value of approximately $4,884,244. Today the island hosts a number of tourist establishments such as the historic Chebeague Island Inn. Other destinations include the Great Chebeague Golf Club, Niblic gift shop, and Doughty's Island Market. The town maintains both paved and unpaved roads. Cars are transported to Great Chebeague Island via cargo barge, where they often remain for life.

Public services on the island include a fire department, library, recreation center, and internet services provided by locally owned Chebeague.net. The town's school educates children from Pre-K through fifth grade, with approximately 30 students enrolled. From sixth grade on, students attend school on the mainland in Yarmouth.

5.0 Existing Conditions

As the channel approaches the Stone Wharf on Great Chebeague Island, controlling depth is reduced to shallower than -4 feet MLLW. Vessels currently using the site require a controlling depth of -5 to -9 feet MLLW, so these vessels can only access the wharf at mid to high tides. The Town dredged the ferry berth at the wharf in 2003, but that area along with the un-dredged approach channel has continued to shoal. Approximately 200 feet past the ferry docking area is a barge ramp located at the end of Stone Wharf Road. The ramp can only be used at high tide because the channel is not dredged completely to the ramp and the bottom is fully exposed during low tides.

The Harbormaster reports several problems with the existing channel conditions. Lobster vessels have been damaged on shoals located within the channel when bringing in catch. These vessels must also tie up to a floating dock in order to load supplies or off load catch because the area along the Stone Wharf is too shallow. Loading and off-loading from a rocking vessel to an equally unstable dock increases the risk of vessel damage and injury to crew members.

Barging between Cousins Island or Portland, ME is also severely restricted by the tide at the Great Chebeague Island end of the routes, and the ferries now have less than one foot underkeel clearance at low tide when tying up to the wharf. Low underkeel clearance could cause the ferry to suddenly strike bottom; causing damage to the vessel or cargo and injury to passengers. Most importantly, low depth may restrict rescue services in an emergency situation.

6.0 Without-Project Condition

The "without-project condition" is the expected condition if the Federal government takes no action to improve the navigation capabilities in the Great Chebeague Island area. In this case, if conditions become much shallower, then the ferry may not be able to reach the wharf, except on high tides. If the current conditions continue, the challenges faced by commercial fishing fleet, the restriction of tidal access to the wharf, and the possibility of grounding damages to their vessels will remain unabated. In the without-project condition, tidal delays, grounding damages and impeded emergency services currently experienced due to inadequate channel depth will continue to occur. These delays and damages increase the operating costs of Great Chebeague Island vessel operators, reducing their net incomes and reducing overall emergency and economic efficiency.

A controlling depth of -5 feet was used to calculate the existing condition. This was determined by reviewing channel depths and -5 feet is a conservative estimate of the shallowest point of the channel that the vessels encounter.

7.0 With Project Condition

The proposed navigation improvements at Chebeague Landing would create a new channel at the Stone Wharf, as shown in Figure D-1. The channel would extend from deep water in Casco Bay southeasterly ~1,600 feet to Great Chebeague Island public landing. The channel would be 100 feet wide and -10 feet deep mean lower low water (MLLW), widening to 150 feet alongside the pier. An upper turning basin at -8 feet MLLW between the channel and the boat/barge ramp would also be constructed to accommodate maneuvering of vessels. A range of channel depths between -8 and -11 feet MLLW and turning basin depths of between -6 and -9 MLLW were examined.

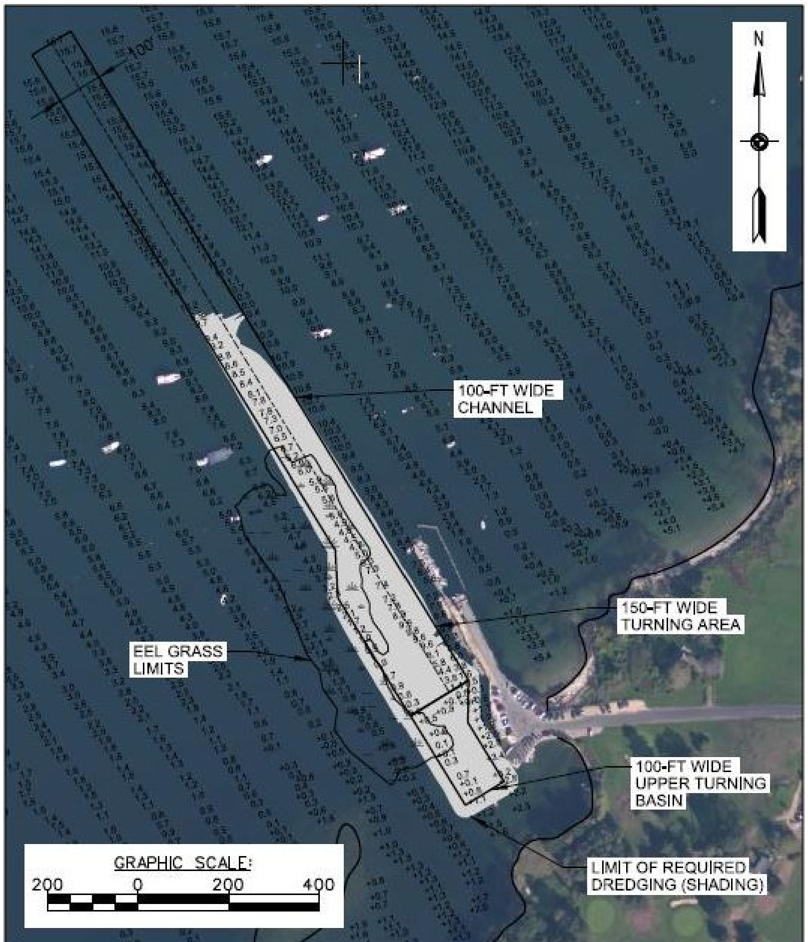

Figure D-1 – Proposed Channel and Turning Basin

8.0 Calculation of Benefits

Benefits are calculated using information provided by the Harbormaster, town administrator, and the Chebeague Transportation Company. The Harbormaster identified 64 vessels that regularly use the proposed improvement area. The 64 vessels include 44 commercial fishing vessels, 6 passenger ferries, 3 freight barges and one push boat. Based on information collected from port officials and in discussion with the Harbormaster, the commercial fishing vessels make an average of 180 trips per year and generally have a crew of 2 to 3, depending on the size of the vessel.

To calculate the opportunity cost of time for boat operators and crew on commercial vessels during tidal delays, the value of time is estimated using one-third of the average wage for production workers in manufacturing in Maine, as required for Corps small boat harbor analyses. The average production wage in 2019 (latest available) for Maine was $32.50 (US Bureau of Labor Statistics: Average Weekly Wage in Private Manufacturing accessed 14 September 2020), one-third of which is $10.83. Wages were updated to the 2020 price level using the average of the construction cost index and the GDP deflator. A price level update factor of 1.03 resulted in a 2020 wage of $11.16/hour. Wages for the captain and deck hands of the ferry vessels were obtained from the Chebeague Transportation Company and used to estimate the value of time lost for non-fishing commercial vessels during tide delays. A rate of $28/hour was used for the captain and $15.50/hour for the deck hands. Fuel costs during delays are calculated using the average cost of diesel fuel between the beginning of the boating season in March ($3.18) and the end of the season in September ($2.61) for a price of $2.90 per gallon.

The new channel would reduce tide delays and related labor and fuel costs incurred while waiting for the tide to come up to access the floating dock, wharf, and boat/barge ramp. Delays due to inadequate landside off-loading capacity, including lack of space for lobster pods and fishing gear, would not be reduced by the proposed project. The deeper channel would provide all tide access to the Stone Wharf, preventing labor and fuel costs incurred during tide delays. The proposed turning basin would provide all tide access to the boat/barge ramp and prevent costly tide delays experience by the CTC barge and service vessels, as well as providing sufficient room for vessels to safely maneuver. The proposed channel and turning basin would also prevent potential increased maintenance costs incurred when the ferry or fishing vessels bump bottom due to insufficient depth.

Benefits to the proposed channel widening are calculated for the 64 vessel that regularly transit the area of the proposed channel, in the following categories:

1. Prevention of Tide Delays – Time costs while delayed waiting for the tide to access the Stone Wharf
2. Prevention of Tide Delays – Fuel Costs while delayed waiting for the tide to access the Stone Wharf

Average tidal delays were calculated by vessel draft using a mean tide chart based on a 9.1-foot tidal range and an underkeel clearance requirement of two feet for fishing and commercial non-fishing vessels and three feet for ferries. A controlling depth of -5 feet was used. This was determined by reviewing channel depths and -5 feet is a conservative estimate of the shallowest point of the channel that the vessels encounter. Tidal delay costs are calculated only for those vessels identified as having drafts of 3 feet or greater, since shallower draft vessels are able to use the area with little or no problem. The tide cycles are calculated on a diurnal basis over 24.8 hours. Table D-4 shows the average tidal delays for the commercial fishing vessels. Table D-5 and Table D-6 show tidal delay labor and fuel costs for commercial fishing vessels.

Table D-4 – Average Tidal Delays Commercial Fishing

Vessel Draft (feet)	Number of Vessels	Controlling Depth (feet)	Underkeel Clearance (feet)	Tide Height Required (feet)	Average Delay (hours)
8-9	2	5	2	5.50	1.50
7-7.9	5	5	2	4.50	1.21
6-6.9	6	5	2	3.50	0.95
5-5.9	9	5	2	2.50	0.46
3-4.9	22	5	2	1.00	0.04

Table D-5 – Tidal Delay Time Labor Costs Commercial Fishing						
Draft (feet)	Number of Vessels	Average Delay (hours)	Trips/ Year	Number of Crew per Boat	$/Hour	Delay Time Cost (rounded)
8-9	2	1.50	180	2.5	$11.16	$15,100
7-7.9	5	1.21	180	2.5	$11.16	$30,300
6-6.9	6	0.95	180	2.5	$11.16	$28,600
5-5.9	9	0.46	180	2.5	$11.16	$20,600
3-4.9	22	0.04	180	2.5	$11.16	$3,900
	44				**Total**	**$98,500**

Table D-6 – Tidal Delay Time Fuel Costs Commercial Fishing						
Draft (feet)	Number of Vessels	Average Delay (hours)	Trips/Year	Gallons /Hour	Fuel Price/ Gallon	Delay Fuel Cost (rounded)
8-9	2	1.50	180	4	$2.90	$6,300
7-7.9	5	1.21	180	4	$2.90	$12,600
6-6.9	6	0.95	180	4	$2.90	$11,900
5-5.9	9	0.46	180	4	$2.90	$8,600
3-4.9	22	0.04	180	4	$2.90	$1,600
					Total	**$41,000**

Table D-7 shows the average tidal delays for commercial non-fishing vessels such as waste barges, push boats and other vessels listed in Table D-2 above. Table D-8 and Table D-9 show the tidal delay labor and fuel costs for commercial non-fishing vessels.

Table D-7 – Average Tidal Delays Commercial Non-Fishing					
Vessel Draft (feet)	Number of Vessels	Controlling Depth (feet)	Underkeel Clearance (feet)	Tide Height Required (feet)	Average Delay (hours)
8-9	0	5	2	5.50	1.50
7-7.9	0	5	2	4.50	1.21
6-6.9	2	5	2	3.50	0.95
5-5.9	8	5	2	2.50	0.46
3-4.9	4	5	2	1.00	0.04

Table D-8 – Tide Delay Time Labor Costs Commercial Non-Fishing						
Draft (feet)	Number of Vessels	Average Delay (hours)	Trips/ Year	Number of Crew per Boat	$/Hour	Delay Time Cost (rounded)
6-6.9	2	0.95	250	2.5	$20.50	$24,300
5-5.9	8	0.46	250	2.5	$20.50	$46,726
3-4.9	4	0.04	250	2.5	$20.50	$1,800
	14				**Total**	**$72,800**

Table D-9 – Tide Delay Time Fuel Costs Commercial Non-Fishing						
Draft (feet)	Number of Vessels	Average Delay (hrs)	Trips/Year	Gallons/ Hour	Fuel Price/ Gallon	Delay Fuel Cost (rounded)
6-6.9	2	0.95	250	4	$2.90	$5,500
5-5.9	8	0.46	250	4	$2.90	$10,600
3-4.9	4	0.04	250	4	$2.90	$400
	14				**Total**	**$16,500**

Table D-10 shows the average tidal delay for commercial passenger vessels. Table D-11 and Table D-12 show tidal delay labor and fuel costs for commercial passenger vessels.

Table D-10 – Average Tidal Delays Commercial Passenger					
Vessel Draft (feet)	Number of Vessels	Controlling Depth (feet)	Underkeel Clearance (feet)	Tide Height Required (feet)	Average Delay (hours)
8-9	0	5	3	6.50	2.18
7-7.9	2	5	3	5.50	1.50
6-6.9	0	5	3	4.50	1.21
5-5.9	4	5	3	3.50	0.95
3-4.9	22	5	3	2.00	0.23

Table D-11 – Tide Delay Time Labor Costs Commercial Passenger						
Draft (feet)	Number of Vessels	Average Delay (hours)	Trips/ Year	Number of Crew per Boat	$/Hour	Delay Time Cost (rounded)
7-7.9	2	1.50	2000	2.5	$20.50	$307,500
3-4.9	4	0.23	250	2.5	$20.50	$11,800
					Total	**$319,300**

Table D-12 – Tide Delay Time Fuel Costs Commercial Passenger						
Draft (feet)	Number of Vessels	Average Delay (hours)	Trips/Year	Gallons/ Hour	Fuel Price/ Gallon	Delay Fuel Cost (rounded)
7-7.9	2	1.50	2000	4	$2.90	$69,600
3-4.9	4	0.23	250	4	$2.90	$2,700
					Total	**$72,300**

Table D-13 below summarizes total annual tidal delay costs experienced under existing channel conditions.

Table D-13 – Total Annual Tide Delay Costs		
	Annual Labor Cost	Annual Fuel Cost
Commercial Fishing	$98,500	$41,000
Commercial Non-Fishing	$72,800	$16,500
Commercial Passenger	$319,300	$72,300
Total Annual Cost	$490,600	$129,800
Annual Cost of Current Conditions		**$620,400**

To estimate the benefits of other channel depths, annual benefits are apportioned based on the distribution of vessel drafts for those vessels identified as regularly using the channel and landing at the Stone Wharf.

Based on the vessel draft data, 100% of the vessels have drafts of 9 feet or less, 96.9% have drafts of 7 feet or less, 85.9% have drafts of 6 feet or less and 73.4% have drafts of 5 feet or less. Because this area has strong tides, an underkeel clearance requirement of two feet is assumed, thus a channel depth of 10 feet would fully accommodate all but one vessel safely under typical tides (8-foot draft plus 2-foot underkeel clearance). Likewise, a channel depth of 9 feet would fully accommodate 96.8% of the vessels (7-foot draft plus two foot underkeel clearance), and a channel depth of 8 feet would fully accommodate 85.9% of vessels.

Table D-14 shows the projected annual benefits by channel depths with the turning basin always 2 feet shallower than the channel due to the smaller draft of the barges that would use this area the most. To evaluate channel depths from 8 to 11 feet MLLW (and turning basin depths from -6 to -9 feet MLLW), additional tidal delay calculations were made to determine the annual delay costs that would be prevented at each incremental channel depth. It is assumed that all tidal delay costs would be prevented with channel depths of 10 feet and above, since the deepest draft of vessels using this area is 9 feet and it is assumed that two feet of underkeel clearance is adequate to transit this more protected area. At channel depths of 8, 9, 10, and 11 feet, the residual tidal delay costs were calculated, and annual benefits adjusted as appropriate. The results of these costs prevented are summarized in the table below.

Table D-14 – Annual Benefits by Channel Depth				
Tidal Delays	8' Channel	9' Channel	10' Channel	11' Channel
Commercial Fishing				
Labor Cost Prevented	$88,200	$96,200	$98,500	$98,500
Fuel Cost Prevented	$36,700	$40,000	$41,000	$41,000
Commercial Non-Fishing				
Labor Cost Prevented	$72,800	$72,800	$72,800	$72,800
Fuel Cost Prevented	$16,500	$16,500	$16,500	$16,500
Commercial Passenger				
Labor Cost Prevented	$225,800	$272,300	$319,300	$319,300
Fuel Cost Prevented	$51,100	$61,700	$72,300	$72,300
Total Annual Benefits	**$491,100**	**$559,500**	**$620,400**	**$620,400**

8.1 Recreation Benefits

Recreational users of the harbor will experience increased accessibility and improved safety when channel and turning basin have been constructed. To estimate the value of improvement in the recreational quality with the project, the Unit Day Value method was used. Benefits were calculated for the 100 recreational vessels using the channel (as provided by the Harbormaster). The number of recreational users will likely increase when the channel and basin are constructed.

Recreational activities are evaluated based on five criteria that characterize the quality of the recreational experience. Point values for the existing without-project conditions are compared to the with-project condition. Total point values are converted to dollar values based on current Corps guidance as contained in EGM 20-03 Fiscal Year 2019. Additional recreational benefits of approximately $16,400 would be realized if the channel and turning basin are constructed. The Unit Day Value analysis for Stone Wharf is shown in Table D-15 below.

Table D-15 – Recreation Benefits				
UDV CRITERIA	POINT RANGE	POINTS		JUSTIFICATION
		WITHOUT PROJECT	WITH PROJECT	
Recreation Experience	0 - 30	5	7	There are several general activities such as fishing and sailing that increase in number with project.
Availability of Opportunity	0 - 18	4	4	There are other harbors in the area such as Portland but none that offer the same atmosphere.
Carrying Capacity	0 - 14	3	4	With the project, the adequate facilities would become optimum.
Accessibility	0 - 18	10	14	There is good road access to the harbor and access will not change with the project.
Environmental Aesthetic	0 - 20	20	20	The harbor has very good aesthetic qualities, which will not change after the project is constructed.
TOTAL POINTS		42	49	
UNIT DAY VALUE		$8.11	$8.87	
NUMBER OF DAYS		72	72	
USERS PER BOAT		3	3	
NUMBER OF BOATS		100	100	
DOLLAR VALUE		$175,176	$191,592	
RECREATION BENEFIT (Rounded)			**$16,400**	

8.2 Benefit Summary

This section summarizes the benefits of constructing a channel and turning basin at Chebeague Landing. The annual benefits are summarized in Table D-16. Benefits include the avoided cost associated with tidal delays including lost labor cost, increased fuel consumption cost and recreation benefits.

Table D-16 – Annual Benefits by Channel Depth				
Tidal Delays	8' Channel	9' Channel	10' Channel	11' Channel
Commercial Fishing				
Labor Cost Prevented	$88,200	$96,200	$98,500	$98,500
Fuel Cost Prevented	$36,700	$40,000	$41,000	$41,000
Commercial Non-Fishing				
Labor Cost Prevented	$72,800	$72,800	$72,800	$72,800
Fuel Cost Prevented	$16,500	$16,500	$16,500	$16,500
Commercial Passenger				
Labor Cost Prevented	$225,800	$272,300	$319,300	$319,300
Fuel Cost Prevented	$51,100	$61,700	$72,300	$72,300
Annual Benefits	**$491,100**	**$559,500**	**$620,400**	**$620,400**
Recreation Benefits	$16,400	$16,400	$16,400	$16,400
Total Annual Benefits	**$507,500**	**$575,900**	**$636,800**	**$636,800**

9.0 Project Costs

Project alternatives include constructing the channel at a depth of 8, 9, 10, or 11-feet MLLW and constructing the turning basin 2-feet shallower than the channel at a depth of 6, 7, 8, or 9-feet MLLW. Details of each design are provided in the main feasibility report. Annualized cost estimates of each alternative, presented in Table D-17, are calculated at the FY 2020 federal interest rate of 2.75% and based on a construction period of 2 weeks. Annualized costs are converted to present value equivalents based on a 50-year project life.

Table D-17 – Annualized Cost Calculation				
	Plan A-1	Plan A-2	Plan A-3	Plan A-4
	8-Foot Channel and 6-Foot Turning Basin	9-Foot Channel and 7-Foot Turning Basin	10-Foot Channel and 8-Foot Turning Basin	11-Foot Channel and 9-Foot Turning Basin
First Cost (2020)	$1,606,000	$1,704,000	$1,836,000	$2,007,000
Interest During Construction	$1,900	$2,000	$2,200	$2,400
Total Investment Cost	$1,607,900	$1,706,000	$1,838,200	$2,009,400
Average Annual Cost	$59,600	$63,200	$68,100	$74,400
Operation & Maintenance Cost	$26,200	$27,800	$30,100	$33,100
Total Annual Cost	$85,800	$91,000	$98,200	$107,500

10.0 Economic Justification

The alternative that maximizes net annual benefits, is the National Economic Development (NED) plan, provided that plan also has a benefit-cost ratio greater than one. The benefit-cost ratio of each alternative is determined by dividing its total annual benefits by its total annual costs. A project is considered economically justified if it has a benefit to cost ratio of 1.0 or greater. The alternative that maximizes net annual benefits, and with the greatest BCR is the alternative chosen for the National Economic Development (NED) plan. Over a 50-year analysis period, Plan A-3 is the NED plan based on the highest net annual benefits of $538,600 and a 6.5 to one benefit to cost ratio. The NED plan will construct a channel with a length of ~1,600 feet, 100 to 150 feet wide and a depth of 10-feet MLLW and a turning basin at a depth of -8 feet MLLW.

Table D-18 – Benefit Cost Ratio 2020 *				
	Plan A-1	Plan A-2	Plan A-3	Plan A-4
	8-Foot Channel and 6-Foot Turning Basin	9-Foot Channel and 7-Foot Turning Basin	10-Foot Channel and 8-Foot Turning Basin	11-Foot Channel and 9-Foot Turning Basin
First Cost (2020)	$1,606,000	$1,704,000	$1,836,000	$2,007,000
Interest During Construction	$1,900	$2,000	$2,200	$2,400
Total Investment Cost	$1,607,900	$1,706,000	$1,838,200	$2,009,400
Average Annual Cost	$59,600	$63,200	$68,100	$74,400
Operation & Maintenance Cost	$26,200	$27,800	$30,100	$33,100
Average Annual Cost	$85,800	$91,000	$98,200	$107,500
Average Annual Benefits without Recreation	$491,100	$559,500	$620,400	$620,400
Net Benefits	$405,300	$468,500	**$522,200**	$512,900
BCR	5.7	6.1	**6.3**	5.8
NED Benefits calculated with Recreation Benefits				
Recreation Benefits	$16,400	$16,400	$16,400	$16,400
Average Annual Benefits with Recreation	$507,500	$575,900	$636,800	$636,800
Net Benefits with Recreation	$421,700	$484,900	**$538,600**	$529,300
BCR	5.9	6.3	**6.5**	5.9

*Calculated at 2020 Price Level and 2020 Federal Discount Rate of 2.75%

11.0 Risk and Uncertainty

The net benefits of Plan A-4 ($529,300) and the net benefits of the selected plan, Plan A-3 ($538,600) are considerably close. Given that all vessels, with the exception of one fishing vessel, have a draft of 8-feet or below, the incremental benefit of dredging an additional foot does not outweigh the additional costs of dredging the additional foot. Given 98% of all vessels can safely travel with a 2-foot clearance at 10-feet, net benefits of Alternative 3 will always be greater than net benefits of Alternative 4. No further risk and uncertainty analysis was deemed necessary.

Another source of risk and uncertainty is the channel depth used in the calculation of labor and fuel delay costs. There is variability in water depth throughout the channel. Therefore, a sensitivity analysis was performed using a controlling depth of the shallowest portion of the channel used by the different groups of vessels. For the ferry and water taxis a controlling depth of -4 feet MLLW was used in the sensitivity analysis. A controlling depth of 0-feet MLLW was used for commercial non-fishing vessels such as barges and service boats that need access to the boat/barge ramp because this area is exposed at low tide. A controlling depth of -1-foot MLLW was used for fishing vessels because they may require access to the boat/barge ramp or the upper portion of the channel where conditions are shallower.

Table D-19 – Channel Depth Uncertainty Summary

Alternative	Description	Average Annual Cost	Average Annual Benefits	Net Benefits	Benefit-Cost Ratio
Plan A-1	8-Foot Channel and 6-Foot Turning Basin	$85,800	$1,280,800	$1,195,000	14.9
Plan A-2	9-Foot Channel and 7-Foot Turning Basin	$91,000	$1,349,200	$1,258,200	14.8
Plan A-3	10-Foot Channel and 8-Foot Turning Basin	$98,200	$1,410,100	$1,311,900	14.4
Plan A-4	11-Foot Channel and 9-Foot Turning Basin	$107,500	$1,410,100	$1,302,600	13.1

*Calculated at 2020 Price Level and 2020 Federal Discount Rate of 2.75%

Table D-19 above summarizes the results with the adjusted channel depths. The 10-foot channel still maximizes net benefits but has a slightly lower BCR than the 9-foot channel. The incremental annual cost of $7,200 is outweighed by the $53,700 in additional annual benefits or an incremental BCR of 7.5 to 1 to construct the 10-foot channel.

Adjusting the channel depth for the various types of vessels did not impact the outcome that net benefits are maximized in Plan A-3. In the study, a -5-foot channel depth was used as a conservative assumption of average channel depth for all vessels.

12.0 Economic Update

Table D-20 below presents the suite of channel alternatives with costs and benefits updated to 2021 Price Level using the Civil Works Construction Cost Index for Navigation Ports and Harbors found in EM 1104-2-1304, 31 March 2020.

Table D-20 – Benefit Cost Ratio 2021				
	Plan A-1	Plan A-2	**Plan A-3**	Plan A-4
	8-Foot Channel and 6-Foot Turning Basin	9-Foot Channel and 7-Foot Turning Basin	10-Foot Channel and 8-Foot Turning Basin	11-Foot Channel and 9-Foot Turning Basin
First Cost **(FY 2021)**	$1,659,000	$1,761,000	$1,897,000	$2,072,000
Interest During Construction	$2,000	$2,100	$2,300	$2,500
Total Investment Cost	$1,661,000	$1,763,100	$1,899,300	$2,074,500
Average Annual Cost	$61,500	$65,300	$70,400	$76,800
Operation & Maintenance Cost	$27,000	$28,700	$31,100	$34,200
Average Annual Cost	$88,500	$94,000	$101,500	$111,000
Average Annual Benefits without Recreation	$505,400	$575,800	$638,500	$638,500
Net Benefits	$416,900	$481,800	**$537,000**	$527,500
BCR	5.7	6.1	**6.3**	5.8
NED Benefits Calculated with Recreation Benefits				
Recreation Benefits	$16,900	$16,900	$16,900	$16,900
Average Annual Benefits with Recreation	$522,300	$592,700	$655,400	$655,400
Net Benefits with Recreation	$433,800	$498,700	**$553,900**	$544,400
BCR	5.9	6.3	**6.5**	5.9

13.0 Regional Benefits and Other Social Effects

The impacts of project spending on the employment, income, and output of the regional economy are considered part of the Regional Economic Development (RED) account. These regional impacts associated with construction spending for the NED Plan are calculated using the USACE Regional Economic System (RECONS) certified regional economic model. The RECONS model uses IMPLAN® modeling system software developed by Minnesota IMPLAN Group, Inc. to trace the economic ripple, or *multiplier*, effects of project spending in the study area. The model is based on data collected by the U. S. Department of Commerce, the U.S. Bureau of Labor Statistics, and other federal and state government agencies. RECONS uses categories defined by the U.S. Office of Management and Budget's North American Industry Classification System (NAICS). Nationally developed input-output tables represent the relationships between the many different sectors of the economy to allow an estimate of changes in economic activity on the larger economy as a whole, brought about by spending in the project area.

The expenditures associated with dredging activity in Cumberland (ME) are estimated to be $1,800,000. Of this total expenditure, $857,000 will be captured within the local impact area. The remainder of the expenditures will be captured within the state impact area and the nation. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized for the local, state, and national impact areas in Table D-21 below.

The NED expenditures of $1.8 million support a total of 6.2 full-time equivalent jobs, $429,000 in labor income, $764,000 in value added, and $1.3 million in economic output in the local impact area. More broadly, these expenditures support 9.5 full-time equivalent jobs, $628,000 in labor income, $1 million in value added, and $1.8 million in economic output in the state of Maine. For the overall nation, the regional dredging expenditure supports 14.1 jobs, $1 million in labor income, $1.7 million in value added, and $3 million in economic output.

13.1 Other Social Effects

The No Action Alternative could have negative effects on the socioeconomic environment of Great Chebeague Island. The island is only accessible by boat or ferry as there are no bridges to the island. The lack of adequate navigation access to the island could negatively impact resident's ability to travel to and from the island and receive goods and services from the mainland.

Table D-21 – RED Benefits

Area	Local Capture ($000)	Output ($000)	Jobs*	Labor Income ($000)	Value Added ($000)
Local					
Direct Impact		$812	3.3	$267	$486
Secondary Impact		$479	3.0	$163	$279
Total Impact	$857	$1,291	6.2	$429	$764
State					
Direct Impact		$1,105	4.9	$398	$636
Secondary Impact		$690	4.6	$230	$390
Total Impact	$1,240	$1,795	9.5	$628	$1,026
US					
Direct Impact		$1,245	5.3	$463	$744
Secondary Impact		$1,756	8.8	$563	$941
Total Impact	$1,695	$3,001	14.1	$1,026	$1,685

14.0 Sources

Town of Chebeague Island, Maine, Comprehensive Plan. 9 February 2011. Accessed March 2019 from https://www.townofchebeagueisland.org/?SEC=B4D04587-4C49-4E0D-88E1-5755426FAE05

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United States Census Bureau, Chebeague Island Town, Cumberland County, Maine. Accessed 14 September 2020 from https://data.census.gov/cedsci/profile?q=Chebeague%20Island%20town,%20Cumberland%20County,%20Maine&g=0600000US2300512300