NORFOLK HARBOR NAVIGATION IMPROVEMENTS

ANCHORAGE F MODIFICATIONS

DRAFT LIMITED REEVALUATION REPORT AND SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT

APPENDIX C

Economic and Social Considerations

US Army Corps of Engineers

THE PORT OF VIRGINIA

Norfolk Harbor

Economic Reevaluation Report

U.S. Army Corps of Engineers

Deep Draft Navigation Planning Center of Expertise

April 2025

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1. Introduction

This Economic Reevaluation for this Limited Reevaluation Report (LRR) was done in accordance with Director of Civil Works Policy Memorandum (CWPM) 12-001, Methodology for Updating Benefit-to-Cost Ratios (BCR) for Budget Development, signed 08 March 2012. The Program Development Guidance (PDG) memo for FY27 Budget Development requires that approval date of the latest economic analysis must not precede the date of the Major Subordinate Command (MSC) budget submission date by more than two years for projects seeking new start funding for preconstruction, engineering and design or construction. This economic update was conducted in accordance with the Civil Works' Policy Memorandum (CWPM 12-100) for an update to the benefit-to-cost ratios in support of a revision to the scope of the Norfolk Harbor and Channels Navigation Improvement Limited Reevaluation Report to reassess the benefits associated with deepening and widening Anchorage F along the Norfolk Harbor.

The US Army Corps of Engineers (USACE) conducted a review of the documented historical vessel calls for the Norfolk Harbor to determine the need for additional depth and width of Anchorage F located alongside the Norfolk Harbor (Figure 1). This project is a modification of the authorized Norfolk Harbor and Channels, Virginia (Public Law 99-662). It has been seven years since the original analysis was completed, and there have not been any major changes in trade routes, major new users or loss of major port users, or major changes in types and tonnages of commodities, however, due to an ERDC report, published August 2021, stating that Anchorage F needed to be larger in order to accommodate the deepening design vessel, a detailed update of benefits, including HarborSym economic model re-runs, and new commodity and fleet forecasts, was required to analyze the economic feasibility of deepening Anchorage F.

This analysis required specific plan formulation to determine the most economically justified anchorage depth and included engineering, design, and environmental updates. The Supplemental Environmental Assessment (EA) for the project is underway and will include any recommended design changes. Therefore, per Supplement 4, CWPM 12-001, the Deep-Draft Navigation Planning Center of Expertise concurred with NAO's recommendation that a Level 3, Economic Reevaluation should be performed for this deep-draft navigation project. Because this project will require new plan formulation and authorization, the maximum project cost limit established by Section 902 of the Water Resources Development Act (WRDA) of 1986, as amended (Section 902 limit) will be reassessed. NAO is initiating the required change management protocols in accordance with USACE policies and regulations with the Post-Authorization Change Report (PACR).

The period of analysis for this study extends from 2028 to 2077. This reevaluation uses a base year of 2027 with a discount rate of 3.0% and applies October 2024 price levels.

2. Purpose and Scope of Economic Reevaluation

The purpose of this review is to identify whether the authorized plan is still in the federal interest and to evaluate measures which would improve the operational efficiency of the Norfolk Harbor and Channels Navigation Improvement project for commercial vessels that are currently using the project and commercial vessels that are projected to use the harbor in the future. The need for this investigation arises from inefficiencies experienced by commercial vessels currently using the Norfolk Harbor and Channels project. These inefficiencies are projected to continue in the future as vessels shift to a larger fleet. This economic analysis will estimate the National Economic Development (NED) benefits associated with harbor improvements, specifically the widening and deepening of Anchorage F, that are designed to allow more efficient navigation in the Norfolk Harbor by the existing and future fleet.

The economic evaluation is limited to the legislatively authorized depth of -55 MLLW and as such the recommended anchorage depth may or may not coincide with the authorized depth of the channel, rather the recommended plan is the plan that reasonably maximizes the NED benefits within the constraints of the anchorage. The economic analysis was prepared in level of detail commensurate with the complexity of the project.

The requirements of this Level 3 Economic Reevaluation, per CWPM 12-001, are as follows:

- Clearly document authority;
- Clearly document scope has not changed since last approved report (i.e. still within Chief's discretionary authority);
- Clearly document all of the key economic (benefit) assumptions;
- Collect all necessary economic and engineering data for full reassessment of benefits;
- Re-run economic model using updated economic and engineering data;
- Display economic benefits at current price levels;
- Display updated costs;
- Display BCR and Remaining Benefits Remaining Costs Ratio (RBRCR) for both current discount rate and a 7 -percent discount rate;
- Recalculate 902 Limit and display all of the required tables and fact sheets in Appendix G of ER 1105-2-100;
- Signed District Approval Sheet.

3. Federal Project and Study Authority

The Norfolk Harbor Navigation Improvements, Virginia Final Integrated General Reevaluation Report and Environmental Assessment, 2018 (GRR) was prepared as a response to a vessel fleet composed of larger, deeper-draft container ships calling upon the Norfolk Harbor and Channels. While this GRR update did provide efficiency improvements, the differing anchorage and channel depths has been problematic in maneuvering within the channel. Considering the new discoveries from August 2021 ERDC report, Anchorage F needed to be larger in order to accommodate the deepening design vessel potentially new traffic patterns, this reevaluation was initiated at the request of the Port of Virginia to investigate the deepening and widening of Anchorage F, as a supplement to the Norfolk Harbor and Channels 55-foot channel depth, which was authorized by Section 201 of the Water Resources Development Act of 1986 (Public Law 99-662);

Section 201 of the Water Resources Development Act of 1986 (Public Law 99-662) authorized the construction of the Norfolk Harbor and Channels, Virginia, Project, as described in House Document 99-85, dated 18 July 1985, entitled "Norfolk Harbor and Channels, Virginia."

This law authorized the construction of the Norfolk Harbor and Channels, Virginia, Project, as described in House Document 99-85, dated 18 July 1985, entitled "Norfolk Harbor and Channels, Virginia." The original authorization included channel deepening from 45 to 55 feet within most of the project area and 57 feet within the Atlantic Ocean Channel (AOC).

3.1. USACE Transportation Guidelines

The role of USACE with respect to navigation is to provide safe, reliable, and efficient waterborne transportation systems (channels, harbors, and waterways) for movement of commerce, national security needs, and recreation. USACE accomplishes this mission through a combination of capital improvements and the operation and maintenance of existing projects. The base economic benefit of a navigation project is reduction in the value of resources required to transport commodities.

National Economic Development (NED) deep-draft navigation benefits generally fall into six major groups of transportation cost savings including cost reduction benefits for existing movements, shift of mode, shift in origin, shift in destination, induced movement, and non-standard, but with respect to this LRR, the most relevant is the reduction in the cost of transport. The benefits attributed to transportation cost savings are due to the elimination or reduction in transit times, the use of larger and more efficient vessel loadings, the use of alternative mode (land versus water), and/or the anticipated net reductions in vessel accident rates between the without and with project conditions.

4. Background and Study Information

4.1. Location

Norfolk Harbor (sometimes referred to as the Port of Hampton Roads) is located in the southeastern part of the Commonwealth of Virginia at the southern end of Chesapeake Bay, midway on the Atlantic Seaboard (approximately 170 miles south of Baltimore, Maryland, and 220 miles north of Wilmington, North Carolina). The harbor is formed by the confluence of the James, Nansemond, and Elizabeth rivers. The land area surrounding the harbor encompasses approximately 1,500 square miles and includes the cities of Chesapeake, Norfolk, Portsmouth, Suffolk, and Virginia Beach, as well as Hampton and Newport News on the north side and Isle of Wight County on the south side.

4.1.1. Anchorage F

Anchorage F is one of the series of anchorages located along the Norfolk Harbor Channel and is widely used for traffic deviation as well as a mooring location for malfunctioning vessels. Anchorage F is federally authorized to a depth of -51 feet and width of 3,620 feet while the channel is authorized at a 55’ depth. As the vessel fleet and traffic patterns transition over time, there is a concern that the federally authorized anchorage may not support the larger vessels calling at the Norfolk Harbor. The 2018 GRR reviewed the larger vessel fleet, however, assumptions have been adjusted due to the August 2021 U.S. Army Engineer Research and Development Center (ERDC) report, “Norfolk Harbor and Channels, VA Navigation Improvements Project: Anchorage F Design”. This report identified problems with the existing anchorage and stated that it is “insufficient to fully accommodate existing vessel fleet” (ERDC). This was attributed to the lateral windage of the ship’s surface area and the longer chain lengths associated with the longer ships calling at the Norfolk Harbor.

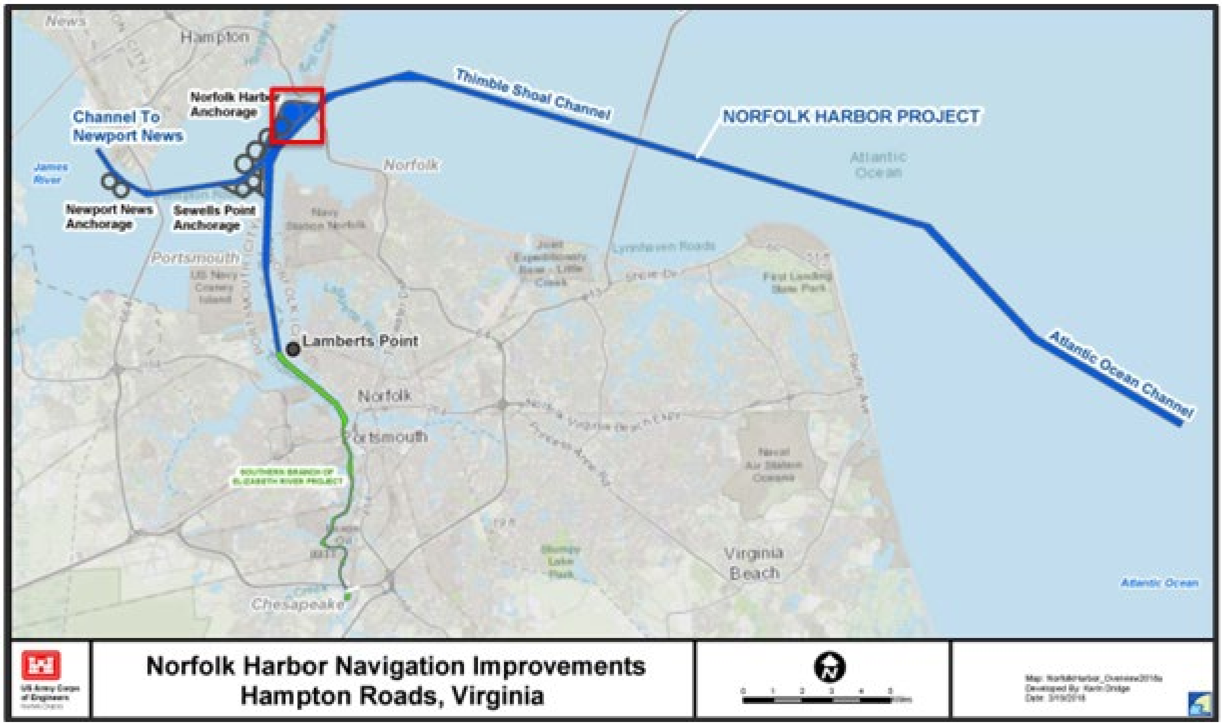

Figure 1: Study area

4.2. Problems and Opportunities

The Norfolk Harbor and Channels was authorized for construction a 55' channel along the entrance of the Norfolk Harbor, however, the Anchorage F analysis did not support the 55' channel depth, but did support a modification of the Anchorage from 3000' in diameter with a 50' depth to 3620' diameter with a 51' depth. Considering new traffic and maneuvering patterns, Anchorage F's current configuration poses limitations on the size and type of the vessels that can utilize the anchorage that was anticipated to occur during the 2018 analysis. This could increase transit delays in the future and has the potential to create security risks for US Navy vessels as demand increases.

Anchorage F lies tangent to the US Navy's degaussing site within the Norfolk Harbor. The degaussing site is an area used by Navy vessels to neutralize the magnetic signature of their ships and submarines, which is a natural phenomenon caused by ships constructed of steel as it disturbs Earth's magnetic field. Adversaries use magnetic detection vessels to identify these types of vessels and during the degaussing stage, this is neutralized (Navy.mil). During typical events, military vessels will cross this portion of the channel alone, however, with two-way traffic volumes increasing, there can be instances when the degaussing area is occupied. This would potentially delay or cause Navy vessels to bypass the site. As more vessels call upon the harbor there is a concern that the limitations of Anchorage F will stall commercial traffic, reducing the efficiency of commercial vessels and increasing traffic delays. Modifications at Anchorage F will provide opportunities for larger vessels to operate more efficiently, improve economic competitiveness of producers, and provide an opportunity to beneficially use the dredged materials.

4.3. Planning Objectives

WRDA 2007 established the Federal Objectives for water resources investments. Federal water resources investments must reflect national priorities, encourage economic development, and protect the environment by: (1) Seeking to maximize sustainable economic development; (2) Seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and (3) Protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems. Navigation channels meet the federal objective by reducing transportation costs and improving the efficiency and safety of the deep-draft navigation system, thereby reducing vessel operating costs, resulting in potential savings to the consumer. The specific planning objective for this study include to increase the transportation efficiency of the fleet transiting Norfolk Harbor and Channels, reduce vessel operating costs by reducing wait times for the fleet, improve safety of navigation for vessel operations, and reduce operating constraints in the federal navigation channels and anchorage in the harbor. The objectives are evaluated over the 50-year period of analysis from 2028 to 2077.

4.4. Planning Assumptions

The PDT developed the following preliminary assumptions for the reevaluation study:

- The Anchorage F would be dredged to the depth and size justified by the 2018 GRR in the future without project scenario.
- Annual maintenance dredging would occur within the same dredging year as the deepening project.
- Each of the deepening alternatives would require subsequent maintenance dredging.
- The reduction in vessel operating costs is cost savings that is passed on to the consumer, thus improving consumers' economic condition and quality of life.
- The future vessel origin and destination are expected to be similar as the base year of the 2018 Norfolk Harbor and Channels Deepening Study.
- Based on the ERDC report "Norfolk Harbor and Channels, VA Navigation Improvements Project: Anchorage F Design", vessels allowed to utilize the FWOP anchorage would be limited to around 9,000 to 9,500 twenty-foot equivalent units (TEUs).

5. Existing Conditions

Data was collected from multiple sources over a multiyear time frame for the purpose of characterizing existing conditions for modeling and reporting purposes. All data is collected for a variety of reasons and is subject to error, gaps, and limitations. Existing conditions of the harbor were reassessed in this reevaluation to determine new trends and to compare any deviations from the previous study. These updates were used to inform the future with and without project condition with adjustments made to better understand the current demand and traffic present in the harbor. It will reassess the channel make-up and traffic patterns; analyze the empirical vessel call data, including volumes and fleet; and formulate a baseline for the future conditions in the harbor.

5.1.1. Local Economy

The Port of Virginia is the 9th largest Port in the United States by volume totaling 69.4 million tons of cargo in 2022 (US Department of Transportation 2024). The economic impact of the Port of Virginia that is directly or indirectly attributable is $124.1 billion in output in 2022. Some of this output is outside of Virginia, but the Virginia value added to the Gross State Product (GSP) was $63.0 billion or 10% of the gross state product. In its 2022 fiscal year, the Port of Virginia contributed $41.4 billion in Virginia labor income with 83% of employment impacts flowing from businesses in Virginia using or handling imports or the products as part of the finished goods process (Swan, 2023).

The Hampton Roads area has the largest concentration of military bases and facilities of any metropolitan area in the world and the employment in Hampton Roads consists mainly of military personnel and federal civilians as well as other industries that are connected to the Department of Defense (CNRMA). Additionally, the healthcare sector has continued its growth in the region and Virginia is also home to over 1,451 biomedical and life science companies, many of which are located in Hampton Roads area (Hampton Roads Alliance). Despite the economic downturn resulting from the coronavirus epidemic (COVID-19) in 2020, the region has been able to recover these employment and supply chain disruptions and has affirmed its resiliency in the commercial navigation sector.

5.2. Current terminals

There has been additional terminal capacity added within the Norfolk Harbor since the GRR study. The Port of Virginia and its neighboring facilities will be the primary users of Anchorage F. The Port of Virginia currently has two container terminals on 1,085 acres in Norfolk Harbor. The existing total container throughput capacity for Norfolk Harbor is 2.2 million TEUs. As in the GRR study, forecasted cargo will never exceed the harbor's throughput capacity. The container terminals located within the Norfolk Harbor are Norfolk International Terminal (NIT), Virginia International Gateway (VIG), and the future Craney Island Marine Terminal (CIMT).

5.2.1. Changes to the Port Facilities & Operations

Since the GRR study, two terminals that have recently expanded or is in the process of expansion include VIG and the NIT. Since the GRR, VIG completed Phase II of its expansion project in 2019 and now has a container capacity of 2.1 million TEUs. NIT completed organization of the southern portion of the terminal in 2020 and expansion of its central rail yard in 2024. Planned expansion of NIT is underway for the northern portion of the terminal, and the first phase is expected to come online in 2025. The combined improvements at NIT will increase total TEU capacity to 3.6 million TEUs per year.

5.2.2. Bulk Terminals

Bulk terminals include Dominion Terminal, Kinder Morgan Bulk Terminals-Pier IX, and Lamberts Point Coal Terminal. These are located east bank of the James River in Newport News, VA and Elizabeth River in Norfolk, VA. The facilities stockpile and blend coal from the eastern United States and loads coal exports on coastal barges and colliers with annual throughput capacity is 48 million tons. Operators include Norfolk Southern and Kinder Morgan that with capacity to 8,000.

5.3. Empirical Data

Empirical data was used to examine the existing conditions, to confirm the forecast methodology used to justify the Norfolk Harbor and Channels deepening and to establish or justify new trends within the channel. Transit patterns and loading modifications within the harbor are the basis for the economic update on Anchorage F. Data used in the analysis was comprehensive, considering data from several sources to establish consistency. Vessel movement data was received and analyzed from the following data sources: National Navigation Operation & Management Performance Evaluation & Assessment System (NNOMPEAS); the Virginia Pilots Association (VPA), USA Trade Online, the Port of Virginia, and the Waterborne Commerce and Statistics Center (WCSC). These data combined covered vessel movement from January 2017 to December 2023.

Each of the datasets were compared against each other to inform the vessel type and movement, draft, and port stops. Raw data was validated for accuracy while report roll-ups, interviews, and news articles were used to confirm data that could not be explained quantitatively. Commerce data from the US Census Bureau's US Trade Online database helped to confirm the commodity make-up of the vessel commodity data within the harbor as well as tonnage. Data reports from years 2017 through years 2023 by the Port of Virginia and the WCSC were used to assess container TEU ratios for loaded and unloaded containers in the analysis.

The below data shows the aggregation of data from the various sources. Data was assessed by year and analyzed in metric tonnage for bulk cargo and TEUs for container cargo.

The below table compares data sources and provides an annual comparison of loaded TEU data.

Table 1: Historical TEU Data

Year	TEU (WCSC)	TEU (Port of VA)	TEU (NNOMPEAS)
2019	2,207,180		2,167,010
2020	2,172,284		1,533,822
2021	2,769,965	2,729,116	2,658,644
2022	2,861,864	2,805,057	2,647,493
2023		2,627,520	

*Loaded TEUs

Table 2: Bulker Tonnage by Year

Year	Tonnage (NNOMPEAS)	Tonnage (USA Trade Online)
2018	36,611,627	
2019	36,544,542	36,276,705
2020	25,631,577	30,580,519
2021	34,713,063	33,754,187
2022	38,446,696	37,271,898
2023		38,401,210

The data sources generally complemented each other with the exception of a discrepancy in 2020. In both container and bulker data, 2020 volumes decline, however, after a closer review, NNOMPEAS data shows a greater decline than USA Trade Online and the Port of Virginia data for bulkers and containerships respectively. Both 2019 and 2021 data were more consistent with each other, within a 3% margin of error from their corresponding data sets.

5.4. Vessels Calling in the Norfolk Harbor and its Channels

To complete the analysis, it was necessary to define the vessel classes for the vessels that call at the Norfolk Harbor. For the review, the vessel classes were defined by the vessel's beam. NNOMPEAS data provided comprehensive data for the container and bulker fleet to confirm the vessel compositions that call upon the Norfolk Harbor.

5.4.1. Container Ships Vessel Classification

Similarly to the GRR, vessel classes were defined based on the beam range and dead-weight tonnage (DWT) range. This method was developed by IWR to help distinguish vessel types and their requirements within the harbor due to the overlapping vessel characteristics for each class.

For analysis purposes the container fleet is divided into six distinct vessel classes for which the distributions of dimensions and capacities are presented in Table 3. The vessel class designations for containerships are defined as Sub-Panamax (SPX), Panamax (PX), Post Panamax Generation 1 (PX1), Post Panamax Generation 2 (PPX2), and Post Panamax Generation 3 (PPX3). The largest container ships calling Norfolk Harbor today are PPX3 vessels with the PPX3-Max is the largest container ship class anticipated to call consistently over the 50-year period of analysis.

Table 3: Vessel Class Designation

Vessel Class	Beam Range	DWT Range
SPX	< 102	16,908 – 39,420
PX	102 – 114.9	35,021 – 68,578
PPX1	115 - 134.9	51,100 – 108,306
PPX2	135 – 149.9	79,278 – 131,938
PPX3	150 – 168	89,893 – 187,625
PPX3-Max	158 +	132,584 – 187,625

Similar to the GRR, containership size ranges were computed using the empirical data provided NNOMPEAS. The vessel percentile bins used NNOMPEAS data from 2021 through 2023, resulting in the following vessel statistics:

Table 4: Containership Size Ranges

Containership Size Ranges					
Percentile Bin	**Class**	**DWT**	**LOA**	**Beam**	**MSLLD**
25%	**SPX**	26,021	589.8	90.7	35.1
50%	**SPX**	28,142	611.4	92.1	36.1
75%	**SPX**	33,794	685.8	92.4	37.7
100%	**SPX**	34,567	695.1	99.9	38.1
25%	**PX**	49,835	849.7	106.0	41.1
50%	**PX**	50,697	855.1	106.0	41.4
75%	**PX**	61,433	958.3	106.0	44.3
100%	**PX**	68,578	965.1	114.9	45.0
25%	**PPX1**	59,623	962	124.1	42.7
50%	**PPX1**	81,247	982.6	131.4	46.0
75%	**PPX1**	85,517	997.2	132.0	47.6
100%	**PPX1**	108,306	1,044.7	132.8	52.2
25%	**PPX2**	105,337	1,096.2	141.3	47.6
75%	**PPX2**	108,770	1,138.4	142.0	49.2
85%	**PPX2**	115,770	1,145.1	142.6	49.2
100%	**PPX2**	131,938	1,205	141.3	51.9
25%	**PPX3**	94,661	1,051.1	150.4	46.0
50%	**PPX3**	96,980	1,097.7	150.5	46.6
75%	**PPX3**	103,668	1,098.5	150.5	46.7
100%	**PPX3**	125,307	1,145.1	151.8	50.9
25%	**PPX3-Max**	130,573	1,095.7	159.1	50.9
50%	**PPX3-Max**	145,560	1,200.6	159.2	50.9
75%	**PPX3-Max**	146,906	1,201.1	167.5	52.5
100%	**PPX3-Max**	187,625	1,299.3	176.9	54.1

5.4.2. Bulkers

Bulker data was also reviewed and categorized similarly to the GRR. However, rather than the vessel's beam and DWT range, as in containerships, vessel class was established by the incremental DWT Range. The ranges are denoted the design vessel range with the DWT range categorized by the design DWT at or below the next vessel category. The DWT range is described below:

Table 5: Non-Containerized Vessel Categories

Vessel Class	DWT Category
Bulker	10K DWT
Bulker	20K DWT
Bulker	30K DWT
Bulker	40K DWT
Bulker	50K DWT
Bulker	60K DWT
Bulker	70K DWT
Bulker	80K DWT
Bulker	90K DWT
Bulker	100K DWT
Bulker	200K DWT
Bulker	>200K DWT

Vessel Class	DWT Category
General Cargo	10K-30K
General Cargo	40K
General Cargo	50K
Gas Tanker	10-30K
Gas Tanker	50K
Gas Tanker	60K
Other	10K-20K
Tanker	10K-30K
Tanker	40K
Tanker	50K
Tanker	60K
Tanker	70K
Tanker	80K
Tanker	200K

5.5. Container Vessel Calls

The trend in prior year vessel call data helped to understand changes in traffic movement from the initial GRR to now. This provides a better understanding of movement and patterns. Data used to assess the historical traffic include NNOMPEAS and the Virginia Pilot logs and includes both inbound and outbound call data, tonnage, and destination data for years 2017 to 2023. The overlap in the GRR data connected the data points, ensuring similar information was used in both analyses.

Data was compared and assessed in the below table. For the economic analysis, outbound-only vessel calls were used to eliminate duplication, similar to the Norfolk Harbor and Channels GRR. With less than a 5% margin in the vessel call counts between inbound and outbound traffic, the decision to use outbound traffic.

Table 6: Vessel Call History by Data Source

	2017	2018	2019	2020	2021	2022	2023
NNOMPEAS Calls	1,585	1,146	1,366	959	1,441	1,419	
Pilot Calls				1,320	1,417	1,411	1,472

The below table shows inbound traffic calls for both the NNOMPEAS and Pilot datasets. For the analysis, the average of total calls between 2021, 2022 and 2023 were used to inform the baseline data in the existing condition scenario. The below table lists the vessel calls by class for years 2017 to 2023:

Table 7: Inbound Vessel Calls by Vessel Type

Vessel Class	2017	2018	2019	2020	2021	2022	2023
SPX	114	91	115	82	174	193	188
PX	404	225	260	205	238	311	340
PPX1	431	315	320	210	312	267	303
PPX2	452	342	414	273	397	307	405
PPX3	125	102	147	80	82	141	95
PPX3-Max	59	71	110	109	238	200	141
Total	1,585	1,146	1,366	959	1,441	1,419	1,472

Loaded and Unloaded TEU

Related to the vessel calls is the ratio of loaded to unloaded TEUs per containership. This would help to inform the trends of vessel loading patterns and its impact on future vessels that call on the Harbor.

The below table lists the vessel classes calculated by loaded TEUs from years 2017 to 2022:

Table 8: TEU by Vessel Class

	2017	2018	2019	2020	2021	2022
Inbound-TEU						
SPX	18,455	14,360	19,836	14,121	64,136	101,077
PX	146,452	84,197	93,699	86,566	147,449	205,493
PPX1	307,935	231,932	216,289	136,655	229,113	216,997
PPX2	512,542	355,349	517,621	355,381	654,654	562,850
PPX3	58,438	81,677	166,376	82,174	59,339	226,086
PPX3-Max	185,217	179,432	295,191	251,568	540,946	410,416
Total Inbound	1,229,039	946,946	1,309,012	926,466	1,695,638	1,722,920
Outbound – TEU						
SPX	21,378	15,685	15,384	10,112	24,155	28,114
PX	164,607	91,110	112,053	85,824	102,707	66,057
PPX1	212,119	118,966	137,022	78,147	156,870	146,401
PPX2	391,428	289,477	346,043	217,340	317,159	256,808
PPX3	74,560	72,857	111,691	81,790	52,817	152,562
PPX3-Max	82,676	78,138	135,804	134,143	309,299	274,632
Total Outbound	946,768	666,234	857,998	607,356	963,006	924,574

5.5.1. Cargo Types & Commodities

Cargoes moving through Norfolk Harbor include containers, dry-bulk, liquid-bulk and break-bulk freight. Dry Bulk commodities include coal, chemical products, crude materials, dry-bulk building materials, fertilizers, and some food & farm products. Liquid-bulks include petroleum and other chemical products.

5.6. Bulk Cargo Vessel Volumes

Bulk cargo data was also arranged into Vessel Type Categories, similarly to that in the Norfolk GRR study to help describe forecasted commodities. Cargo volume is expressed in terms of average metric tonnage per year. Commodity classes by vessel types were available with the NNOMPEAS data for years 2018 through 2022 as described below.

Table 9: Tonnage by Vessel Type and Year

	Import	Export	Total
Barge			
2018	1,525,647	1,236,964	2,762,611
2019	1,811,137	1,011,021	2,822,158
2020	1,954,077	1,112,911	3,066,988
2021	2,131,221	1,304,039	3,435,260
2022	2,262,254	1,254,828	3,517,082
Bulker			
2018	675,819	30,852,379	31,528,198
2019	993,704	30,309,759	31,303,463
2020	542,650	19,939,467	20,482,117
2021	1,103,071	27,741,474	28,844,545
2022	960,215	31,870,126	32,830,341
Gas Tanker			
2018		130,338	130,338
2019		253,860	253,863
2020		190,535	190,535
2021		222,917	222,917
2022		135,007	135,007
General Cargo			
2018	85,564	223,224	308,788
2019	207,173	245,631	452,804
2020	105,481	73,502	178,983
2021	291,488	225,525	517,013
2022	208,810	218,963	427,773
Other			
2018	1,099,671	193,383	1,293,054
2019	883,389	121,248	1,004,637
2020	947,876	96,177	1,044,053
2021	866,943	61,583	928,526
2022	997,894	32,645	1,030,539
Tanker			
2018	351,681	236,957	588,638
2019	433,428	274,242	707,670

	Import	Export	Total
2020	437,132	231,769	668,901
2021	539,682	225,120	764,802
2022	342,283	163,671	505,954

5.7. Non-Containerized Vessel Call Data by Year and Vessel Class

The complete list of bulk and non-container vessel call data is required to fully analyze the traffic patterns within the harbor. Vessel call data below is from NNOMPEAS and was arranged by year, vessel type, and size.

Outbound-only data was used to calculate total vessel calls and was compared to the Pilot's data for completeness.

Table 10: Non-Containerized Vessel Classes by Year

Vessel Class	2018	2019	2020	2021	2022
Bulker					
10K DWT	2				
20K DWT	4	11	3	4	4
30K DWT	12	10	9	3	6
40K DWT	57	71	49	92	91
50K DWT	3	2	1	3	11
60K DWT	46	68	31	76	85
70K DWT	50	72	56	83	112
80K DWT	105	87	58	55	60
90K DWT	154	160	118	127	170
100K DWT	22	21	17	17	19
200K DWT	28	42	20	40	46
>200K DWT		4	3	4	12
Gas Tanker					
10K		12	20	17	4
20K	1		2		1
30K	5	10	4	7	4
50K			1	1	
60K	1		1		1
General Cargo					
10K	29	36	17	23	40
20K	48	54	35	54	46
30K	30	24	8	19	9
40K	20	27	17	19	13
50K	9	10	8	9	8
Other					

Vessel Class	2018	2019	2020	2021	2022
10K	1,759	1,599	1,528	1,460	1,311
20K	2	12	2		30
Tanker					
10K	381	251	265	337	331
20K	29	41	40	18	26
30K	11	15	9	11	10
40K	6	7	8	13	7
50K	9	11	12	20	14
60K		5	1	6	1
70K	1				
80K	2		1		
200K			1		

5.8. Coal Cargoes

Norfolk Harbor is the busiest coal exporting seaport in the United States. Coal exports are used primarily for power generation or metallurgical purposes. Coal is exported from two terminals in Newport News and one terminal in the Norfolk Harbor Main Channels.

5.8.1. Coal Cargo by Tonnage & Trade Region

Coal is exported from Norfolk Harbor to regions throughout the world. Most of Norfolk coal exports are metallurgical coal exports to Europe, while a smaller percentage is thermal coal exported for use in power generation. Coal continues to be an economic driver for the Norfolk Harbor and Channels. Coal exports for the period of analysis remain relatively constant with the potential for modest growth, however, had shown a period of reduction in growth since the GRR. The decrease in coal export tonnage from Norfolk can be attributed several factors, including increasingly strict environmental regulations and decreasing gas prices. Also, metallurgical coal exported through Norfolk Harbor is high quality and therefore more expensive than other coal sources, making it difficult for this coal to compete on the world market.

As in the GRR study, coal is the primary dry bulk analysis. The below data represents coal data tonnage imports and exports. The coal-specific commodity will be considered in the analysis and in the forecast. As in the GRR, this analysis will focus on containerized and coal traffic.

Below is the empirical coal data included in the analysis.

Table 11: Coal-Specific Tonnage History

Year	Imports	Exports
2017	4,990	30,214,900
2018		26,925,208
2019		26,628,632
2020	2,994	17,745,862
2021		24,066,587
2022		26,889,292

Sailing Draft Distribution

Empirical data on the sailing draft was used to assess the percentage of vessels that were maximizing their cargo load within the channel currently. Sailing draft distributions were compared and updated for incorporation into the model through the generated vessel call lists. The expectation is that the vessels will continue to distribute cargo loads proportionally as demand increases, capped at the channel depth or maximum draft of the vessel. The below tables list the sailing draft distributions for inbound and outbound of bulker and container vessels. Pilot log data was used and compared against NNOMPEAS to confirm accuracy. This distribution is based on the current channel depth of 50’.

Containerships

The below table compares the inbound and outbound draft distribution of Generation 2, 3, and 3-Max vessels calling at Norfolk Harbor. sub-Panamax, Panamax and Generation 1 Post Panamax vessels are not included in this comparison table because those vessel classes would be able to sail at their design drafts and not need additional width or depths beyond the currently authorized anchorage configuration of 3,620 wide by 51 feet deep. The sailing distribution was compared against the Pilot log data and upon final review, the Pilot log data was used for incorporation into the model.

Table 12: Container Sailing Draft Distribution

	Inbound			**Outbound**		
Draft	***PPX2***	***PPX3***	***PPX3-Max***	***PPX2***	***PPX3***	***PPX3-Max***
draft to 38	64%	58%	47%	63%	57%	46%
39	7%	4%	16%	8%	8%	13%
40	6%	7%	11%	6%	10%	11%
41	6%	6%	9%	5%	7%	12%
42	5%	6%	7%	6%	6%	7%
43	4%	5%	5%	5%	3%	4%
44	5%	6%	2%	4%	5%	5%
45	3%	4%	1%	3%	3%	2%
46	0%	3%	2%	1%	1%	1%
47	0%	0%	0%	0%	1%	0%
48	0%	0%	0%	0%	0%	0%

Bulker Vessels

Similarly, bulker vessels were compared against inbound and outbound drafts. NNOMPEAS and Pilot Logs were used for this comparison with the Pilot Log distribution carried forward for incorporation into the model. The below table compares the inbound and outbound draft distribution of Bulk Cargo vessels calling at Norfolk Harbor. As can be seen in the data, the export or outbound movement drives the benefits associated with the additional depth/width of Anchorage F. General Cargo, Tankers, Dry Barges, and Miscellaneous vessels were not included in this comparison table because their design draft is less than 48’ and do not require an anchorage with additional width.

Table 13: Bulker Sailing Draft Distributions

	Inbound			Outbound		
Draft	***10K-30K Bulker***	***40K-70K Bulker***	***Capesize Bulker***	***10K-30K Bulker***	***40K-70K Bulker***	***Capesize Bulker***
Draft to 38	100%	99%	90%	100%	62%	5%
39	0%	1%	2%	0%	7%	2%
40	0%	0%	1%	0%	5%	1%
41	0%	0%	1%	0%	5%	2%
42	0%	0%	2%	0%	8%	3%
43	0%	0%	1%	0%	7%	5%
44	0%	0%	1%	0%	5%	4%
45	0%	0%	1%	0%	1%	5%
46	0%	0%	0%	0%	0%	13%
47	0%	0%	0%	0%	0%	21%
48	0%	0%	0%	0%	1%	20%

This economic update will use the IHS commodity forecast for the Atlantic Coast region as in the Norfolk Harbor GRR. USACE economists used this information as a resource in developing the commodity forecast applied to the Norfolk Harbor study. The report provided by IHS cites increased demand for consumer products as the driving factor behind the growth in import container tonnage, including both finished consumer products and parts to be manufactured into finished consumer goods.

6. Alternative Analysis

6.1. Analytical Approach, Assumptions, and Formulation Strategy

The purpose of this Economic Reevaluation Report for this LRR is to measure the change in transportation cost associated with deepening and widening Anchorage F to improve port traffic and travel costs associated with transit delays. This analysis will be conducted incrementally to determine added value in its expansion. The benefits are based on reductions to the total time in the system. For each of the measures, the analysis will utilize the same port traffic assumptions as those used in the FWOP.

The purpose of this analysis is to understand when during the planning horizon certain features of the project should occur to optimize net NED benefits. The economic analysis was conducted in accordance with ER 1105-2-100, Appendix D. Net benefits for all measures in each analytical phase were calculated assuming the project would be constructed in the associated model year (2028, 2030, 2035, 2040, & 2045). HarborSym was run for these years with construction commencing within the first quarter of 2027. Using a 1-month construction schedule, costs were escalated using mid-point Interest During Construction (IDC) and operations and maintenance (O&M) after construction, discounted to the base year. Annualized project cost used in this analysis were discounted to reflect the fact that that costs would occur later in the lifecycle. The benefits of the measure were adjusted in a similar fashion to reflect the fact that benefits cannot occur until there is a project in place. Increasing net NED benefits indicates to consider implementing a measure/ feature later in the period of analysis.

6.1.1. Analytical Approach

Plan formulation and economic modeling was used to analyze study alternatives and "build" a Recommended Plan (RP). This reevaluation will follow the Norfolk Harbor GRR methodology and will focus on the following factors, including location of the vessels in the harbor and the benefitting vessel classes associated with these benefits. Benefits to Anchorage F modifications will primarily model measures that reduce in-harbor congestion rather than impact the number of calls. The plan formulation strategy was to prioritize the measures that have the most significant change in the fleet composition and transportation cost savings.

6.2. Final Array of Alternatives

Initially, the team analyzed incremental depths and anchorage diameters, but through screening, five alternatives were identified. Alternatives with a 3,620-foot diameter were screened as insufficient from a safety perspective with inadequate swing arm radius as the design vessel, the MSC Daniela, would require a minimum of 8 shots of chain during high wind/current conditions. Using the minimum required swing radius, a total anchorage diameter of 3,840 feet would be required and any alternative less than 3,840 feet in diameter would not allow for all vessels anticipated to call in the future access to the anchorage. Below lists the final array of alternatives for Anchorage F, by depth and diameter options.

Table 14: Final Array of Alternatives

Alternatives	Anchorage Depth (feet)	Anchorage Diameter (feet)
1 (No Action)	-51	3,620
4	-51	3,840
5	-52	3,840
6	-53	3,840
7	-54	3,840
8	-55	3,840

Each alternative was evaluated against the project objectives to determine if it:

(1) Increases transportation efficiency of fleet transiting Norfolk Harbor and Channels from 2028 to 2077,

(2) Reduces vessel operating costs by reducing wait times for the fleet in Norfolk Harbor and Channels from 2028 to 2077,

(3) Improves safety of navigation for vessel operations in the harbor from 2028 to 2077 to allow Post Panamax vessels full utilization of the anchorage, and

(4) Reduces operating constraints in the federal navigation channels and anchorage in the harbor for the existing and future fleet from 2028 to 2077.

6.2.1. Anchorage F Deepening and Widening Formulation

The expansion of Anchorage F includes increasing the diameter and the depth of the anchorage primarily increases operational efficiencies by allowing its use by larger Post-Panamax vessels and Capesize coal bulkers with deeper drafts. This would also allow two-way traffic and support the US Navy by allowing larger vessels the ability to maneuver in the area of the degaussing range by allowing those vessels to continue transiting even when the range is in use. This modification does not influence the composition of the fleet and the operations outside the main channel.

The formulation of alternatives takes into consideration the modifications of the approved anchorage width of 3620' from the current width of 3000'. Considering the potential for a reanalysis as a result of the ERDC report and the potential to benefit from economies to scale, construction has not commenced for the 3620' widening project. Construction modifications to the anchorage will happen concurrently and aligned with next approved maintenance dredging contract. Therefore, the approved plan costs for the anchorage widening in the GRR becomes the FWOP condition for this Anchorage F analysis. Costs, in excess, of the approved plan are used to analyze benefits for Anchorage F deepening and widening alternatives beyond the GRR approved plan.

The following assumptions apply to all analysis phases:

- Base year: 2027
- Duration (n): 50 years
- Useable Tide: 2 feet
- Price level: October 2024
- Discount Rate (i): *3.0%* (FY2025)
- Model Years: Baseline, 2030, 2035, 2040, 2045
- Interpolation: Linear interpolation was calculated to estimate transportation costs between the model years.

6.2.2. Key Economic (Benefit) Assumptions

In the economic analysis of the 2018 GRR, there were two basic economic assumptions that drove project benefits. It was assumed that two conditions would exist in the future that would allow the potential for economic benefits:

1) The channel modification measures will not trigger a transition of cargo from other East Coast ports. Rather the FWOP fleet loads more efficiently in the FWP condition.
2) Cargo throughput for container vessels and crude oil tanker vessels will increase over time, creating more vessel traffic at the port with or without a channel modification.
3) The size of Post-Panamax vessels at the port will increase over time.

An additional assumption that this reevaluation review will consider is:

4) At the current dimension of Anchorage F, larger, Post-Panamax and Capesize vessels drafting greater than 48' will not be able to use the anchorage for passing, forcing that area of the channel exclusive to one-way traffic during these instances.

6.2.2.1. *Commodity Forecast and Future Fleet Assumptions*

In examining the empirical data, no major changes in the fleet and commodity forecasts were observed. The reevaluation review will use commodity and fleet forecasts from the GRR but with an updated baseline discussed earlier in the report. The commodity forecast in the GRR was provided by IHS Global Insight, and the fleet forecast was provided by MSI. All FWOP and FWP commodity projections will remain the same, using an updated base year estimate. It is not assumed that the FWP conditions will increase commodities moving through Norfolk Harbor, and it is also assumed that the rate of fleet transition is the same both in the FWOP and FWP conditions.

6.2.2.1.1. Port Facility Assumptions

It is assumed that port facility capacity is the same in both the FWOP and the FWP condition. As such, all increases in port capacity discussed in the Existing Conditions discussion to include the anticipated development of the container terminal at Craney Island in 2040 occur in the FWOP and FWP conditions.

6.2.2.2. *Analytical Approach for Containers*

As per NED guidelines, the primary economic benefit of deep draft navigation includes the cost reduction in the value of resources required to transport commodities. This would include allowing vessels to transport more cargo per trip to reduce the overall transit cost of the given commodities. When more cargo is loaded onto the vessels, the total number of vessels calling at the harbor is reduced. This would, in turn, reduce congestion within the harbor as well as transit delays.

The future with and without project condition utilizes the empirical data provided to establish a baseline condition and forecast the outyear vessel call and commodity data for the period of analysis. Future vessel conditions will remain the same in both the with and without project conditions.

7. Commodity Forecast

The commodity forecast for this analysis is the same forecast used in the Norfolk GRR study. The forecast is a comprehensive analysis by IHS Global Insight for future commodity estimates specific to the Norfolk Harbor through 2045. Commodities were compared for significant changes to the commodity patterns. From the review, there were not significant changes to the commodity patterns that warranted adjustments to the commodity forecast and the commodity forecast was presented as stated.

Table 15: Containership Size Ranges

Norfolk GRR Commodity Forecast		
Imports	**2020-2035**	**2035-2045**
Dry Bulk	2.90%	2.38%
Liquid Bulk	0.70%	0.57%
Container Tons	4.20%	3.65%
General Cargo	4.70%	2.55%
Total	4.42%	3.43%

Exports	2020-2035	2035-2045
Dry Bulk	1.18%	0.97%
Liquid Bulk	2.34%	2.07%
Container Tons	3.99%	2.93%
General Cargo	4.55%	3.32%
Total	2.44%	2.02%

7.1. Bulk Commodity Forecast

The below table describes the process of establishing the baseline condition. The baseline averaged years 2019, 2021 and 2022 bulk commodity categories and applied the respective growth rates to each of the commodities.

Table 16: Containership Size Ranges

Commodity Category	Commodity GRR Growth Rate	Vessel Type	Baseline 2019, 21, 22 Avg (Import)	Baseline 2019, 21, 22 Avg (Export)
Dry Bulk	2.90%	10-30K Bulker	71,821	79,018
Dry Bulk	2.90%	40-70K Bulker	947,162	8,530,443
Dry Bulk	2.90%	Capesize Bulker	-	21,364,326
Dry Bulk	2.90%	Dry Barge	1,155,001	404,808
General Cargo	4.70%	General Cargo	235,824	230,040
Liquid Bulk	0.70%	Liquid Barge	418,730	785,155
General Cargo	4.70%	Misc	916,075	71,825
Liquid Bulk	0.70%	Tanker	438,464	221,011
Liquid Bulk	0.70%	Gas Tanker	1	203,928

7.1.1. Bulk Forecast

The below table estimates the incremental commodity forecast for the baseline through 2045. For the purposes of this analysis, growth is projected through 2045 and held constant through the remaining period of analysis. This is due to the risk and uncertainty associated with forecasting beyond 2045. The below forecast establishes the growth rate for the existing and future condition analysis.

Table 17: Containership Size Ranges

	Import Tonnes				Export Tonnes				
	10-30K Bulker	*40-70K Bulker*	*Tanker*	*Other*	*10-30K Bulker*	*40-70K Bulker*	*Capesize Bulker*	*Tanker*	*Other*
BL	71,821	947,162	438,464	2,725,631	79,018	8,530,443	21,364,326	221,011	1,695,756
2030	85,260	1,124,389	472,822	3,292,233	84,780	9,126,498	22,922,250	253,914	2,214,662
2035	97,863	1,290,604	509,379	3,784,452	89,715	9,685,247	24,256,509	284,293	2,733,934
2040	110,077	1,451,673	531,830	4,288,030	94,151	10,164,183	25,455,995	314,961	3,218,919
2045	123,815	1,632,843	598,203	4,858,616	98,807	10,666,803	26,714,796	348,937	3,789,937

7.2. Container Commodity Forecast

The container commodity forecast used the compounded average growth rates for exports and imports of the Hampton Roads IHS commodity estimate. Import growth rates were 4.10% and export growth rates were 3.51%. The baseline condition was estimated using 2021 – 2023 Virginia Port Authority TEU data for imports and exports. The proportion of empty containers were calculated using the average percentage of the total TEU. The below table estimates the incremental commodity forecast for the baseline through 2045. For the purposes of the analysis growth is projected through 2045 and held constant through the remaining period of analysis. This is due to the risk and uncertainty associated with forecasting beyond 2045. The below forecast establishes the updated growth rate for the existing and future condition analysis. Container TEUS were then converted to tonnes for the growth rate analysis.

Table 18: Import and Export Growth Rate by TEUs

Year	Import	Import-Empty	Export	Export-Empty	Total TEUs
BL	1,644,780	40,002	1,075,785	739,365	3,499,931
2030	2,093,207	50,908	1,323,181	909,395	4,376,690
2035	2,558,973	62,236	1,572,283	1,080,598	5,274,090
2040	2,663,891	64,787	1,627,470	1,118,527	5,474,676
2045	2,773,111	67,444	1,684,594	1,157,787	5,682,936

8. Fleet Forecast

The fleet forecast was developed using the baseline vessel and tonnage data. This forecast will be used in the initial economic modeling runs for the future without and with project conditions. For the purposes of the analysis growth is projected through 2045 and held constant through the remaining period of analysis. Both the bulker and container forecasts are similar to the GRR fleet forecast applying the empirical data as needed.

8.1. Bulk

The bulker call lists is expected to increase from the baseline through 2045, in which it will remain constant for the remaining period of the analysis. The below table examines the bulk forecast for both the FWOP and FWP conditions by vessel class. It is expected that the smaller bulker fleet will reduce as demand continues to grow with the larger, capsize bulkers, supporting the cargo demand in the future.

Table 19: Baseline and Projected Bulk Carriers

	Baseline	2030	2035	2040	2045
10K-30K Bulker	12	14	6	6	6
40K-70K Bulker	255	273	286	256	267
80K Bulker	67	72	76	80	84
90K Bulker	152	163	171	179	188

100K Bulker	22	24	25	26	27
200K Bulker	53	57	60	63	66
Total	***561***	***603***	***624***	***610***	***638***

Containers

Similarly, the container call list is expected to grow through 2045 with calls are expected to potentially double by 2040 given the demand trends. While there is growth along the entire fleet, there is a projected shift of Sub Panamax fleet to Post-Panamax vessels.

Table 20: Baseline and Projected Container Vessels

	Baseline	2024	2030	2035	2040	2045
SPX	117	121	154	188	231	282
PX	214	223	284	346	425	518
PPX1	319	331	423	516	631	772
PPX2	378	394	501	613	750	915
PPX3	174	181	231	282	345	422
PPX3-Max	243	253	322	392	480	587
Total	***1,444***	***1,503***	***1,915***	***2,337***	***2,862***	***3,496***

9. HarborSym Model Development & Calibration

9.1. HarborSym Model

For the economic analysis the Norfolk Harbor and Channels system was represented as a HarborSym, version 1.5.5.8 model and modeled using the simulation nodes of the Norfolk Harbor and Channels Final General Reevaluation Report (Norfolk Harbor GRR). HarborSym is a planning-level simulation model designed to assist in economic analyses of coastal harbors. This was developed through an extensive calibration process that included a comparison of modeled existing and recent historical conditions to actual conditions. This comparison was reviewed by the Port of Virginia, the Virginia Pilots Association, and their consultants, which lead to improvements in final calibration. The components necessary to reasonably represent the Norfolk Harbor system in the HarborSym model include vessels, commodities, port structures, port traffic, and tide. With user provided input data, such as the port layout, vessel calls, and transit rules, the model calculates vessel interactions within the harbor.

Characterization of the existing, future without and future with project conditions as well as each condition’s transportation costs are made using HarborSym. Data inputs are aggregated by component of maritime trade as port facilities, vessels, commodities, and trade routes. The existing condition economic inventory, for the most part, is expressed in the same terms used in the Norfolk Harbor GRR. Unproductive wait times result when vessels are forced to delay sailing due to transit restrictions within the channel; HarborSym captures these delays. Using the model, analysts can calculate the cost of these delays and any changes in overall transportation costs resulting from proposed modifications to the channel’s physical dimensions or sailing restrictions. This, in turn, will drive the calculation of the NED benefits.

9.2. HarborSym Modifications

The GRR model representation of the channel was used to develop dimensions and reasonable spatial relationships between project features such as channel reaches, docks, anchorages, channel entrance/ exit points, and turning areas for this Economic Reevaluation. The main modification to the current study was that the channel depth was adjusted to its authorized 55’ for the with and without project condition while the dimensions of Anchorage F are 51’ and 3,620 feet in diameter.

9.3. Traffic Patterns

The PDT discussed operations of the harbor with operational members of the Port of Virginia, the Virginia Pilots Associations, and the US Navy through interviews. These interviews were used to help explain the traffic patterns and rules of the road, both stated and implied within the Norfolk Harbor. The standard procedure along the harbor was not changed. The harbor operates two-way traffic, as available. Tide cycles are used, and pilots typically enter at low tide so that it can capitalize on high tide upon the outbound. When there is maintenance at the harbor, if there is any variance in entrance greater than 30 minutes, pilots will have a delay and will have to enter the next 12-hr period. This allows Generation 1 and Generation 2 Post Panamax vessels to pass through the harbor and permits two-way traffic.

9.3.1.1. General Navigation Features & Operations

For this analysis, General Navigation Features and Operations were not changed. The tidal analysis follows the GRR study’s structure with tide stations and data similar to those used in the previous study.

9.3.1.2. Vessel Transit Patterns

For this analysis, transit patterns from the GRR maintained with the exception of passing along Anchorage F. In addition to its ability to moor vessels during congestion, maintenance, etc., the Norfolk Harbor and Channels uses Anchorage F as an area not only for stopping due to maintenance, but it is also utilized for two-way traffic when there is congestion in the harbor and when available, draft dependent.

9.3.1.3. Existing & Future Container Fleet Composition

The largest container ships calling Norfolk Harbor today are Post Panamax Generation 3 vessels (PPX3). The PPX3Max is the largest container ship class anticipated to call consistently over the 50-year period of analysis. The distribution of containership vessel sizes in were used for the HarborSym calibration, FWOP and alternative analysis model runs.

The existing condition vessel fleet was characterized using datasets from the Waterborne Commerce Statistics Center (WCSC), the Harbor pilots, and NNOMPEAS. These data combined covered a timeframe between 2017 and 2023. All information was condensed into an annualized call list which serves as a baseline for change over time. Table 21 displays the vessel classes, types, and associated distribution of calls representative of the existing condition.

Table 21: Historical Vessel Distribution by Vessel

Inbound	2017	2018	2019	2020	2021	2022	2023	Baseline
SPX	7%	8%	8%	9%	12%	14%	13%	13%

PX	25%	20%	19%	21%	17%	22%	23%	21%
PPX1	27%	27%	23%	22%	22%	19%	21%	20%
PPX2	29%	30%	30%	28%	28%	22%	28%	26%
PPX3	8%	9%	11%	8%	6%	10%	6%	7%
PPX3-Max	4%	6%	8%	11%	17%	14%	10%	13%

The historical sailing drafts of container ships and bulk vessels already calling the harbor indicate at least a portion of these vessel are constrained by the current channel depths. This means that given the physical capacity and loading practices of such vessels, the vessels are entering and/or exiting Norfolk Harbor at the maximum depth possible under the current channel constraints.

9.3.2. Vessel Call List

A vessel call list was generated for HarborSym that incorporated the empirical data updates including tonnage, sailing draft distribution, and vessel call volume. Vessel calls for the existing and future without project conditions will not be altered; however, the future without project condition will be constrained describe this constraint.

9.4. Future Commodity Movements

9.4.1. Units

Units of measurement used in the analysis are as follows:

- Distance: Sea distance was characterized in nautical miles, while channel transit distance was converted to feet for modeling purposes.
- Weight: Cargo loading weight is represented in metric tonnes.
- Volume: Containership volume is typically measures in TEU while bulker volume is measured in cubic meters.
- Density: Density for coal is captured as metric tonnes per cubic meter and container cargo density is measured in metric tonnes per TEU.

9.4.1.1. Container Ship Sailing Draft Distribution

Sailing drafts for vessel classes were considered based on the empirical data for PPX3 class vessels, including data from the Port of Virginia and the Virginia Pilots. The empirical data asserted IWR's CADET model estimate for the underkeel clearance (UKC) at around 4.25 feet for PPX3-Max vessels. Using the current authorized channel and anchorage depth, and the assumption of 4.25 feet of underkeel clearance, there is evidence that some PPX3 (and PPX3-Max) vessels are depth-constrained at Anchorage F.

The presence of depth-constrained calls is important because it indicates that such vessels may benefit from and use additional channel depth in the case that the channel is deepened. Furthermore, sailing drafts greater than 47.6 feet (channel depth of 50 feet) indicating that vessels are using tide to gain depth beyond the channel's federally constructed 50 feet. The information is based on Virginia Pilots Association data and was used in the development of containership sailing draft distributions for the calibration of the HarborSym model, and as a basis for the FWOP condition and the alternative analysis.

The below table compares the inbound and outbound draft distribution of Generation 2, 3, and 3-Max vessels calling at Norfolk Harbor. Sub-Panamax, Panamax and Generation 1 Post Panamax vessels are not included in this comparison table because those vessel classes would be able to sail at their design drafts and not need additional depths beyond 51 feet.

Table 22: NNOMPEAS Sailing Draft Distribution - Containers

	Inbound			Outbound			Percentage Point Change (In-Out)		
Draft*	***PPX2***	***PPX3***	***PPX3-Max***	***PPX2***	***PPX3***	***PPX3-Max***	***PPX2***	***PPX3***	***PPX3-Max***
draft to 38	54%	63%	39%	53%	60%	36%	1%	3%	3%
39	9%	11%	14%	8%	10%	14%	0%	1%	0%
40	8%	8%	16%	9%	11%	16%	0%	-3%	0%
41	8%	7%	13%	8%	5%	12%	1%	2%	1%
42	4%	3%	5%	6%	3%	8%	-1%	0%	-3%
43	4%	5%	5%	4%	3%	6%	1%	2%	-1%
44	5%	2%	3%	5%	3%	3%	0%	-1%	0%
45	4%	1%	2%	4%	2%	2%	0%	-1%	0%
46	2%	0%	2%	3%	1%	1%	-1%	-1%	1%
47	1%	0%	1%	2%	0%	1%	0%	0%	0%
48	1%	0%	0%	0%	0%	0%	0%	0%	0%

*Draft does not include underkeel clearance of 4.6'

This data was compared with the Pilot log data for the same period. The below table represents the Pilot log draft distribution.

Table 23: Pilot Log Sailing Draft Distribution - Containers

	Inbound			Outbound		
Draft*	***PPX2***	***PPX3***	***PPX3-Max***	***PPX2***	***PPX3***	***PPX3-Max***
draft to 38	59%	58%	47%	63%	57%	46%
39	7%	4%	16%	8%	8%	13%
40	6%	7%	11%	6%	10%	11%
41	6%	6%	9%	5%	7%	12%
42	5%	6%	7%	6%	6%	7%
43	4%	5%	5%	5%	3%	4%
44	5%	6%	2%	4%	5%	5%
45	3%	4%	1%	3%	3%	2%
46	4%	3%	2%	1%	1%	1%
47	1%	0%	0%	0%	1%	0%
48	0%	0%	0%	0%	0%	0%

*Draft does not include underkeel clearance of 4.6'

9.4.1.2. Existing & Future Bulker Fleet Composition and Sailing Draft Distribution

Similarly, the bulker fleet is divided into vessel classes based on vessel capacity. The bulker class with the ability to load deeper and thus benefit from a deeper anchorage is mainly the 200K DWT Bulker class, with a few of the 100K DWT vessels also benefitting. The 80K DWT bulkers are also important from an analysis perspective because this is the bulker vessel class for which calls are assumed to utilize Anchorage F. Bulkers are assumed to use 1.75 feet of underkeel clearance, which means that any sailing draft observations of 48.25 feet or greater are using tide to transit the channel, a practice that is common for 200 DWT Bulkers. This information is based on Virginia Pilots Association data and was used in the development of coal bulker sailing draft distributions for the calibration of the HarborSym model, and as a basis for the FWOP condition and the alternative analysis.

The below table compares the shows the inbound and outbound draft distribution of Bulk Cargo vessels. calling at Norfolk Harbor. General Cargo, Tankers, Dry Barges, and Miscellaneous vessels were not included in this comparison table because their design draft is less than 48'.

Table 24: NNOMPEAS Sailing Draft Distribution - Bulkers

	Inbound			Outbound			Percentage Point Change (In-Out)		
Draft	***10K-30K Bulker***	***40K-70K Bulker***	***Capesize Bulker***	***10K-30K Bulker***	***40K-70K Bulker***	***Capesize Bulker***	***10K-30K Bulker***	***40K-70K Bulker***	***Capesize Bulker***
draft to 38	100%	99%	95%	98%	63%	8%	2%	36%	87%
39	0%	1%	1%	1%	10%	2%	1%	9%	1%
40	0%	0%	0%	0%	7%	2%	0%	7%	2%
41	0%	0%	0%	0%	4%	2%	0%	4%	2%
42	0%	0%	0%	0%	5%	4%	0%	5%	4%
43	0%	0%	1%	0%	4%	4%	0%	4%	4%
44	0%	0%	1%	0%	3%	4%	0%	1%	4%
45	0%	0%	0%	0%	1%	5%	0%	1%	5%
46	0%	0%	0%	0%	1%	11%	0%	1%	11%
47	0%	0%	0%	0%	1%	22%	0%	1%	22%
48	0%	0%	0%	0%	1%	20%	0%	1%	20%

This data was compared with the Pilot log data for the same period. The below table represents the Pilot log draft distribution.

Table 25: Pilot Log Sailing Draft Distribution - Bulker

	Inbound			Outbound		
Draft	***10K-30K Bulker***	***40K-70K Bulker***	***Capesize Bulker***	***10K-30K Bulker***	***40K-70K Bulker***	***Capesize Bulker***
Draft to 38	100%	99%	90%	100%	62%	5%
39	0%	1%	2%	0%	7%	2%
40	0%	0%	1%	0%	5%	1%

41	0%	0%	1%	0%	5%	2%
42	0%	0%	2%	0%	8%	3%
43	0%	0%	1%	0%	7%	5%
44	0%	0%	1%	0%	5%	4%
45	0%	0%	1%	0%	1%	5%
46	0%	0%	0%	0%	0%	13%
47	0%	0%	0%	0%	0%	21%
48	0%	0%	0%	0%	1%	20%

10. Alternative Analysis

The full utilization of the anchorage highlights potential improvements in channel efficiency, particularly in terms of vessel traffic flow and capacity. As more vessels occupy the anchorage area, congestion can occur, leading to delays in mooring operations and limiting the ability of other vessels to pass freely through the harbor.

The NED Plan generates benefits by reducing the number of vessel calls and the time needed to transit the harbor system. Reductions in system time consist primarily of delay/ wait time, reach transit time, maneuvering time and time at dock. Time waiting for facility nodes increases with the FWP condition because larger vessels are able to use Anchorage F due to the expansion.

To assess these dynamics, HarborSym was used to simulate vessel movement and quantify delays and inefficiencies under various channel alternatives. Inputs for the model are the same in the FWOP and FWP conditions with the number of vessels able to use the anchorage varying between alternatives Table 26 summarizes the number of calls, system time in hours, and the distribution of voyage cost and port cost by model year, for the FWOP and the FWP conditions.

Table 26: HarborSym Inputs and Resulting Outputs

	Baseline	2030	2035	2040	2045
Number of Calls	2005	2516	2961	3515	4179
FWOP Time In System (hrs)	45647	58123	68049	81630	98194
FWP Time In System (hrs)	45328	57541	67165	80405	96622

Also provided are the differences between FWOP and FWP expressed in terms of reduced time in system, transit cost, and port cost. The simulation results, shown in the table below, indicate that both container ships and tankers make substantial use of the anchorage. Moreover, the data demonstrates that a deeper channel configuration reduces delays and enhances overall harbor efficiency by facilitating better traffic flow and reducing the frequency and duration of wait times. This underscores the operational advantages of channel deepening projects in high-traffic maritime environments.

Table 27: Vessels Calls Utilization of Anchorage F

Alternative (depth x diameter)	Container Utilization	Tanker Utilization
Alternative 4 (51’ x 3480’)	84%	46%

Alternative 5 (52 x 3480’)	85%	51%
Alternative 6 (53’ x 3480’)	88%	56%
Alternative 7 (54’ x 3480’)	90%	61%
Alternative 8 (55’ x 3480’)	93%	67%

The NED plan represents the measures that, when implemented, reasonably maximizes net benefits. As more vessels are able to utilize the Anchorage for transiting, overall channel efficiency improves, reducing congestion, minimizing delays, and enhancing the flow of maritime traffic. The table below presents an assessment of the project benefits associate with each plan based on outputs from the HarborSym model.

Table 28: HarborSym Benefits Calculation by Alternative

Alternative (depth x diameter)	Average Annual Benefits
Alternative 4 (51’ x 3480’)	$1,055,719
Alternative 5 (52 x 3480’)	$1,847,670
Alternative 6 (53’ x 3480’)	$2,026,498
Alternative 7 (54’ x 3480’)	$2,192,552
Alternative 8 (55’ x 3480’)	$2,333,060

*Oct 24 price level with a 3.0% discount rate

10.1. Costs

Construction Schedule. For the purposes of computing interest during construction (IDC), construction of is expected to begin in the year 2027 and will take one month to complete.

Interest during construction was calculated for each of the alternatives. Interest during construction was calculated using a mid-year payment schedule and 3.0% discount rate.

Cost estimates for the final array were developed by the Norfolk District Cost Engineering Branch. An abbreviated cost risk analysis was completed to determine the contingencies used for measures. All costs are in October 2024 price levels.

Annual Project Costs. Costs were developed for each alternative, including the no action alternative. As a supplement to the GRR, Alternative 1, the No Action alternative will incur costs from the authorized plan to then be dredged additionally for Alternatives 2 through 5 (Table 30). The first costs incurred for each of the alternatives is the additional amount of dredging required to reach the required width and depths of their respective alternatives. The initial construction costs (first costs) and the schedule of expenditures were used to determine the interest during construction and gross investment cost at the end of the installation period (2025). A new cost estimate for the entire Norfolk Harbor and Channels project was certified on 30 January 2025. The FY 2025 Federal interest rate of 3.0 percent was used to discount the costs to the base year and then amortize the costs over the 50-year period of analysis.

Table 29: Estimated Dredging Volumes and Project Costs for the Final Array of Alternatives

Alt	Depth (ft) MLLW	Diameter (ft)	Pay Volume* (CY)	Max Volume** (CY)	First Cost (New Work + O&M)	Fully Funded (New Work + O&M)	Incremental Change from No Action (2018 GRR/EA Dimensions) New Work Only
1 (No Action)	-51	3,620	1,338,696	1,779,764	$32,112,000	$40,071,000	$27,945,000
4	-51	3,840	2,074,530	2,587,443	$42,957,000	$52,364,000	$10,325,000
5	-52	3,840	2,296,932	2,958,540	$45,065,000	$54,614,000	$12,433,000
6	-53	3,840	2,587,443	3,414,329	$47,316,000	$57,014,000	$14,683,000
7	-54	3,840	2,958,540	3,971,151	$50,339,000	$60,342,000	$17,633,000
8	-55	3,840	3,414,329	4,612,072	$54,052,000	$64,322,000	$21,330,000

Table 30 summarizes costs for each of the alternatives carried forward.

Table 30: Summary of Costs for Alternatives Carried Forward

National Economic Benefits	ALT 1 Approved Plan**	ALT 4 (51’ x 3840’)	ALT 5 (52’ x 3840’)	ALT 6 (53’ x 3840’)	ALT 7 (54’ x 3840’)	ALT 8 (55’ x 3840’)
Total First Costs (Oct 24 price level)	$27,945,000	$38,270,000	$40,378,000	$42,628,000	$45,578,000	$49,275,000
First Cost (less Approved Plan)	$0	$10,325,000	$12,433,000	$14,683,000	$17,633,000	$21,330,000
Net Interest During Construction	$0	$11,146	$13,421	$15,850	$19,034	$23,025
Total Investment Costs	$0	$10,336,146	$12,446,421	$14,698,850	$17,625,034	$21,353,025
Annualized Investment Costs	$0	$410,700	$483,700	$571,300	$686,100	$829,900
Annualized OMRR&R	$0	$9,000	$9,000	$9,000	$10,300	$10,300
Total Average Annual Equivalent Costs	**$0**	**$410,700**	**$492,800**	**$580,300**	**$696,400**	**$840,200**

**Authorized cost to dredge Anchorage F as per the GRR study

Oct 24 price levels; 3.0% discount rate 50-year period of analysis

10.2. Operations and Maintenance

Operations and Maintenance (O&M) dredging and placement for Anchorage F is included in the authorized dredging for the construction of the Norfolk Harbor and Channels, Virginia, Project, as described in House Document 99-85, dated 18 July 1985, entitled “Norfolk Harbor and Channels, Virginia”. Operations and Maintenance dredging for Anchorage F will occur every 15 years and will follow the Norfolk Harbor and Channels dredging placement with material placed and spread within the Craney Island Dredged Material Management Area (CIDMMA). This is the Federal Standard for placement and will be utilized unless otherwise authorized.

As a result of the engineering analysis, “the shoaling that occurs within Anchorage F is minimal and does not cover the entire width of the current anchorage. The advanced maintenance is 1-foot, allowable over-depth 1-foot meaning an additional 2 feet total would be available a significant portion of time during the period of analysis.” From discussions with the Virginia Pilots, and an evaluation of empirical data displaying current use of the anchorage, a 1-foot UKC from the authorized channel depth was considered reasonable for bulker vessels in the anchorage when the vessel is in a static condition (no change in UKC when the vessel is in motion).

10.3. National Economic Development (NED)

The National Economic Development (NED) Plan includes reasonably maximizing net annual benefits while remaining consistent with the Federal objective of protecting the nation’s environment. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units.

Table 32 below includes the NED benefit calculation for each alternative. The NED Plan that reasonably maximizes net economic benefits is Alternative 8 which includes deepening Anchorage F to -55 ft and widening the diameter to 3,840 ft. The NED Plan results in a BCR of 2.8 and provides average annual net benefits at approximately $1.5 million at FY25 price levels, using a discount rate of 3.0%.

Table 31: NED Benefit Calculation by Alternative

National Economic Benefits	**ALT 1/ Approved Plan**	**ALT 4**	**ALT 5**	**ALT 6**	**ALT 7**	**ALT 8**
First Costs (less appr Plan)	$0	$10,325,000	$12,433,000	$14,683,000	$17,633,000	$21,330,000
Interest During Construction	$0	$11,146	$13,421	$15,850	$19,034	$23,025
Total Investment Costs	$0	$10,336,146	$12,446,421	$14,698,850	$17,625,034	$21,353,025
Annualized Investment Costs	$0	$410,700	$483,700	$571,300	$686,100	$829,900
Annualized OMRR&R	$0	$9,000	$9,000	$9,000	$10,300	$10,300
Total Average Annual Equivalent Costs	**$0**	**$410,700**	**$492,800**	**$580,300**	**$696,400**	**$840,200**
Total Average Annual Equivalent Benefits	***N/A***	***$1,060,000***	***$1,856,000***	***$2,042,000***	***$2,245,000***	***$2,449,000***
Net Avg Ann Benefits (Incremental of App Plan)		$649,300	$1,363,200	$1,461,700	$1,548,700	$1,608,800
BCR		2.6	3.8	3.5	3.2	2.8

Oct 24 price level with a 3.0% discount rate

10.4. Remaining Three Accounts

While the NED Account is the governing authority for navigation, all USACE planning studies must consider and evaluate the total benefits of alternative plans across all benefit categories. This policy directive seeks to ensure that the U.S. Army Corps of Engineers (USACE) has “carefully evaluated, calculated, and documented the totality of a proposed project’s benefits and impacts to support USACE recommendations for potential future investments in water resources projects.” The benefit categories for this directive include social, environmental, and economics with the evaluation and consideration of a proposed project’s benefits across all these categories.

10.4.1. Regional Economic Development

The impacts of the employment, income, and output of the regional economy are considered part of the Regional Economic Development (RED) account. To analyze Regional Economic Development (RED) benefits, the RECONS (Regional ECONomic System) model was used. The input-output macroeconomic model, RECONS, was used to address the impacts of the construction spending associated with the Recommended Plan (RP).

RECONS is a USACE certified model that allows the USACE to evaluate the regional economic impact and contribution associated with USACE expenditures, activities, and infrastructure. This modeling tool automates calculations and generates estimates of jobs, labor income, value added, and sales through the use of IMPLAN®'s multipliers and ratios, customized impact areas for USACE project locations, and customized spending profiles for USACE projects, business lines, and work activities.

The RECONS Standard Geographic Area for the Hampton Roads region, which includes 15 bordering counties and cities in North Carolina and Virginia, was selected using an expenditure year of 2025. A RECONS Work Activity based on Civil Works Navigation Construction, within the Navigation Business Line . The baseline data used by RECONS to represent the regional economy of Southeastern Virginia and North Carolina.

The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in the following table. As the construction project with the greatest expenditure, it will contribute the most to the local and regional economy through supporting more jobs and providing the greatest labor income.

The regional economic effects are shown for the local, state, and national impact areas. Based on the impacts of each alternative, Alternative 8 provides the greatest Regional Economic Development benefit. In summary, the $43,174,000 expenditures support a total of 498.3 full-time equivalent jobs, $53,452,600 in labor income, and $65,001,000 in economic output in the local impact area. More broadly, these expenditures support 730.8 full-time equivalent jobs, $115,274,100 in labor income, and $66,369,900 in economic output in the nation. Table 32 summarizes the results of the model.

Table 32: Overall RECONS Summary of Alternatives

Impact	Alt 1	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
Construction Cost	$24,485,000	$33,532,000	$35,379,000	$37,350,000	$39,935,000	$43,174,000
Local *Output*	$30,314,500	$41,514,100	$43,800,800	$46,241,000	$49,441,300	$53,452,600
*Jobs**	243.5	333.5	351.8	371.4	397.1	429.3
Value Added	$18,506,300	$25,344,200	$26,740,200	$28,230,000	$30,183,800	$28,084,100
State *Output*	$36,863,800	$50,483,300	$53,264,000	$56,231,300	$60,123,100	$65,001,000
*Jobs**	282.6	387.0	408.3	431.1	460.9	498.3
Value Added	$22,494,800	$30,806,500	$32,502,600	$34,314,100	$36,689,000	$39,665,700
US *Output*	$65,373,100	$89,528,000	$94,459,300	$99,721,800	106,623,500	$115,274,100
*Jobs**	414.4	576.6	598.8	632.2	676.0	730.8
Value Added	$373,639,100	$51,546,414	$54,385,700	$57,415,600	$61,389,300	$66,369,900

**Jobs are presented in full-time equivalence (FTE)*

10.4.2. Other Social Effects

The Other Social Effects account evaluates project alternatives in respect to key human needs. Each alternative was evaluated for their effect on human health and safety. From a national safety perspective, the safety of the nation's assets and ensuring the Navy's ability to traverse through the channel, in particular the degaussing area is necessary. From a regional human health standpoint, Norfolk Harbor and Channels provides an economic support for the region and local community.

10.4.2.1. Anchorage F Improvements to Naval Passage

Adjacent to Anchorage F is the Navy Degaussing facility, which is an underwater sensor that neutralizes the magnetic signature of the vessel. Each Navy vessel must pass through the degaussing area for Naval operational protocol. In the current condition, when Navy vessels traverse this portion of the channel, it is one-way traffic. Navy vessels must go through the degaussing region in the harbor that helps to reduce the magnetic field produced by the ship. This process is performed to make sure that the vessels are properly calibrated given the electrical charges on the vessel. Each military vessel exiting the harbor must go through the degaussing region to adjust its calibration.

The degaussing area is located at the Entrance of the Norfolk Harbor Channel, adjacent to Anchorage F. In most cases, the Navy alerts vessels when it is enroute to the degaussing area so that they can stand clear; however, there have been several occurrences where the degaussing area is blocked, and the vessels must use Anchorage F to go around. In 2021, the Navy experienced 27 maritime encounters and in 2022, the Navy experienced 23 maritime vessel encounters. These did not comply with typical Navy procedures and the vessels had to transit Anchorage F. In most cases, vessels not able to enter the degaussing range during their one-way trip will be required to pass through the range on their next stop; however, this is a necessary and tracked activity that is of a concern with the Norfolk Naval Base.

10.4.2.2. Anchorage F Improvements to Vessel Safety

Norfolk Harbor is not relieved of vessel events at sea and the use of the anchorages will assist in vessel safety for repair or mooring purposes. These incidents range from pilot missteps and fuel leakages to engine and propulsion malfunctions. Improvements to Anchorage F would increase safety by increasing the port's ability to react to any future incidents while keeping commerce moving though the harbor. This analysis assumes that the channel will be maintained to its authorized depths meaning the anchorage is available 24/365 for any vessel that needs it based on the transiting rules provided by the Pilots.

10.4.2.2.1. Vessel malfunctions at the harbor

The largest container vessels in the fleet forecast have design drafts around 52 feet and the pilots stated that they would keep the 4.3-foot UKC clearance requirement in the anchorage as well. Based on this rule, there would be vessels would not be able to use the anchorage at the current authorized depth.

The federal navigation channel system from the Port of Virginia's NIT container terminal to the sea has a combined distance of approximately 24 miles to the Cape Henry Pilot Area, which provides an area of naturally deep water for some maneuvering flexibility, and then an additional 15 miles to open ocean. There are no areas of refuge between NIT and the Cape Henry Pilot Area, either anchorages or terminals, with depths equivalent to the federally maintained channel or the container terminal berths. Note also that the channel is not wide enough for containerships to turn around.

A containership in the federal navigation channel has no alternative other than transiting the entire 24-mile length between NIT and Cape Henry. A vessel that becomes distressed anywhere along the federal navigation channel must complete the 24-mile journey or run aground. Were a containership to run aground, the federal channel system would be blocked to commercial vessels and the naval vessels based at the Norfolk Naval Station would be cut off from access to the sea.

Deepening the existing Anchorage F to the authorized channel depth would create an area of refuge for containerships and capsize bulkers transiting the federal navigation channel system. Deepening Anchorage F to the authorized channel depth would increase the margin of safety for vessels by reducing the distance to an area of refuge from 24 miles to 6 miles for vessels departing NIT and from 24 miles to 18 miles for vessels arriving from the sea. In percentage terms, deepening Anchorage F to the authorized channel depth would be a 75% reduction in distance to a refuge for vessels departing NIT and a 25% reduction in distance to a refuge for vessels arriving from the sea. The increased margin of safety would reduce the risk of disrupting commercial traffic and US Navy operations.

From the model runs, the below table shows the portion of container vessels that are able to utilize Anchorage F by alternative.

Table 33: Model Outputs for the Percentage of Vessels able to use Anchorage F by Alternative

	Alt 1	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
Container Vessels	83%	84%	85%	88%	90%	93%
Tanker Vessels	46%	46%	51%	56%	61%	67%

Based on the above model analysis results, the greatest percentage of vessels able to use Anchorage F in the event of vessel malfunctions would be Alternative 8, with a depth of 55’ and 3480’ diameter. Model runs show that 93% of container vessels within the model would be able to utilize Anchorage F for mooring while 67% of tanker vessels would have the ability to utilize the Anchorage F for mooring.

10.4.2.3. Anchorage F Improvements to the Local Community

10.4.2.3.1. Incorporating the needs and considerations of all at-risk communities

A community may be considered either as a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect. At-risk communities are identified using the Bureau of the Census Current Population Reports, Series P-60 based on Income and Poverty (U.S. Census Bureau 2010). The threshold for low-income status for 2022 was an income of $14,800 for an individual and $29,950 for a family of four (U.S. Census Bureau, 2023). This threshold is a weighted average based on family size and ages of the family members.

Table 34: Percent Race and Poverty by County

City of County	2022 Population	White	Black	Native American	Hispanic	Percent in Poverty
Chesapeake	252,459	57.3%	29.3%	0.2%	7.0%	7.6%
Hampton	137,858	38.7%	49%	0.3%	6.6%	13.5%
Newport News	183,980	47%	43.9%	0.7%	11%	17.2%
Norfolk	232,558	49.1%	41.7%	0.7%	10.3%	18.8%

Poquoson	12,624	92.5%	1.8%	0.1%	3.4%	4.5%
Portsmouth	96,954	37.7%	51.4%	0.4%	5%	17.4%
Suffolk	98,426	48.6%	41.6%	0.3%	4.8%	9.4%
Virginia Beach	455,069	62.8%	18.9%	0.2%	8.8%	8.0%
Williamsburg	15,685	69.2%	15.2%	0.4%	7.7%	13.7%
Currituck Co., NC	31,008	89.1%	6%	0.8%	5.4%	8.9%
Gates Co., NC	10,370	65.6%	30%	0.8%	2.1%	14.2%
Gloucester Co., VA	39,550	87.6%	8%	0.5%	4.5%	8.7%
Isle of Wight Co., VA	40,135	72.2%	23%	0.5%	4.6%	8.5%
James City Co., VA	81,483	78.7%	14.5%	0.5%	7.4%	6.9%
Surry Co., VA	6,527	58.0%	38.1%	0.5%	3.3%	12.4%
York Co., VA	71,164	73.6%	14.6%	0.5%	8.1%	5.1%

Source: U.S. Census Bureau, Population Division

Long-term forecasts for the region indicate continued growth of both population and employment, but at slower rates than has been experienced in the past decades. The HRPDC's Hampton Roads 2040 Socioeconomic Forecast predicts that the population and employment within the Hampton Roads MSA will both increase by 2040 (HRPDC, 2013a).

The HRPDC has estimated population growth for the constituent counties and cities as listed in Table 35; the total population is projected to increase from 1,666,310 in 2010 to 2,037,000 (approximately 22-percent) by 2040 (HRPDC 2013a). No changes have been made to this forecast from the feasibility study.

Table 35: Hampton Roads Planning District Commission Predicted Population Change between 2010 and 2040

City or County	2010 Population	2040 Population	Percent Change
Chesapeake	222,209	314,600	41.58
Hampton	137,436	137,200	-0.17
Newport News	180,719	189,100	4.64
Norfolk	242,806	253,200	4.28
Poquoson	12,150	12,400	2.06
Portsmouth	95,535	98,200	2.79
Suffolk	84,585	182,700	116.0
Virginia Beach	437,994	497,500	13.59
Williamsburg	14,068	17,200	22.26
Gloucester Co., VA	36,858	40,200	9.07
Isle of Wight Co., VA	35,270	62,800	78.06
James City Co., VA	67,009	104,200	55.5
York Co., VA	65,464	82,700	26.33

Although At-risk communities are identified in the areas surrounding Anchorage F, there are no anticipate impacts expected any of the evaluated alternatives. This OSE factor, therefore, was not used as a basis for Plan Selection.

10.4.3. Environmental Quality

In accordance with the Comprehensive Benefits Analysis, Anchorage F alternatives were evaluated for its impact to the environment, the Environmental Quality Account. Considerations to the environmental damages and benefits were analyzed for Anchorage F. While there are adverse environmental impacts borne in construction, the misalignment of the channel depths with the anchorage depths increases the risk of potential environmental impacts from groundings, discharges, and spills in the Hampton Roads Harbor that could impact fish and wildlife species, habitat, and water quality. The current channel depths are -55ft MLLW and the anchorage depth is currently maintained at -50ft MLLW. When comparing the alternatives, there are increasing EQ benefits as the depths of the Future With Project alternatives reach the -55ft MLLW depths of the adjacent channels. As the channel and anchorage depths align, the reduction in the risk of environmental impacts is maximized. The Least Environmentally Damaging, practicable alternative is Alternative 8 in which the channel depth aligns with the anchorage depth, reducing the potential of groundings, discharges, and spills in the Hampton Roads Harbor.

Additionally, in connection with dredging for the Anchorage F construction and maintenance, beneficial use of the dredged material would be used to supply resources to a nearby habitat restoration project. The beneficial use of this dredged material would have the ability to enhance and create safe, permanent, and suitable habitat for a large unique multispecies seabird colony of 25,000 individuals that have been displaced and are currently temporarily occupying an area that is not in an ideal situation. The use of dredged material from Anchorage F could be used to supply sand for an area to develop this area for the seabird colony.

USACE has identified Hampton Bar as an area for material placement for new dredging projects and would be a potential candidate for material placement of sand from Anchorage F. The location of this placement site is within the region and will provide resources for seabird and oyster habitat that will soon be displaced at Fort Wool. With the reuse of dredge material, the opportunity to incorporate measures into the design of new seabird habitat would also provide aquatic habitat benefits for resident and migratory fish species.

Dredged material from Anchorage F would equally benefit the Hampton Bar project for all construction alternatives. Placement at Hampton Bar is around 400,000 cubic yards of dredged material, which amounts to only a portion of the sand from Anchorage F. Any remaining dredged material will be disposed at Craney Island Dredged Material Management Area.

10.5. Sensitivity analysis

In accordance with ER 1105-2-100, “districts are expected to use risk and uncertainty techniques in all deep draft navigation studies at least in the form of sensitivity analysis. The uncertainty in the estimates of critical variables should be analyzed.” For this analysis, the variables used to measure risk and uncertainty include the cost of commodity movements, the traffic projections, and the commodity growth rates. These projections will be analyzed to show both favorable and adverse impacts of project implementation.

10.6. Summary of Economic Evaluation of Alternatives

These delays can significantly impact port efficiency and vessel turnaround times, particularly for high-volume traffic such as container ships and tankers. As delays accumulate, port throughput decreases, potentially leading to logistical bottlenecks both at sea and onshore. The operational cost implications are also substantial, as idle vessels consume fuel and resources without advancing in their journey.

Per ER 1105-2-100, the primary decision criteria for identifying the National Economic Development (NED) Plan includes reasonably maximizing net annual benefits while remaining consistent with the Federal objective of protecting the nation's environment. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units.

The NED Plan that reasonably maximizes net economic benefits is Alternative 8 which includes deepening Anchorage F to -55 ft and widening the diameter to 3,840 ft. The NED Plan results in a BCR of 2.8 and provides average annual net benefits at approximately $1.6 million at Oct 2024 Price levels using a discount rate of 3.0%. Costs for the NED plan was provided by Norfolk Cost Engineering. Interest during Construction (IDC) was calculated for a six-month PED and construction period and Operations and Maintenance was estimated at 15-year increments. Table 36 provides a breakdown of the cost and benefits of the NED Plan.

Table 36: NED Plan Economic Analysis

National Economic Benefits	**ALT 8 (55' x 3840')**
First Costs FY 25 PL	$49,275,000
Interest During Construction	$23025
Total Investment Costs	$21353,025
Annualized Investment Costs	$829,900
Annualized OMRR&R	$10,300
Total Average Annual Equivalent Costs	*$840,200*
Total Average Annual Equivalent Benefits	*$2,449,000*
Net Avg Ann Benefits	**$1,603,000**
BCR	**2.8**

Oct 24 Price level; 3.0% discount rate

Considering the economic impacts on the remaining accounts, Alternative 8 provides the greatest RED benefit by supporting a total of 498.3 full-time equivalent jobs, $53,452,600 in labor income, and $65,001,000 in economic output in the local impact area. Alternative 8 also provides the greatest percentage of vessels able to use Anchorage F in the event of vessel malfunctions and user conflicts with the USN. Under OSE, Alternative 8 created a safer, more reliable and efficient channel. Under EQ, Alternative 8 was the least environmentally damaging, practicable alternative maximizing the reduction of risks associated with environmental spills and discharges caused by groundings with the alignment of channel and anchorage depths. All alternatives provide adequate dredged material for beneficial use activities, but Alternative 8 provides the greatest benefit under an evaluation of all four accounts.

10.7. 902 Calculation

Section 902 of the Water Resources Development Act (WRDA) of 1986 defines the maximum amount that a project may cost. This is often called the 902 Limit or Project Cost Cap. It is, "The maximum project cost limit imposed by Section 902 is a numerical value specified by law which must be computed in a legal manner (ER 1105-2-100 Appendix G).

This project resulted from the August 2021 ERDC report that identified problems with the existing anchorage its inability to fully accommodate existing vessel fleet. Section 8223 of the Water Resources Development Act (WRDA) of 2022 (Public Law 117-263) authorized the completion of a Post Authorization Change Report (PACR) to evaluate modifications to Anchorage F in Hamptons Roads, Virginia.

Because this project was authorized in WRDA 1986, the Section 902 limit on total project cost applies. The 902 Calculation will be included in the Final Report for the Anchorage F LRR/SEA.

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