Appendix B – Economics

Galveston Harbor Channel Extension, TX

Section 216

Draft Validation Report

November 2023

US Army Corps of Engineers

Galveston District

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Summary

This Level 2 Economic Update was completed 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.

In accordance with the annual Budget Development Process, this economic update involved no major new analysis. Its first purpose was to support the budget development process and not to reevaluate authorization. Its second purpose was to evaluate a proposed post-authorization change that will be discussed in more detail in the Scope section of this appendix as well as the accompanying post-authorization change report (PACR).

The update was limited to reviewing and updating previous assumptions and limited surveying, sampling, and application of other techniques to affirm a reasonable revised estimate of project benefits.

This update analysis was conducted using the 7% discount rate and the current year discount rate (2.75%, FY24). BCRs were calculated using total project cost and total benefits. Preconstruction, engineering and design (PED) costs that have accrued for this project that were provided by Engineering were subtracted from the total costs to calculate a remaining cost. These were used to calculate a remaining benefits-to-remaining costs ratio (RBRCR). Interest during construction was only calculated on remaining construction costs and a schedule to complete that assumed adequate funding. The Section 902 limit per the Water Resources Development Act (WRDA) of 1986, as amended, is recalculated to affirm that the current cost of the project and any modifications therein do not exceed maximum project cost limits.

A summary of the parameters and results of this Economic Update are listed in the following table, compared to their 2017 values.

Parameter / Result	2017	2024	
	Approved Plan	Approved Plan	Modified Plan
Base Year	2019	2025	
Period of Analysis	50	50	
Price Level	FY 2017	FY 2024	
Discount Rates	2.875	2.75	
Recommended Plan Details			
Total First Cost	$13,395,000	$15,373,000	$17,077,000
Associated Cost	$1,108,000	$3,250,000	$3,250,000
Interest During Construction (IDC)	$38,000	$86,000	$219,000
Total Investment Costs (incl. IDC)	$14,541,000	$18,709,000	$18,842,000
Average Annual Costs incl. IDC	$585,000	$693,000	$1,365,000
Avg. Ann. Increased O&M Costs	$0	$0	$161,000
Total Avg. Ann. Costs	$585,000	$693,000	$917,000
Sum of Total Present Value Benefits	$42,091,000	$52,602,000	$52,602,000
Average Annual Benefits	$1,597,000	$1,948,000	$1,948,000
Avg. Ann. Net Benefits	$1,012,300	$1,255,000	$1,031,000
BCR	2.7	2.8	2.1
RBRCR	-	3.1	2.3

The requirements of this Economic Update, per CWPM 12-001, are as follows:

- Clearly document authority;
- Clearly document scope has not changed since last approved report (i.e., still within Chiefs discretionary authority);
- Clearly document all of key economic (benefit) assumptions;
- Clearly document changes in economic assumptions
    - Use sampling to update economic data
    - Re-run economic model to update benefits to current price level;
- Clearly document that engineering does not need updating (e.g., H&H)
- Display benefits at current price level;
- Display updated costs;
- Display BCR and RBRCR for both current discount rate and 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.

Study Authority

The Galveston Harbor Channel Extension (GHCE) study authorization is Section 216 of the Flood Control Act (FCA) of 1970, P.L. 91-611, which authorizes the Secretary of the Army to review existing USACE constructed projects due to changes in physical and economic conditions and report to Congress recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest.

The Galveston Harbor and Channel, Texas, Project was part of an earlier study for improving the deep-draft navigation channels within the Galveston Bay area authorized by a resolution of the House Committee on Public Works in October 1967. This resolution authorized a review of previous reports on the Houston Ship Channel (HSC), Galveston Harbor Channel (GHC), and the Texas City Channel. The channels at this time were 37 feet in depth.

The Galveston Bay Area Navigation Study (GBANS), Feasibility Report and Environmental Impact Statement (EIS) for improving the Houston and Galveston channels was completed in 1987 and recommended that the Galveston Harbor and Channel be deepened to 51 feet and widened to 450 feet to provide access to deeper water in the Gulf of Mexico. Issues raised during the Washington review of the 1987 GBANS resulted in a decision by the Assistant Secretary of the Army for Civil Works (ASA (CW)) that a reevaluation study would be performed.

A limited reevaluation report (LRR) was completed in November 1995 and made recommendations for project implementation. The Port of Houston Authority (PHA) and the City of Galveston were the non-Federal sponsors of the Houston-Galveston Navigation Channels, Texas Project (HGNC). By letter dated May 24, 2006, the NFS for the project transferred from the City of Galveston to the Board of Trustees of the Galveston Wharves (Port of Galveston, (POG)).

The 1995 LRR presented a plan that consisted of deepening and widening the HSC and deepening of the Galveston Harbor and Channel in two phases. Phase I consisted of deepening the channels to a depth of 46 feet; Phase II further proposed deepening the channels to 51 feet. Environmental studies were conducted at that time to assess the impacts of a 51-foot channel; however, it was later determined that deepening the channel to 51 feet was not economically justified.

Deepening of the Houston portion to 46 feet was completed in 2005. Deepening of the Galveston Channel did not proceed at that time due to the NFS lack of funds. Once funds were available, the benefits and costs of the Recommended Plan as identified in the 1995 LRR and authorized by WRDA 1996, were updated by the Houston-Galveston Navigation Channels, Texas, Galveston Channel Project, Final Limited Reevaluation Report, dated May 31, 2007, (2007 LRR). The 2007 LRR updated project design, cost, benefits, and environmental impacts specifically related to the Galveston Channel Reach. The 2007 LRR recommended plan consisted of deepening portions of the Galveston Harbor Channel to 46 feet from Station 0+000 to Station 20+000 (2.16 miles) with a bottom width varying from 650 to 1,112 feet and a side slope of 1 vertical to 3 horizontal. Deeping was completed in January 2011, not including the last 2,571 feet which remained at a 41 feet depth.

The 2017 Galveston Harbor Channel Extension Feasibility report presented an evaluation of extending the 46 feet deep Galveston Harbor Channel the remaining 2,571 feet (Station 20+000 to Station 22+571) to reach the west end of the limits of the 41-foot channel.

Scope

For purposes of this economic update two project scopes are being evaluated. The first is the recommended plan contained in the *Galveston Harbor Channel Extension Feasibility Study, (2017)*. The project would deepen from the existing 41-foot mean lower low water (MLLW) channel to 46 feet MLLW from Station 20+000 to Station 22+571.

The second scope evaluated via this economic update is based on an ongoing Post-Authorization Change Report (PACR) that plans to add an additional 500 feet to the GHCE to allow for maneuverability of a larger class of a Suezmax-sized vessel. Utilization of this vessel class was not included in this economic update, though it is

anticipated that economic benefits (i.e., transportation cost savings per ton) would be greater than displayed in this economic update after accounting for the use of a larger vessel class.

Furthermore, there are additional liquid bulk commodities and tonnage associated with the commissioning of a new crude oil processing facility that occurred in 2022. This new tonnage is not included in this economic update, but it is expected that benefits of the extension will be greater than the projections that were based on historical tonnage.

The extension portion of the channel has a depth of 41 feet MLLW and serves fives docks: Port of Galveston Piers 39, 40, and 41, Gulf Sulphur Services, and Texas International Terminals. Port of Galveston Piers 39, 40, and 41 handle general cargo but are not routinely subject to draft constraints, and therefore are not considered benefiting by the channel deepening. Texas International Terminals and Gulf Sulphur Services handle liquid and dry bulk commodities and are the two docks that were considered to benefit from a deeper channel in the feasibility study.

This economic update was completed using the same spreadsheet that was used to calculate benefits, net benefits, and BCRs in the 2017 feasibility study. This spreadsheet was originally certified and used to evaluate the channel extension in a 2013 PACR; that PACR was converted to a feasibility study, and the spreadsheet was approved for use in lieu of a HarborSym model.

Key Economic (Benefit) Assumptions

The following were the key economic assumptions made in the 2017 Feasibility Study that correlated directly to project benefit calculations:

1) Cargo throughput on Panamax and Post-Panamax size vessels would increase over time at the two benefiting docks.
2) The design vessel is an 80,000-deadweight ton (DWT) bulk vessel.

Assumption 1. Bulk cargo throughput on Panamax and Post-Panamax size vessels would increase over time.

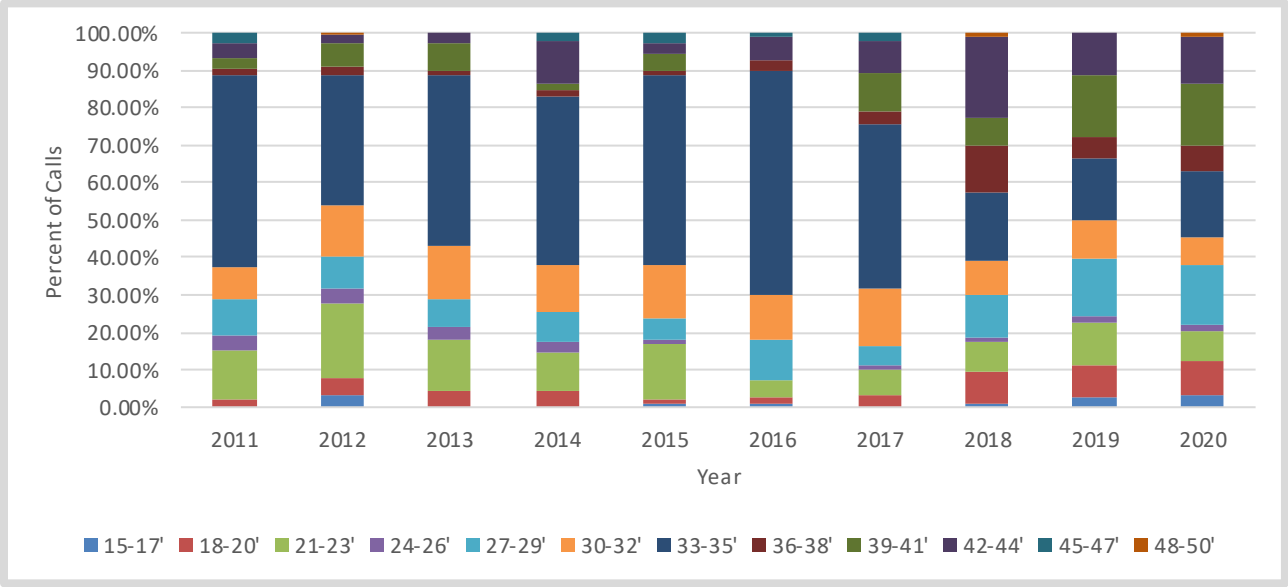
In the WSCS data obtained for the feasibility study, commodity types were aggregated, and thus, all benefiting tonnage from Texas International Terminals was assumed to be barite, a non-metallic mineral that is primarily used in the petroleum industry. Benefiting tonnage from Gulf Sulphur was palletized (dry) sulfur. Tonnage from the two benefiting docks in the extension portion of the channel were considered benefiting if:

1) Tonnage was loaded on a Panamax or Post-Panamax vessel. (Note: The economic analysis completed during feasibility classified any vessel with a design draft of 39 feet or greater as a Panamax/Post-Panamax vessel); and
2) The sailing draft of the vessel was 37' or greater.

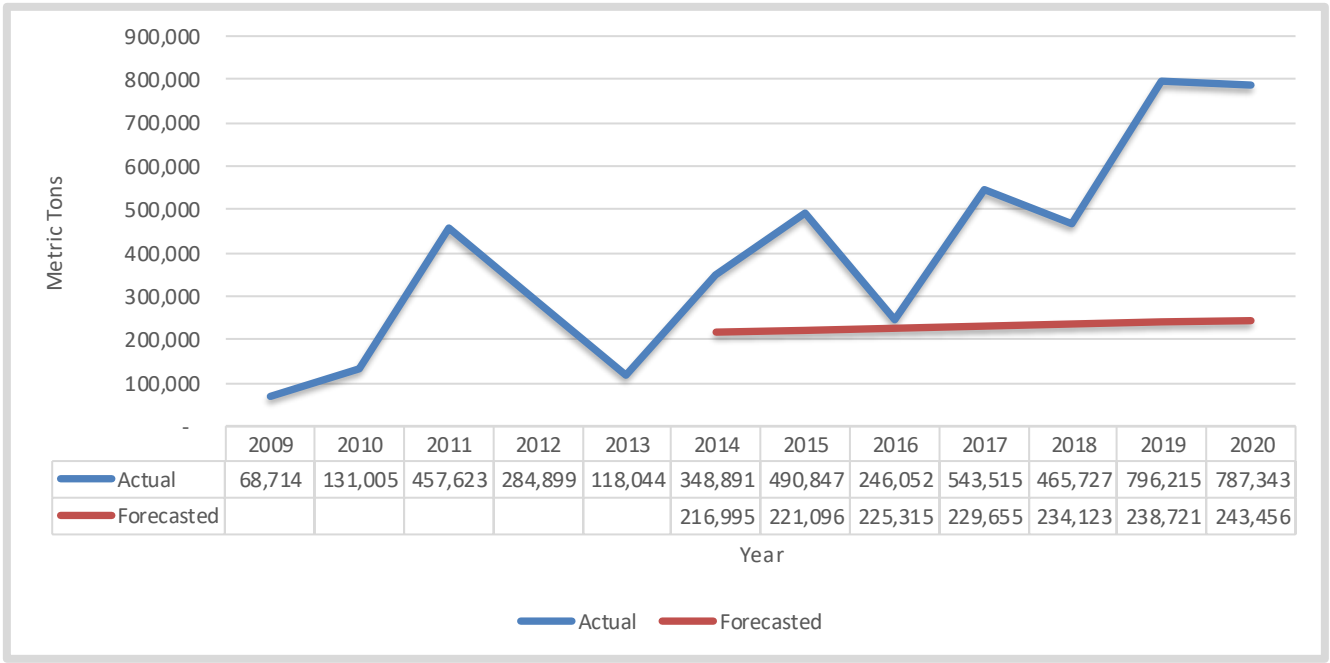
Waterborne Commerce data was accessed via National Navigation Operation & Management Performance Evaluation & Assessment System (NNOMPEAS) to update the assumptions from the feasibility study.

As shown in Figure 1 below, the percentage of calls by Panamax and Post-Panamax vessels at the benefiting docks has increased significantly in recent years. In 2014, 15% of calls were by vessels with design drafts of 39' or greater (i.e., Panamax or Post-Panamax vessels). The share of calls on Panamax and Post-Panamax vessels had increased to 23% in 2017 and 34% in 2020.

Figure 1 Historical Calls at Benefiting Docks by Design Draft (2011-2020)



In addition to the share of calls on Panamax and Post-Panamax vessels increasing over time, the amount of tonnage on these vessel classes also increased. Figure 1 shows actual and forecasted Panamax and Post-Panamax tonnage for both benefiting docks in the extension. As the figure shows, the amount of tonnage forecasted to be moved on Panamax and Post-Panamax vessels was significantly exceeded.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Actual	68,714	131,005	457,623	284,899	118,044	348,891	490,847	246,052	543,515	465,727	796,215	787,343
Forecasted						216,995	221,096	225,315	229,655	234,123	238,721	243,456

Figure 1. Panamax and Post-Panamax Tonnage at Benefiting Docks

Tonnage levels on Panamax and Post-Panamax vessels were separated by dock and

are listed in Table 1. The table also compares the forecasted versus actual Panamax tonnage between the years of 2017 and 2020 as well as the average of those four years.

Table 1. Tonnage on Panamax and Post-Panamax Vessels at Benefiting Docks

Year	TXIT		Gulf Sulphur	
	Forecasted	Actual	Forecasted	Actual
2017	162,247	494,973	67,409	48,542
2018	163,950	304,117	70,172	161,610
2019	165,672	468,193	73,049	200,103
2020	167,496	783,013	76,662	0
Average (2017 – 2020)	162,294	428,847	67,715	77,774

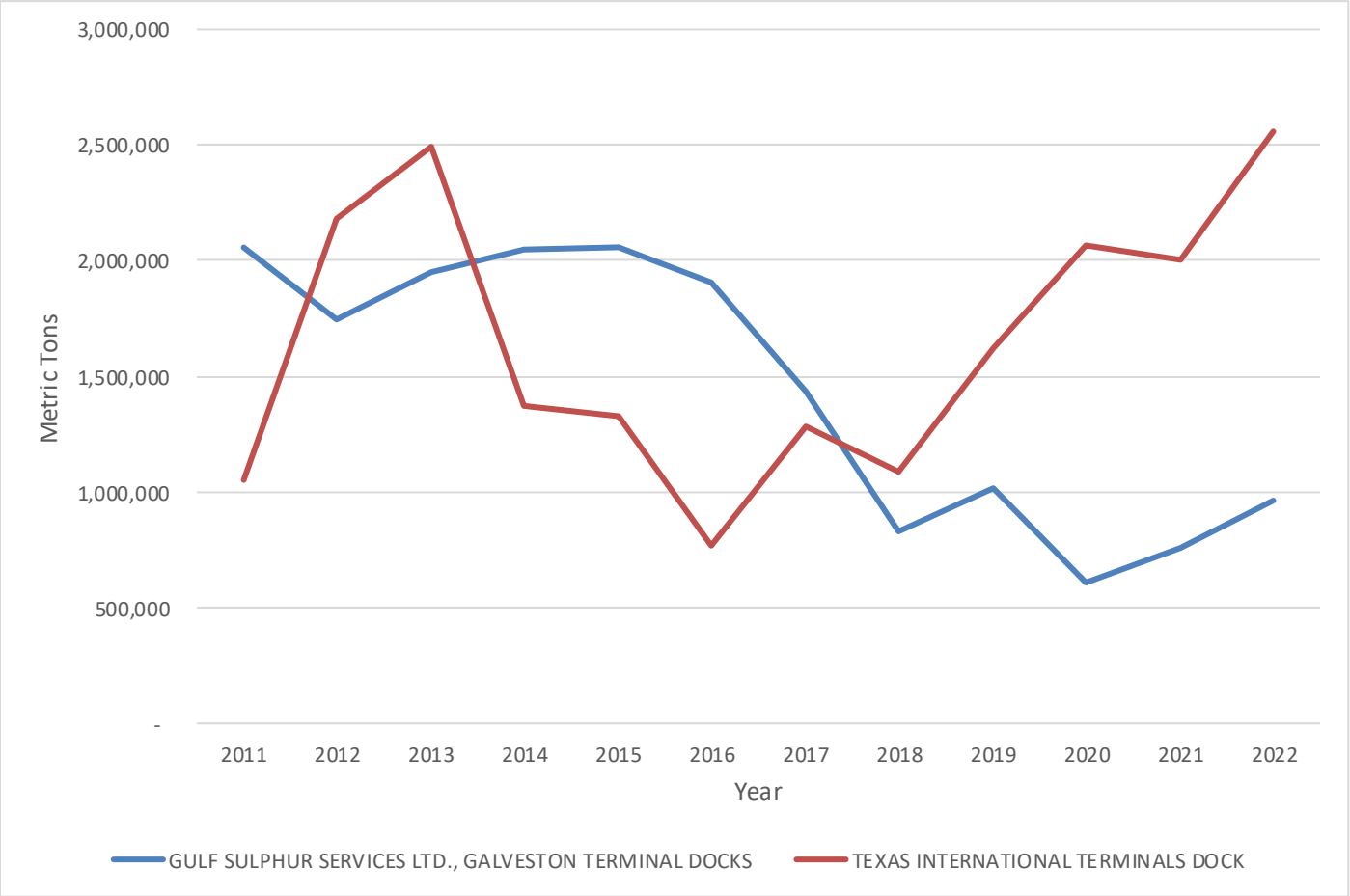
Based on the deviation between the forecasted and actual tonnage, it was determined that the benefiting tonnage baselines for each dock should be re-established. Initially, 2017 through 2019 NNOMPEAS data was used to update the baseline tonnage assumption; 2020 data was added to the baseline when it became available during the economic update process.

The NNOMPEAS data for the benefiting docks is summarized in Figure 2 below. Volatility in tonnage levels can be observed at both docks throughout the years. Some of this instability can be attributed market conditions related to the benefiting commodity types from the feasibility study (e.g., barite and sulfur). For example, a downturn in tonnage was observed at Texas International Terminals in 2016. Also in 2016, the count of active oil and gas drilling rigs, which has long been considered a good barometer of barite consumption, reached its lowest level since the inception of the count in the 1940s.[1] As for sulfur, production decreased in 2017 as the result of hurricanes in the Gulf Coast region that temporarily shut down several refineries; in 2020, sulfur production decreased because of a decline in refinery capacity utilization as a result of decreased demand for refinery products owing to the global COVID-19 pandemic; in 2021, U.S. sulfur production was lower than 2020 because of the cold weather that affected the central United States in mid-February, leading to the largest reduction in Gulf Coast refining operations over the past several years. In addition, Hurricanes Ida and Nicholas brought Gulf Coast refining to a standstill.[2]

Due to the volatility in the main benefiting commodities in the years since the feasibility study, economic benefits were updated with the latest years of data to ensure the economic justification of the project was unchanged. This involved creating a new baseline tonnage amount and benefiting tonnage percentage. No changes in future commodity growth rates were made.

[1] https://www.usgs.gov/centers/national-minerals-information-center/barite-statistics-and-information
[2] https://www.usgs.gov/centers/national-minerals-information-center/sulfur-statistics-and-information

Figure 2. Tonnage at Benefiting Docks in Galveston Channel Extension (2011-2022)



Source: NNOMPEAS (2011-2020); Port of Galveston Channel Users (2021-2022)

The amount of benefiting tonnage was determined using the same methodology from the 2017 feasibility study. That is, calls on vessels with design drafts of 39 feet or greater were isolated and their tonnage summed to calculate a baseline of tonnage. Then, calls with sailing drafts of 37' or greater were identified and their tonnage summed to identify the percentage of the baseline that is considered to benefit in the future with-project (FWP). The resulting benefiting tonnage is summarized in Table 2.

Table 2. Benefiting Tonnage Update

	TXIT		Gulf Sulphur	
	2017 Feasibility	Economic Update	2017 Feasibility	Economic Update
Baseline	157,242	535,556	59,753	97,311
Benefiting Percentage	65%	54%	82%	34%
Baseline Benefiting Tonnage	102,984	290,950	48,971	33,287

Assumption 2. The design vessel is an 80,000-deadweight ton (DWT) bulk vessel.

When reviewing Panamax and Post-Panamax calls at the benefiting docks in recent years, it was determined that the fleet composition at the benefiting docks has changed with the addition of liquid bulk at Texas International Terminals. This shift was especially pronounced in 2020 when less bulk tonnage was moved at the benefiting docks. Nevertheless, in terms of vessel dimensions, a bulk carrier with approximately 80,000 DWT capacity remains the largest vessel calling in the 2017 to 2020 NNOMPEAS data.

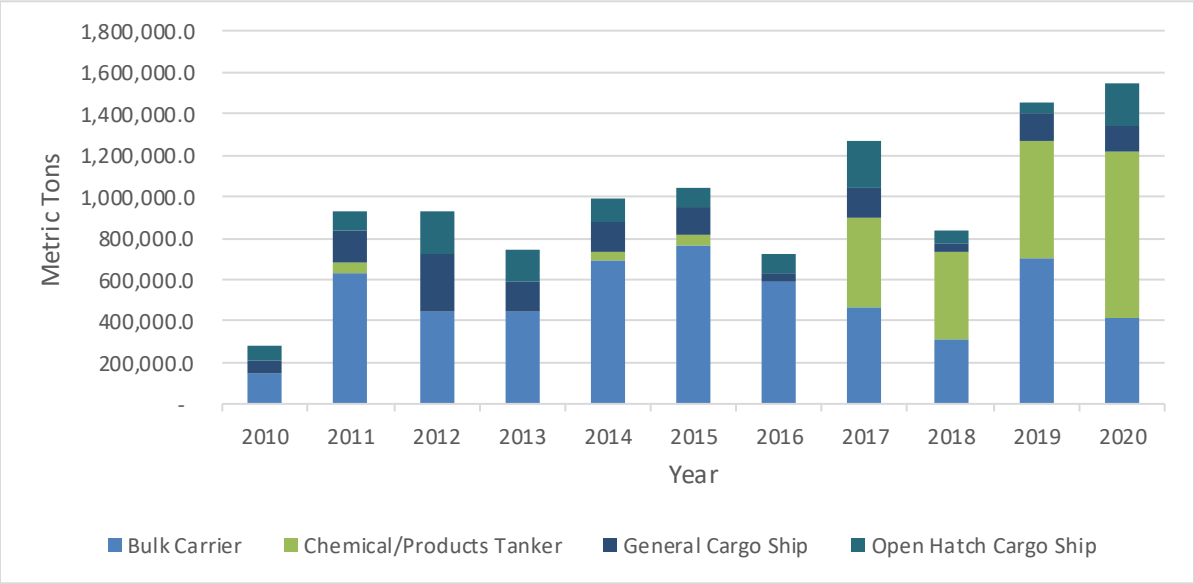


Figure 3. Tonnage by Vessel Type (2010-2020)

In the 2017 feasibility study, the source of the benefits could be attributed to a shift from a 60,000 DWT bulk vessel to an 80,000 DWT bulk vessel. When all variables, other than discrete vessel attributes, are held constant, tanker vessels experience a greater savings per ton when an equivalent shift in tanker vessel class is made, as demonstrated in Table 3. Due to limitations of the approved spreadsheet model, only one savings per ton amount can be applied to benefiting tonnage. As such, the bulk vessel operating costs provided a reasonable (though understated) estimate of benefits than the tanker vessel operating costs and remained the proxy by which savings per ton was estimated at the benefiting docks.

Table 3. Benefiting Vessels Savings per Ton

	Bulk Vessel Savings er Ton		Tanker Savings per Ton (for reference only)	
Channel Depth (MLLW)	**41'**	**46'**	41'	46'
Vessel Deadweight Tons	60,000	80,000	50,000	70,000
Design Draft (ft)	42	47	42	44
Cargo Capacity (%)	95%	95%	95%	95%
Cargo Capacity (metric tons)	57,000	76,000	47,500	66,500
Immersion Factor (tons per inch)	150.5	180.2	135.1	171.7
Under keel Clearance (ft)	1	1	1	1
Weighted Mileage	17390	17390	17,390	17,390
Speed (Knots)	12.6	12.6	12.9	13.1
Total Voyage Cost	$1,251,480	$1,389,630	$1,376,132	$1,514,083
Maximum Load	51,421	69,037	42,800	67,036
Total Cost in Port	$86,957	$108,724	$118,079	$157,944
Total Cost Per Ton	$26.03	$21.70	$34.91	$24.94
Savings per Ton		**$4.33**		**$9.97**

Engineering Updates

There are two main changes to the study's engineering since the 2017 Chief's Report. The first change is the ~500' addition to the GHCE, which was proposed by the NFS to allow Suezmax-size vessels to call at the end of the channel and dock at TXIT.

The second change is to the advanced maintenance and allowable over depth of the channel. In the original study, the channel depth was 46 feet MLLW with 3 feet of allowable over depth and 2 feet of advanced maintenance. The advanced maintenance and allowable over depth amounts are changing to 4 feet and 1 foot, respectively.

Neither of these two changes are considered significant from an engineering perspective. Although the additional channel area for Suezmax vessels could provide significant additions to economic benefits, it did not change the assumptions of the economic analysis. Instead, benefits were calculated using the same assumptions and methodology as the feasibility report. The construction duration remained at five months for purposes of calculating interest during construction (IDC).

Benefit Calculation

The verified and updated assumptions were entered into the spreadsheet model from the original feasibility study to obtain a savings per ton value and apply that value to the forecasted tonnage. For the purposes of this update, benefits were held constant between the approved plan and the modified plan. In actuality, benefits with the modified plan are expected to be greater than displayed below, because a larger design vessel is projected to be used for liquid bulk commodities.

Average Annual Equivalent (AAEQ) Benefits from the 2017 Feasibility Report were calculated using the FY17 Federal Discount Rate of 2.875%. AAEQ Benefits were estimated at approximately $1,597,000, at FY17 price levels. For this update, annual benefits were updated to FY24 price levels and adjusted for changes in Deep Draft

Vessel Operating Costs.

As documented in Economic Guidance Memorandum (EGM) 20-04, Deep Draft Vessel Operating Costs FY19 Price Levels: “Deep-draft vessel operating costs (DDVOCs) have been developed by the Institute of Water Resources (IWR) and are published for use by analysts of the U.S. Army Corps of Engineers (USACE) for assessment of potential economic benefits associated with waterway improvement projects.”

The 2017 report relied on FY 2013 deep-draft vessel operating costs as published in EGM 15-04 to analyze transportation costs and benefits. The most recent deep-draft vessel operating cost estimates released in June 2020 (EGM 20-04) exhibited a decline in costs that has been confirmed in the international freight markets. The update to the most recent vessel operating costs resulted in a reduction in transportation cost savings (i.e., savings per ton) for vessels in this study. Once the changes in operating cost, design draft, and immersion factor associated with the benefiting vessels were factored into the savings per ton calculation, savings per ton decreased from $6.47 in the feasibility study to $4.33 in the update.

After accounting for changes in vessel operating costs, AAEQ benefits were calculated at the current year discount rate (2.5%) and 7.0%, in accordance with CWPM 12-001. Table 4 below shows the updated Net Present Value Benefits and AAEQ benefits calculations.

Table 4. Economic Benefits Summary by Discount Rate

	2017 Report (2.875%)	**FY24 Economic Update (2.5%)**	**FY24 Economic Update (7%)**
Total Net Present Value Benefits	$42,091,000	$52,602,000	$25,270,000
AAEQ Benefits	$1,597,000	$1,948,000	$1,831,000

Cost Calculation

Costs from the 2017 feasibility report were calculated at FY17 price levels. An updated Total Project Cost Summary (TPCS) was completed by Cost Engineering in October 2023. The same project scope and schedule durations that were used for the feasibility study were used to update interest during construction (IDC) costs for this PACR. Incremental operations, maintenance, repair, rehabilitation, and reconstruction (OMRR&R) costs were null for the approved plan but were factored into the annual costs for the modified plan.

Table 5. Economic Costs Summary

	Approved Plan			Modified Plan	
	2017 Chief's Report (2.875%)	**FY24 Economic Update (2.75%)**	**FY24 Economic Update (7%)**	**FY24 Economic Update (2.75%)**	**FY24 Economic Update (7%)**
Project First Cost	$13,395,000	$15,373,000	$15,373,000	$17,077,000	$17,077,000
Associated Cost	$1,108,000	$3,250,000	$3,250,000	$3,250,000	$3,250,000
IDC	$38,000	$86,000	$219,000	$93,000	$239,000
Total Investment Cost	$14,541,000	$18,709,000	$18,842,000	$20,420,000	$20,566,000
AAEQ Cost	$585,000	$693,000	$1,365,000	$756,000	$1,490,000
Average Annual OMRR&R Cost	$0	$0	$0	$161,000	$168,000
Total AAEQ Cost	$585,000	$693,000	$1,365,000	$917,000	$1,658,000

BCR Calculation

The BCRs and Remaining Benefit-Remaining Cost Ratios (RBRCRs) for the authorized project and the modified project are shown for comparison in Table 6 at the required Federal discount rates.

Table 6 Summary of Benefit-to-Cost Ratios by Discount Rate

	Approved Plan			Modified Plan	
	2017 Chief's Report (2.875%)	**FY24 Economic Update (2.75%)**	**FY24 Economic Update (7%)**	**FY24 Economic Update (2.75%)**	**FY24 Economic Update (7%)**
AAEQ Costs	$585,000	$693,000	$1,365,000	$917,000	$1,658,000
AAEQ Benefits	$1,597,000	$1,948,000	$1,831,000	$1,948,000	$1,831,000
Net AAEQ Benefits	$1,012,000	$1,255,000	$466,000	$1,031,000	$173,000
BCR Calculation	2.7	2.8	1.3	2.1	1.1
RBRCR Calculation	-	3.1	1.4	2.3	1.2

Section 902 Calculation

The Section 902 calculation began with an authorized cost of $13,925,000 at the October 2018 (FY19) price level[1]. The authorized cost at FY24 price levels is $20,038,000, or $20,547,000 when escalated through construction. After adding 20 percent, the maximum cost limited by Section 902 is $23,332,000.

The newly estimated cost for the modified plan in October 2023 (FY24) price levels was $17,077,000 (excluding associated costs). The current fully funded cost estimate for the modified plan was $17,511,000 (excluding associated costs), of which $1,678,000 had already been spent through FY23. The project cost limit as mandated by Section 902 of WRDA 1986 is $23,332,000 as of FY24. Both the fully funded cost for the approved plan and the fully funded cost for the modified plan are under the Section 902 cost limit as for FY24. Figure 9 below shows the Section 902 maximum cost limit compared to the current project first cost and fully funded cost estimates, as required by CWPM 12-001.

Figure 9 Section 902 Maximum Cost Limit Calculation (FY 24, Thousands)

Table G-4 (ER 1105-2-100 Appendix G)		
Line 1		
a.	Current Project estimate at current price levels:	$17,077
b.	Current project estimate, inflated through construction:	$17,511
c.	Ratio: Line 1b / line 1a	1.0254
d.	Authorized cost at current price levels:	$20,038
	(Column (h) plus (i) from table G-3)	
e.	Authorized cost, inflated through construction:	$20,547
	(Line c x Line d)	
Line 2	Cost of modifications required by law:	$0
Line 3	20 percent of authorized cost:	$2,785
	.20 x (table G-3, columns (f) + (g)	
Line 4	Maximum cost limited by section 902:	$23,332
	Line 1e + line 2 + line 3	

[1] Section 1401, Water Resources Development Act of 2018; P.L. 115-270, October 23, 2018.

APPROVAL SHEET

We submit and certify that all of the requirements for this Economic Analysis have been fulfilled and the reports are in compliance to support budgetary development. The benefits have been calculated and documented as warranted for this analysis, all of the costs are current per ER 1110-2-1302 and the remaining work is in compliance with Section 902 of the Water Resources Development Act of 1986, if applicable, and all of the review requirements for this analysis have been met and documented.

Project Manager	Date
Economist	Date
Technical Director, Deep Draft PCX	Date
Division Economist	Date