SOO LOCKS
ST. MARYS RIVER
SAULT STE. MARIE, MICHIGAN

POST AUTHORIZATION CHANGE REPORT

June 2018

U.S. Army Corps
Of Engineers®
Detroit District

SOO LOCKS
ST. MARYS RIVER
SAULT STE. MARIE, MICHIGAN

POST AUTHORIZATION CHANGE REPORT

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE) received authorization to design and construct a new lock at the Soo Locks Complex in Sault Sainte Marie, Michigan, in the Water Resources Development Act (WRDA) of 1986 at a total project cost of $227.4M (Oct 1986 price level). The existing Poe Lock, which has been in operation since 1969, is vital to the Great Lakes Navigation System because it is the only lock capable of passing the largest cargo vessels and handles a majority of the tonnage moved through the system annually. The benefits associated with construction of an additional Poe-sized lock will greatly reduce the risk of significant national economic impacts associated with a future event that could potentially disrupt service or cause a prolonged closure of the Poe Lock. Subsequently, WRDA 2007 repealed prior cost-sharing requirements and authorized construction at full Federal expense at a total project cost of $341.7M. To date, a total of $32,153,151 has been spent on construction efforts.

In 2018, the Detroit District completed a certified cost estimate for the project, totaling $922.4M (Oct 2018 price level). The cost estimate is at an 80% confidence level and is based on the receipt of efficient funding and use of the continuing contracts clause. The District also completed an economic validation study concurrent with this PACR, which identifies an increase of annual net benefits for the project compared to prior reevaluation reports. The majority of increased benefits are attributed to the inclusion of engineering reliability data and the high cost of economic impacts associated with the unmet demand of iron ore (shipped in the form of taconite pellets) if the Poe Lock were to experience a prolonged closure, and in changes in the federal discount rate. The report concludes that the new lock construction would result in an average annual benefit of $77.4M at an average annual cost of $32.8M, producing an average annual net benefit of $44.7M and a favorable benefit-to-cost ratio (BCR) of 2.42 at the current discount rate (2.75%) or 2.32 at 7% discount rate.

This Post Authorization Change Report (PACR) provides documentation supporting the request to increase the authorized project cost from $341.7M ($415.8M at Oct 2018 price level) to $922.4M (Oct 2018 price level). This increase exceeds the maximum project cost limit of $532.9M (Oct 2018 price level) pursuant to Section 902 of WRDA 1986, as amended. Therefore, a new authorization in the amount of $922,432,000 is recommended to complete construction of the project. The estimated balance to complete the project totals $890.3M (Oct 2018 price level). Remaining project costs have increased a total of $474M primarily due to the following three factors: (1) Direct cost and design changes totaling $193M; (2) Refined contractor markups totaling $111M; and (3) Increased contingency from 20% to 37% totaling $170M. It is important to note that the cost in WRDA 2007 was taken directly from a previous 2004 limited reevaluation report and not escalated to FY 2008 price levels. This missing four years of cost escalation accounts for about $108M (23%) of the total $474M cost increase (Oct 2018 price level).

Table of Contents

Appendices

List of Tables

List of Figures

1. Purpose

The purpose of the PACR is to document the project progress, costs expended to date, proposed plan for future construction activities, and present the updated cost estimate in accordance with ER 1105-2-100. The report is required because the current estimated total project cost exceeds the maximum authorized cost limit as defined in Section 902 of the Water Resources Development Act of 1986.

2. Authorized Project

2.1. Location

The Soo Locks are located on the St. Marys River at Sault Ste. Marie, Chippewa County, Michigan in Michigan's Upper Peninsula (Figure 1). The St. Marys River is the natural outlet of Lake Superior into Lake Huron. The cities of Sault Ste. Marie Michigan and Sault Ste. Marie Ontario, Canada flank the Soo Complex on both sides of the river. The location of the project has not changed since authorization.

Figure 1. Project Area

2.2. Authorization

Congress first appropriated funds to design and construct the first federal lock at the site, the Weitzel Lock, in 1872 (RHA 1872). Congress authorized the Secretary of the Army to accept control of the original lock on the St. Marys River from the State of Michigan on June 14, 1880 (Rivers & Harbors Act (RHA) 1880). The original Poe Lock, which replaced the State Lock, was authorized in 1886 (RHA 1886, 24 Stat. 310) and completed in 1896. In subsequent years,

additional larger locks were constructed: Davis Lock completed in 1914; Sabin Lock completed in 1919; MacArthur Lock in 1943; and the Poe Lock replacement completed in 1969.

In 1985, the Detroit District completed a feasibility study for the construction of a new lock at the site of the Davis and Sabin Locks. The Feasibility Report recommended replacement of the Davis and Sabin Locks with a single large (Poe-size) lock. Congress first authorized construction of the new lock in Section 1149 of the WRDA of 1986, which states:

"Subject to section 903(b) of this Act, the Secretary is authorized and directed to construct a second lock 1,294 feet in length, 115 feet in width, and 32 feet in depth, adjacent to the existing lock at Sault Sainte Marie, Michigan, in accordance with the report of the Board of Engineers for Rivers and Harbors, dated May 19, 1986, at a total cost of $227,428,000. The Federal and non-Federal shares of such project shall be determined in accordance with section 101, with the method of payment to be determined in accordance with the report of the Chief of Engineers." (PL 99-662, 100 Stat 4254, 17 Nov 1986).

Section 107 of WRDA 1990 continued the authorization for the second lock and directed USACE to develop a cost share formula for the eight Great Lakes states as the cost-sharing non-Federal sponsors. (PL 101-640, 100 Stat 4620, 28 Nov 1990). This analysis was completed in May 1991.

Section 330 of WRDA 1996 required the eight Great Lakes States to provide the non-Federal share which could be paid over 50 years or the life of the project, whichever is shorter. (PL 104-303, 110 Stat. 3717, 12 Oct 1996) and Section 330 of WRDA 1999 further modified the non-Federal share by not requiring interest payments. (PL 106-53, 17 Aug 1999, 113 Stat. 305).

However, Section 3091 of WRDA 2007, the most recent authorization, authorized the second lock be constructed at Federal expense and repealed the cost share requirements in Section 107 (1990), Section 330 (1996) and Section 330 (1999). It also modified the dimensions of the new lock, and increased the total cost. It specifically states:

"(a) IN GENERAL.—The text of section 1149 of the Water Resources Development Act of 1986 (100 Stat. 4254) is amended to read as follows:
''The Secretary shall construct, at Federal expense, a second lock, of a width not less than 110 feet and a length not less than 1,200 feet, adjacent to the existing lock at Sault Sainte Marie, Michigan, generally in accordance with the report of the Board of Engineers for Rivers and Harbors, dated May 19, 1986, and the limited reevaluation report dated February 2004 at a total cost of $341,714,000.''.
(b) CONFORMING REPEALS.—The following provisions are repealed:
(1) Section 107(a)(8) of the Water Resources Development Act of 1990 (104 Stat. 4620).
(2) Section 330 of the Water Resources Development Act of 1996 (110 Stat. 3717).
(3) Section 330 of the Water Resources Development Act of 1999 (113 Stat. 305).
(PL 110-114, 121 Stat 1043, 8 Nov 2007)

2.3. Project Description

The Soo Locks consist of two canals and four locks (Figure 2). The North Canal contains the Davis and Sabin locks and the South Canal, the MacArthur and Poe locks. The Sabin Lock was decommissioned in 2010 and a cofferdam was constructed at each end, and the Davis Lock is currently closed to ship traffic. Both the Davis and Sabin locks are obsolete due to their functional depth of 23 ft. Today, ships draft 27 ft. which is the functional constraint on the Great

Lakes Navigation System (GLNS). All cargo vessels moving through the St. Marys River transit either the Poe or the MacArthur lock. In 2017, the Poe Lock handled 89% of the total tonnage that transited the Soo Locks Complex.

Figure 2. The current view of the Soo Locks at Sault Ste. Marie, MI.

The proposed project is to build a new lock in the footprint of the current Davis and Sabin locks (the smallest and oldest locks at the complex). In general, the scope of the new Soo Lock provides for a redundant lock of 1,200-foot length by 110-foot width adjacent to the existing Poe Lock. The new lock will be constructed in an expanded footprint of the existing Sabin Lock. The existing north Sabin Lock wall will remain with rehabilitation of the chamber face and installation of anchors to improve reliability and stability. Approach walls will be constructed both upstream and downstream of the lock chamber and steel sheet pile (SSP) cells will be constructed around existing bridges to protect the established infrastructure. The bedrock approach channels will be deepened to 29-feet below Low Water Datum (LWD). The south Sabin Lock wall will be demolished, rock excavation will be performed to widen the existing chamber, and new concrete monoliths will be constructed on the south wall. The new lock will be filled and emptied through an In-Chamber Longitudinal Culvert System (ILCS). The upper and lower lock gates will be of miter design and have a height of 38.2 and 59.9-feet, respectively, above the sill. Installation of two cofferdams and downstream deepening is the only completed construction work to date. Figure 3 provides a conceptual rendition of the proposed new “Poe-sized” lock.

Figure 3. A conceptual rendition of the proposed "Poe-sized" lock in the footprint of the Davis and Sabin locks.

3. Funding Since Authorization

3.1. Funding and Project History

In 1985, the Detroit District completed a feasibility study for the construction of a redundant lock at the site of the Davis and Sabin locks. The Feasibility Report (19 May 1986) recommended replacement of the Davis and Sabin locks with a single large (Poe-sized) lock to provide redundancy at the critical single point of failure on the Great Lakes Navigation System (GLNS). A draft Limited Revaluation Report (LRR) containing an economic update was submitted to USACE Headquarters in 1999. Revisions were submitted in 2000, 2002, and 2003. From 1989 through 1999 the project received $1,104,800 in General Investigations funding for Planning Engineering and Design work and economic updates (Table 1).

Table 1. General Investigations Funding History

Year	Amount ($)
1989	85,000
1990	281,000
1991	95,000
1992	295,000
1993	49,000
1994	-
1995	-
1996	-
1997	-
1998	-
1999	300,000
2000	-
2001	-
2002	(200)
Total	**$1,104,800**

In 2005 a new LRR was completed along with a Section 902 maximum project cost analysis. The 2005 LRR evaluated an updated project design for the new lock. This report incorporated re-evaluated costs and benefits to reflect changes in economic assumptions around the Great Lakes, specifically in the taconite pellet industry. The 2005 LRR identified a benefit-to-cost (BCR) ratio of less than 1.0, making the project not economically justifiable. Since 2005, however, several key assumptions made for the LRR were determined to be inaccurate, mostly related to the hypothetical alternative transportation modes identified for the analysis.

In 2002, funding was received through the Construction General Account. Funding amount and associated tasks are illustrated in Table 1. Total sunk costs for the project are $32,153,151. This includes construction of two cofferdams in the Sabin Lock at approximately $4M and downstream channel deepening at approximately $7.1M. The remaining funds were utilized for feasibility, PED activities including geotechnical exploration and testing, stability analyses, construction sequencing analysis, ERDC's physical model of the filling and emptying system, a ship simulation study to refine the lock alignment for safe transits, coordination with historic preservation agencies, and S&A activities.

Table 1. Construction General Account Funding History

Year	Amount	Tasks/Actions
2002	$2,283,219.05	1. Continue limited reevaluation effort (LRR) 2. Identified lock alignment alternatives 3. Initiated filling system design 4. Develop project cost estimate
2003	$1,802,957.89	
2004	$1,861,811.18	1. Complete subsurface investigations and hydrologic surveys 2. LRR developed and submitted (2005) 3. Continued coordination on the Project Cooperation Agreement 4. Design refinements made (e.g. alignment changes, cofferdam, lock foundation, approach walls, fill management, deepening) 5. Designs initiated (e.g. operations buildings & vertical lift gate) 6. ERDC modeled filling system 7. Emergency Closure Study completed 8. Drafted DDR & Plans for lock chamber, guide walls, and deepening approach channel.
2005	$1,942,964.50	
2006	$93,446.80	
2007	$608,303.70	
2008	$1,474,518.71	
2009	$4,099,793.71	
2010	$12,779,640.36	Construction of two cofferdams and downstream deepening
2011	$2,443,311.14	
2012	$259,457.38	1. Continue work on DDR for guide walls and lock chamber 2. Finalize ERDC model simulations and ship simulation study 3. Completed Partial Benefits Sensitivity Analysis Report
2013	$263,706.70	
2014	$97,128.10	
2015	$64,638.45	
2016	$503,840.22	Economic Validation Study/Post Authorization Change Report
2017	$1,574,413.14	
TOTAL	**$32,153,151.03**	

3.2 2018 Validation Study

In 2018, a Validation Study was completed that provides an economic update of the 2005 LRR and includes an updated certified, risk-informed, cost estimate, an updated benefits analysis,

and a Section 902 maximum project cost analysis. Most importantly, the economic update takes into consideration the value of taconite pellet tonnage that is unable to transit the Soo Locks in the event of a planned or unplanned closure. Previous studies assumed the long run availability of overland delivery of taconite pellets. Given the supply logistics of the Great Lakes integrated steel mills, this assumption has been adjusted for the Validation Study. This study recognizes that some tonnage would be stranded in the event of a closure and is considered "*unmet demand*". Outcomes from the Validation Study include that construction of a new lock would result in average annual benefits of **$77,437,864** and a benefit-to-cost (BCR) ratio of **2.42** at the current discount rate (2.75%). At a 7% discount rate the BCR is 2.32.

In conjunction with the Validation Study, a value engineering (VE) study following the six phase VE methodology was conducted in October 2017. Fifteen features of work were identified for the project. Function analysis was performed on each feature of work. During the creative phase of the study 43 ideas were generated. The development phase of the study produced 12 proposals and 4 comments. Seven proposals were included in the most recent cost estimate representing approximately $66 million in savings. Three additional proposals representing approximately $71 million in cost savings will be considered during the design documentation phase of the project. The Value Engineering Report is available as an appendix to the Validation Study.

4. Changes from Authorized Project

4.1. Project Scope

The scope has not changed since the last authorization of the project in WRDA 2007.

4.2. Project Purpose

The purpose of the project has not changed since authorization. The project purpose is to build a Poe-sized lock adjacent to the existing Poe Lock in order to eliminate the Soo Locks as the single point of failure on the Great Lakes Navigation System.

4.3. Project First Costs

Table 2 shows the current cost estimate (October 2018 price levels (FY19)). The last authorization in WRDA 2007 estimated the project cost at $341,714,000. It is important to note that this figure was from the 2003 cost estimate and was not escalated from October 2003 through October 2007. Four years of escalation were not included, which would have equaled an additional $108M in FY19 dollars.

The current Section 902 limit for the project is $532,957,000 based on the authorized cost of $341,714,000 in WRDA 2007. The authorized cost at October 2018 price levels (FY19) is estimated at $415,821,000. Based on cost increases described in this report, the certified cost estimate at October 2018 price levels (FY19) is $922,432,000. The FY19 cost estimate is at an 80% confidence level and is based on the receipt of efficient funding and use of the continuing contracts clause. This results in a Section 902 overrun of $389,475,000 (Appendix A includes the Project Cost Increase Fact Sheet that provides greater detail on the Section 902 calculations).

Table 2. Cost Estimations and Authorizations

Project First Cost at Current Price Levels (Oct 2018 – FY19)	WRDA 2007 Authorized Cost (November 2007 price level)	Authorized Cost at Current Price Level (Oct 2018)	Project Cost last Presented to Congress
$922,432,000	$341,714,000	$415,821,000	$341,714,000

There are three main reasons for the project cost increase of $474M. They include:

- *Direct Cost and Design Refinements* – $193M of the total cost increase can be attributed to direct cost and design refinements. Key refinements include increasing the diameter of steel sheet pile approach walls for stability purposes, adjusting the quantity and unit price of concrete, correcting mobilization and demobilization assumptions to be site specific, updated underestimated costs for anchor strands, and increasing the quantities required for channel deepening excavation due to shoaling.

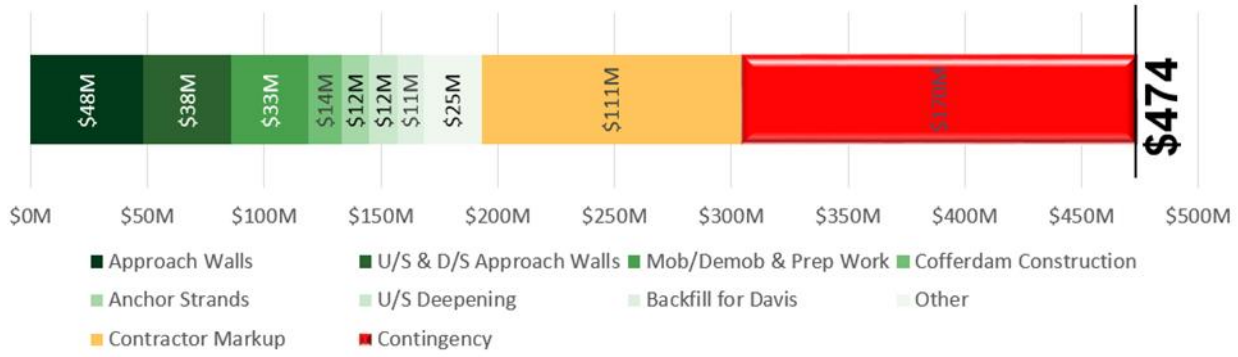
- *Refined Contractor Markups* – The increase in contractor overhead, profits, and bonding amounts to $111M. Cost increases in the FY19 certified cost estimate can be attributed to estimates of field office overhead (FOOH), home office overhead (HOOH), bonding, subcontractor markups, and profit for the prime contractor. As direct costs increase, all of these items also increase the final cost. Contractor markups have been assessed separately to clearly identify this significant component. In recent historic large civil works projects, home office overheads (HOOH) especially for joint ventures, commonly range from 10% to 15%. The FY19 certified cost utilized a HOOH of 14% in contrast the 2007 authorized project cost used a 6% HOOH. This change alone (including the increase in direct costs) resulted in an increase of $42.6M in October 2018 (FY19) dollars.

  Another component of the increases to overhead and subcontractor markups was due to changes in the prime/subcontractor roles (contracting strategy). In the current project as designed, the downstream approach walls were added to the lock contract to improve efficiency. This change will allow for contracting and construction efforts to occur simultaneously for the lock chamber and approach walls. Compressing overall construction schedule will help keep costs under control and cost growth minimized.

- *Contingency* – The FY19 cost estimate incorporates a risk-based cost estimating approach determined by the Cost and Schedule Risk Analysis (CSRA) which resulted in a significantly higher contingency cost of 37% versus 20% in the 2007 authorized cost. The authorized cost was completed at a time prior to USACE's current approach of conducting a comprehensive risk-informed analysis to develop contingency. The CSRA determined that the main cost risk drivers for the project are variance of project scope definition and design refinements, change order (modification) risks, escalation variance from OMB projections and construction means and methods/crew composition and production rates. Although the current design is at 60%, some elements are still at the conceptual phase. This includes electrical system design, diversion and control of water, and concrete mix design. Also, unknown site conditions, design changes during construction, revised design policy, any contractor performance issues relating to unexpected extreme weather conditions or economic conditions, are all risks that could cause future cost growth. Due to this new risk-based approach, contingency estimates increased approximately $170M.

The three items above fully capture the $474M price change from the 2007 authorized cost to the current cost estimate. Figure 1 provides a visual representation of the cost change categories with design changes identified in green, contractor markups in yellow, and current contingency represented by red. The $474M price change reflects remaining costs only and does not include the $32,153,151 in sunk costs to date.

Figure 4. Primary Drivers for Cost Increases



The $474M of the total cost changes includes $108M of lost escalation from 2003 to 2007. The Civil Works Construction Cost Index Series rates during this time were significantly high, resulting in higher construction cost growth. The $108M is captured within all the construction cost increases.

4.4. Design Refinements and Cost Changes

Design refinements represent $193M in cost changes. The project as authorized in WRDA 2007 was based on a conceptual design that originated with the 1985 study. This was prior to site characterization, geotechnical exploration and testing, detailed stability analyses, construction sequencing analysis, and many other analyses and evaluations that naturally occur as a design progresses. The current design is at approximately 60% design level. As detailed design progressed and geotechnical and stability analyses were performed, some project elements required adjustments to provide acceptable safety factors. Changes in construction sequencing were also required.

A significant driver for the cost increase, within the design refinements, were a change in methodology in preparing the estimate. For the new Soo Lock project, the authorized cost was based on a parametric estimate utilizing the Marmet Lock (another USACE lock project located in West Virginia) as a proxy for cost estimating. Although this is an acceptable approach at a conceptual design level, it only provides a rough estimate that will likely change as design details are developed. In addition, per ER 1110-2-1302 (Civil Works Cost Engineering) published 30 Jun 2016, vendor quotes are no longer allowed to be escalated more than 2 years for a certified cost.

The FY19 certified cost was developed using anticipated equipment, labor, and materials necessary to construct the project as designed. Crew size, work hours, seasonal shutdown periods, efficiency losses due to the logistics of accessing the work site, etc. were all included in

the FY19 certified cost. It is very likely that many of the unit costs in the 2007 authorized cost were underestimated due to the fact that historic costs from the Marmet Lock project were utilized in the estimate. The Marmet Lock project was constructed in 2002 and experienced 28% cost growth, suggesting that the original construction estimate for the Marmet Lock project was under estimated. Also, Marmet Lock is not a good proxy for the new Soo lock project considering the additional challenges due to weather and site access.

Project Component Cost Changes (Design Elements)
Project component cost changes from the Authorized cost to the current certified cost, both at the October 2018, price level (FY19) are identified below. The cost difference between the authorized project cost at October 2018 price level (FY19) and the certified cost at the Oct 2018 price level (FY19) is $506.6M. The following paragraphs describe the design elements that make up that difference. All of the price analyses in the paragraphs below are completed at an October 2018 price level (FY19).

Certified Cost at October 2018 price level	$922,432,000
Authorized Cost at October 2018 price level	$415,821,000
Difference	$506,611,000

1. Approach Walls, Upper and Lower (+$48M)
Approach walls on the upper and lower ends of the new lock cost estimates resulted in a net increase of $48M due primarily to refinements s in design for stability reasons.

Overall length of the approach walls did not change significantly, but the construction method did change. The design for the authorized cost consisted of 1,500 ft. of concrete panel walls and 5,413 ft. of 30 ft. diameter steel sheet pile (SSP) cells. The 2018 design now consists of 2,337 ft. of 34 ft. diameter SSP cells (with a thicker concrete cap), 161 ft. of 63 foot-diameter SSP cells and 4,525 ft. of SSP walls as summarized in Table 3 below:

Table 3. Approach Wall Section Lengths

Item	Base Design (ft.)	Current Design (ft.)
Concrete Panel Walls	1,500	0
30 ft. Diameter SSP Cells	5,413	0
34 ft. Diameter SSP Cells	0	2,337
63 ft. Diameter SSP Cells	0	161
SSP Walls	0	4,525
Total	6,913	7,023

The 2003 design for the approach walls utilized one 1,500 ft. reach of concrete panels for the walls on the downstream north approach wall. The 2018 design utilizes a steel sheet pile (SSP) wall for that reach. This design refinement was made due to issues with engineering reliability associated with the concrete panel designs and impacts of ice loads. Analysis during design showed that these panels were susceptible to shear failure during ice loading. This has resulted in an increase to the cost estimate for this reach to reflect a design that would perform satisfactorily under the site specific conditions for the project, which has extremely harsh winter weather and severe ice conditions. These ice conditions are not routinely encountered on other USACE navigation projects; thus the conceptual design did have to be revised appropriately for the site specific conditions.

Also, during stability analyses, the 30 ft. diameter SSP cells were found to be inadequate and were increased to 34 ft. to ensure they remained stable. Current design requires a significant increase in concrete quantities from 5,177 cubic yards to 30,541 cubic yards for the mass concrete cap over the cells, which was 1 ft. thick and is now 7 ft. thick. After design analysis, the previous cap design was not adequate due to stability concerns. The current design also includes wider paved paths along the lock walls for safe operations.

The 2007 authorized cost estimate did not include sufficient labor costs to construct the SSP cells or sufficient equipment costs to place the concrete cap. Material unit costs analysis for SSP steel shows authorized cost estimates for SSP at October 2018 price levels (FY19) increased 125%. In addition, material unit costs for cell fill material have increased approximately 100% when comparing authorized costs at current price levels to October 2018 (FY19) certified costs. Both rates outpace escalation. These refinements collectively amounted to an increased cost of $48M.

2. Concrete for Lock Structures (+$38M)

Concrete for the lock structures cost estimates resulted in a net increase of $38M due to changes in quantities and changes in the assumed unit price.

Concrete quantities used in the 2007 authorized cost were estimated at approximately 240,000 cubic yards, while the quantities for the FY19 current cost estimate are approximately 265,000 cubic yards. The lock wall design includes drawings with greater detail on quantity takeoffs. The 2007 authorized cost utilized a parametric estimate for concrete quantities based on the Marmet lock design. With a detailed quantity takeoff from the 60% design of this project, the concrete quantities better represent the site specific conditions. Concrete quantities were further refined due to site characterization efforts. For instance, the geotechnical investigation showed a deeper depth to bedrock and revealed clay seams, which increased the depth needed for the concrete monoliths. The quantity of steel reinforcement in the concrete also increased.

The unit price for concrete increased from the 2007 authorized cost to FY19 cost estimate. The Marmet Lock project estimated placed concrete at approximately $257 per cubic yard. The FY19 current cost estimate takes into account revised forming costs that are more accurate for the Sault Ste. Marie location, batch plant costs that are more detailed to meet expected site conditions, more details for the concrete movement through the site and increased quantities of reinforcing steel based on revised designs. The unit price for concrete in the FY19 current cost estimate resulted in an increase to approximately $396 per cubic yard. This unit cost of $396 per cubic yard was determined to be more reasonable based upon comparison with other more recent historical costs for large Civil Works Projects including Olmstead Lock, Kentucky Lock and the Chickamauga Lock.

Based on extensive USACE Engineering Research Design Center (ERDC) lock chamber modelling, the lock filling system was redesigned to use cast-in-place concrete for the culverts and intricate formwork to obtain a filling system that could meet filling time requirements for navigation. The conceptual design for the 2007 authorized cost assumed a filling system using pre-cast concrete culverts, which upon site-specific analysis and ERDC's scale model, could not provide the conveyance requirements needed for efficient filling and emptying of the lock chamber. In addition, the uplift pressure on the lock floor (when dewatered) is now factored into the design and resulted in the addition of bar anchors to the lock floor.

3. Mobilization/Demobilization (Mob/Demob) and Prep Work (+$33M)

Mobilization, demobilization, and preparation cost estimates used in the 2007 authorized cost were based on the Marmet Lock and are $2.1M at an October 2018 price level (FY19). However, the difference in site conditions, weather, seasonality, site access, and construction sequencing is very different for the new Soo Lock project. Due to the harsh weather conditions in Sault Ste. Marie, the estimators assumed a 7-8 month construction season. The methodology used in the 2007 authorized cost of relying on Marmet costs as a reasonable approximation grossly underestimated the mobilization and demobilization costs.

The FY19 current cost estimate assumes five mobilizations and demobilizations over the life of the project due to the shortened construction season at the Soo Locks versus the one mobilization/demobilization assumed for the 2007 authorized cost. Other factors that contribute to the increased mobilization and demobilization costs include the logistical challenge of accessing the work site and security considerations at the site. The FY19 current cost estimate assumed winter shutdown demobilization activities (approximately $10M) and standby costs during non-working months (approximately $3.3M). This increase in number of mobilizations resulted in a net increase of $33M.

4. Cofferdam Construction (+$14M)

Cofferdam construction cost estimates resulted in a net increase of $14M. The 2007 authorized project design required four cofferdams, two of which were built in 2009. The assumption was that the Davis Lock would be filled with construction debris from equipment placed in the water, which only required a total of four cofferdams. In the course of developing the detailed design, including a detailed analysis of construction sequencing, it was determined that revising the design to allow for dry (from land) channel excavation was preferred. This would allow a haul road to be constructed in the Davis Lock and through the north wall of the Davis Lock into the Sabin Lock, and would greatly improve excavation efficiency in the Sabin Lock and excavated material removal. To address this design refinement, the FY19 certified cost includes five additional 88 ft. diameter cells (two upstream and three downstream) required to dewater the Davis and Sabin locks for excavation in dry conditions. Three of these cells will be temporary and two cells will be permanently constructed.

5. Anchor Strands (+$12M)

Many advances in the design criteria occurred over the last 15 years. For instance, mass concrete was relied on prior to the 2003 design efforts in order to resist sliding and overturning. Geotechnical data from the 2003 Limited Reevaluation Report identified weak clay seams which would affect stability. In addition, designers in 2003 determined that mass concrete could be reduced (and costs reduced) through utilizing rock anchors. In the 2009 DDR, design refinement of the south lock wall monoliths, located within the lock chamber, resulted in eliminating anchors due to increasing the size of the concrete monoliths. Minor design refinements of the north chamber monoliths, in 2009, resulted in slightly fewer strand anchors that are slightly larger. As a result, the total length of anchor strands was decreased and the relative size was increased (19 to 20 strand anchor) to ensure stability of the monoliths. New corrosion protection standards per the Post Tension Institute industry standard DC35.1-14 have also changed twice since 2007. New standards require larger diameter holes along with additional grout material and a corrugated pipe sleeve to ensure the anchor strands do not deteriorate due to corrosion.

A critical impact to costs is realized when comparing the unit costs for anchor strand installation between authorized costs at current price levels and project first costs. The comparison shows that these unit costs were grossly underestimated. Authorized cost unit rates ranged between $101/LF and $131/LF. Current project first cost unit rates now range between $949/LF and $1,661/LF. This resulted in approximately a $12,000,000 increase in costs.

The updated estimate include costs such as 1st and 2nd stage grouting, grout, performance and proof testing, installation of corrugated pipe and anchors. A quote was obtained for the authorized cost estimate which did not accurately reflect the scope of work. The current project first cost estimate is developed in much more detail than the authorized cost estimate.

6. Upstream Deepening (+$12M)

Upstream deepening of the approach to the new lock cost estimates resulted in a net increase of $12M. This estimate benefits from the actual experience of the 2010 downstream deepening contract. Unit cost for material removal in the 2007 authorized project estimated at October 2018 price levels (FY19) is approximately $102/cubic yard and is based on vendor quotes from contractors. Based on the downstream deepening project $102 per cubic yard is likely low. The FY19 current cost estimate determined a unit cost of $120/cubic yard as a reasonable estimate. Also, the quantity actually excavated in the 2010 downstream deepening project was greater than estimated.

The 2007 authorized project design did not take into account the one foot of required over-depth needed to satisfy EM 1110-2-1613 (Hydraulic Design of Deep-Draft Navigation Projects) published 13 May 2006, for dredging requirements of hard bottom channels. This omission in dredge quantity resulted in approximately 54,000 cubic yards that is now accounted for in the current design. Also, additional, shoaling has occurred in the upstream approach that is similar to shoaling in the downstream approach.

The current design anticipates an additional 200,000 square-feet of deepening due to shoaling based upon most recent conditions soundings as compared to those used in 2003. Factoring in the additional required shoaling volumes (approximately 30,200 cubic yards), one-foot of required over-depth (approximately 7,400 cubic yards), and one-foot of allowable over-depth (approximately 7,400 cubic yards) results in an additional quantity of approximately 45,000 cubic yards of material in the current design. Therefore the current design identifies approximately 307,000 cubic yards of material for excavation versus the 208,000 cubic yards identified in the 2007 authorized project.

7. Backfill for Davis Lock (+$11M)

Backfill for Davis Lock cost estimates resulted in a net increase of $11M due to increase quantities and design refinements. This occurred because the construction sequencing has changed since the 2007 cost estimate.

The updated design associated with the FY19 current cost estimate identified the construction sequencing and determined additional material would require double handling, which attributes to increased costs. In the current design, the Davis Lock will be used for construction access into the project site. In the previous design, 54,600 cubic yards of material was identified as requiring double-handling. The current design identifies approximately 240,000 cubic yards that will need doubling-handling. The increase in quantity represents a $3.0M cost increase. In addition, the current design requires the purchase and placement of 115,000 cubic yards of fine aggregate for the lock backfill which was not required in the 2003 design. Ramps for construction were not factored into the 2007 authorized costs. The FY19 current cost estimate

included a cost of approximately $3.5M for construction of the ramps. The ramps will require approximately 127,000 cubic yards of material.

The 2007 authorized cost design assumed that material from the downstream deepening would be used to fill in the Davis Lock Chamber. Since the downstream deepening occurred in 2009, that material is now located at the Northwest Disposal Area near the Soo Locks site. Additional costs will be incurred to move the material from the Northwest Disposal Area to fill in the Davis Lock chamber. Additional material will be required to ensure monolith stability.

8. Other - changed cost estimate assumption and/or design refinements (+$25M)

Power & Lighting Systems	$6,734,593
Associated General Items	$5,126,666
Steel Structural	$2,031,074
Annual Cofferdam Maintenance/Groundwater Control	$3,386,252
New Pump Well For Lock	$1,301,388
Concrete Demolition	$845,750
Foundation Work	$690,689
Lock Gate and Operating Machinery Upper & Lower	-$1,165,363
Piping System	-$1,341,462
Permanent Operating Equipment (Crane)	-$5,886,087
30 PED*	$5,877,228
31 CM	$4,038,106

***30 PED and 31 CM (+9.8M)** – In the 2007 Authorized Cost estimate the Planning, Engineering & Design (PED - 30 Account) costs and the Construction Management (CM - 31 Account) costs were based on a standard percentage of the cost estimate. For the FY19 cost estimate PED and CM costs were developed by applying resource hours according to the implementation schedule. Developing of PED and CM account costs based on actual resourced estimates produces a higher confidence in the estimates as opposed to using a standard percentage of construction costs. For the FY19 cost estimate the percentage of PED and CM account costs (relative to total construction costs) decreased from the 2007 Authorized cost estimate, however, since the total project cost has increase, PED and CM costs have increased as well.

4.5. Project Benefits

Table 4 illustrates a comparison of benefit categories between the 1986 feasibility report, 2005 Limited Reevaluation Report, and 2018 Validation Study. A complete description can be found in the Economics Appendix Section 7.1 of the Validation Study. Benefits increased from the 2005 report to the 2018 report due to changes in the federal discount rate, assumptions about taconite pellets unmet demand, and the inclusion of engineering reliability data. Specifically the primary drivers for the benefits increase include:

- The discount rate in 2005 was 5.63% which is much higher than the current discount rate of 2.75%.

- The current analysis recognizes and quantifies impacts due to the lack of overland capacity and the capability restrictions to move taconite from Duluth, MN to steel mills on the Lower Great Lakes. There have been substantial overland developments, including

the continued degradation of rail lines, many of which are now not suitable to move a fully loaded taconite pellet rail car, and also the closure of a large trans-modal port at Escanaba, MI. Currently, taconite pellets move exclusively through the Poe Lock in Class 10s during the navigation season. The potential for large quantities of unmet demand exists in the event of lock failures. The 2005 report assumed that taconite pellets could move via overland routes in the event of an unscheduled Poe Lock closure. This means, in 2005, there was no unmet demand to value. This difference represents the greatest change in benefits between the 2005 and 2018 reports and is captured in the "unmet demand transportation costs". To estimate the economic impact of this unmet demand, proxy alternative transportation costs were developed. These proxy methods of transportation are not actual proposed alternatives, but rather serve as a surrogate to value the existing methods of transportation against a next-best, least-cost alternative.

- In 2018, the analysis considers risk due to lock component failures as documented in Appendix A, Engineering Reliability. Previous studies only analyzed the likelihood that vessel accidents could occur.

- In 2018, the analysis considers benefits of avoided lock closure impacts due to the scheduled Poe Lock closures required for miter gate replacement. These closure impacts are mitigated in the with-project condition by the presence of the new lock.

Table 4. Historical Comparison of benefits from past reports with the current Validation Study

Category	1986 Feasibility[1]	2005 LRR[2]	2018 VS
STUDY METRICS			
Price Level:	Jan-85	FY 2000	FY2018
Federal Discount Rate:	8.375%	5.625%	2.75%
PRIMARY BENEFITS			
Disruption Costs Avoided:			
Stockpile Drawdown Costs[3]:	-	$1,226,000	-
Diverted Traffic Costs:	$5,549,000	$2,740,000	$1,592,843
Vessel Layup Costs[4]:	-	$1,702,000	$1,331,584
Safety Costs:	-	$416,000	NC*
Unmet Demand Transportation Costs:	-	-	$39,749,357
Stockpile Inventory Savings:	$8,017,000	-	-
Reserve Fleet Costs:	$2,340,000	-	-
Emission Abatement Costs Avoided:	-	$381,000	NC*
Rehabilitation Costs Avoided:	-	$3,723,000	$4,135,633
Scheduled Maintenance Costs Avoided:	-	-	$3,033,975
Repair Costs Avoided:	-	-	$5,508
Vessel Delay Savings[5]:	$13,116,000	$3,013,000	$1,949,303
Recreation Benefits:	-	$2,235,000	$2,969,700
Decommissioning Cost Savings:	-	$948,000	$781,433
SUPPLEMENTAL BENEFITS INCLUDED IF BCR > 1.0			
Labor Resource Benefits[6]:	$2,284,000	$1,775,000	$1,607,854
Terrorist Disruption Avoided:	-	$1,382,000	NC
Subtotal Primary Average Annual Benefits:	**$29,022,000**	**$16,384,000**	**$56,565,563**
Total Average Annual Benefits (all categories):	**$31,306,000**	**$19,541,000**	**$58,173,417**
COSTS			
With Project Total First Cost:	N/A	$310,000,000	$903,158,305
Total Average Annual Cost[7]:	**$24,056,000**	**$22,564,000**	**$32,708,888**
COST-BENEFIT ANALYSIS:			
Net Incremental Annual Benefits:	$7,250,000	($6,180,000)	$25,464,528
Benefit-Cost Ratio:	1.3	0.73	1.78**

[1] Benefit Reference: 1986 Soo Locks Final Interim Feasibility Report, Economic Appendix, Page I-54

[2] Benefit Reference: 2005 Soo Locks LRR, Economic Appendix, page B-91

[3] Included in the stockpiling component of unmet demand transportation costs

[4] Benefit category was named "idle vessel costs" in the 2005 Soo Locks LRR

[5] 2005 LRR estimate is an aggregation of two benefit categories; lock delay costs ($445,000) and vessel delay savings ($2,568,000)

[6] Category was named "area redevelopment benefits" in previous studies (1986 Feasibility and 2005 LRR)

[7] Includes Interest During Construction (IDC) and Operations and Maintenance (O&M) Costs

*NC - Not calculated. Safety Costs Avoided and Emission Abatement Costs Avoided – These benefit categories were not calculated for the 2018 report since benefits were expected to be relatively small compared to other benefit categories.
** - BCR based on scaling Escanaba, MI capital costs. Reference the 2018 Validation Study for a full discussion about the current project economics.

4.6. Benefit-Cost Ratio

Benefits of the new lock construction include the annualized value of net reductions, relative to the baseline, in service disruption impact costs and in scheduled project costs, as well as gross benefits such as recreation and labor resource benefits. Unscheduled service disruptions at the project [redacted] result in service disruption impact costs. These include costs of tonnage diverted over existing alternate modes, vessel costs, unscheduled repair costs, and unmet demand costs. Scheduled project costs are costs generally associated with scheduled events, and include project investment costs, maintenance costs, and both the investment and maintenance costs for alternative transportation modes, including unmet demand proxy modes. There is some degree of overlap between these categories.

Benefits resulting from these net costs (service disruption and scheduled project costs) were evaluated by comparing annualized costs in the baseline and with-project conditions for the respective subcategories of each (Table 5). In cases in which the with-project condition results in a net reduction in costs of one these subcategories, this reduction is a benefit of the with-project condition. Likewise in cases in which the with-project condition results in a net increase in a cost category, that increase is a cost of the project. See the Validation Study for discussion about the with and without project condition and project costs and benefits (Section 6).

Table 5. Benefit-to-Cost Evaluation, 2020-2076, as Recommended in June 2018 Validation Study

Q1 FY18 Dollars

	New Poe-Size Lock (fixed Escanaba floor cost)	
Cash Flow Category	2.75% Discount Rate	7.0% Discount Rate
Total Average Annual Project Costs	$32,708,888	$69,480,408
Total Average Annual Project Benefits	$77,437,864	$157,962,038
BASE NET BENEFITS	$44,728,975	$88,481,630
BENEFIT-TO-COST RATIO (BCR)	**2.37**	**2.27**
Base Net Benefits	$44,728,975	$88,481,630
Allowable Labor Resource Benefits	$1,607,854	$3,145,301
NET BENEFITS	$46,336,829	$91,626,931
BENEFIT-TO-COST RATIO (BCR)	**2.42**	**2.32**

4.7. Cost Allocation

The cost allocation has not changed since the last authorization. 100% of the project funding is for navigation purposes.

4.8. Cost Apportionment

Per WRDA 2007, construction of the new redundant lock is at full federal expense. There is no cost share sponsor. There are no local cooperation requirements.

5. Environmental Considerations

National Environmental Policy Act (NEPA): Environmental compliance for the proposed construction of the second Poe-sized lock is covered by the Detroit District's Final interim Feasibility Report and Environmental Impact Statement for the Great Lakes Connecting Channels and Harbors Study, prepared in March of 1985 (filed with the Environmental Protection Agency in August of 1986), a subsequent Record of Environmental Consideration dated February 2000, an Information Bulletin made available in 2008, and an updated Record of Decision signed on 27 February 2009.

For the Validation Study, a Supplemental Information Report (SIR) documents that an evaluation of the proposed action has been conducted to determine the sufficiency of existing environmental documents. (Validation Study Appendix D). The SIR indicated that no significant new circumstances or substantial changes have been identified. At this stage/phase of the project, the existing environmental documentation adequately addresses the impacts of constructing a second Poe-sized lock at the Soo Locks Complex on the St. Marys River at Sault Ste. Marie, Chippewa County, Michigan. There is no plan to draft a supplemental NEPA document (Environmental Impact Statement or Environmental Assessment) as implementation of the proposed action will not cause impacts on the environment not previously addressed; and the effects from this action and effects from past, present and reasonably foreseeable actions will not result in any significant new cumulative impacts. Finally, the SIR serves to document that the required NEPA, and other federal law and regulation compliance for the proposed action has been met and the proposed action is environmentally acceptable. When the project moves into the implementation phase, an environmental compliance review will occur, accordingly.

6. Public Involvement

An updated Record of Decision was released in 2009 which included a notice for public comments. Only supportive comments were received for the project. Outside of the NEPA process, several opportunities for public involvement have occurred, most notably a series of stakeholder meetings from 2015 - 2017. In addition, the project is frequently featured on the Detroit District external website and a detail display of the proposed project is located at the Soo Locks Visitor Center (one of the busiest visitor centers in USACE).

7. Remaining Project Schedule

A detailed project scheduled developed in Primavera P6 scheduling software using detailed construction activities and associated network logic to determine project duration is included in the Validation Study as an attachment to Appendix C (costs). Table 6 presents several future key milestones:

Table 6. Key Project Milestones

Key Project Milestones	Date
Receipt of Design Funding	1-Oct-19
Notice to Proceed (NTP) Upstream Channel Deepening Contract	26-May-20
Upstream Channel Deepening Contract Complete	23-Nov-21
NTP Upstream Approach Wall Contract	2-Dec-20
Upstream Approach Wall Contract Complete	26-Oct-22
NTP Lock Contract	25-Jan-22
Lock Contract Complete	27-Aug-27

*Dates are from the base schedule (no contingency)

Three main contracts are proposed for the project. The three contracts would run fairly consecutively with minimal overlap. In short key points include:

- Upstream Channel Deepening (Contract #1) would occur from FY20 – FY22.
- The Upstream Approach Walls (Contract #2) would occur from FY21 – FY23.
- The New Lock construction (Contract #3) would occur from FY22 – FY27.
- According to the base schedule, the project would be completed by FY27. The 80% confidence schedule includes an additional 36 months in the project duration which places project completion in FY30.
- Other key points include the development of a project management plan in FY19 and finalizing the new lock design and acquisition strategy in FY21. A key assumption for this schedule is the use of the continuing contract clause for contract actions. The schedule assumes an efficient funding stream.

Recommendation

The Detroit District, U.S. Army Corps of Engineers recommends a new authorization for construction of a new lock at Sault Ste. Marie, MI with dimensions 1200'L x 110'W. The estimated construction cost is $922,432,000 at FY19 price level. A new lock would eliminate the Soo Locks as the single point of failure within the Great Lakes Navigation System.

The Soo Locks Complex is Nationally Critical Infrastructure. Construction of a new lock is necessary and prudent to ensure reliability at this critical node in the Great Lakes Navigation System, which is essential to U.S. manufacturing and National Security. The benefits of this project reflect a reduction in risk associated with the existing single point of failure for the Nation's value chain of taconite pellets, steel production, and manufacturing.

As described in the June 2018 New Soo Lock Economic Validation Study, disruptions to Poe Lock serviceability would impact the supply chain, which would directly impact production of Advanced High Strength Steel. That disruption would, in turn, impact manufacturing, particularly the automobile industry. Though not considered the National Economic Development Benefits in accordance with the 1983 Principles and Guidelines, this present scenario illustrates the value of a new lock to the national economy and the GDP. This project has a current benefit-to cost ration (BCR) of 2.42 at the current interest rate of 2.75% or 2.32 at the 7% discount rate.

Considering the entirety of information presented herein, Detroit District recommends the approval of the Post Authorization Change Report and that the congressional authorized cost be increased to $922,432,000 for construction of a new lock at Sault Ste. Marie, Michigan.

DENNIS P. SUGRUE
LTC, EN
Commanding

Appendix A

PROJECT COST INCREASE FACT SHEET

(ER 1105-2-100 Appendix G Exhibit G-11)
April 2018

1. **Name of Project:** Soo Locks, Sault Sainte Marie, Michigan

2. **Section and Law that Authorized or Modified the Project:**
   a. Resolution – Senate Committee on Public Works, 2 June 1969
   b. Resolution – Senate Committee on Public Works, 30 April 1976
   c. Water Resources Development Act of 1986 (PL 99-662, 17 Nov 1986), SEC. 1149. SAULT SAINTE MARIE, MICHIGAN, *AMENDED BY SEC 3091, WRDA 2007*
   d. Water Resources Development Act of 1990 (PL 101-640, 28 Nov 1990), SEC. 107. CONTINUATION OF AUTHORIZATION OF CERTAIN PROJECTS, *REPEALED BY SEC 3091, WRDA 2007*
   e. Water Resources Development Act of 1996 (PL 104-303, 12 Oct 1996), SEC. 330. SAULT SAINTE MARIE, CHIPPEWA COUNTY, MICHIGAN, *REPEALED BY SEC 3091, WRDA 2007*
   f. Water Resources Development Act of 1999 (PL 106-53, 17 Aug 1999), SEC. 330. SAULT SAINTE MARIE, CHIPPEWA COUNTY, MICHIGAN, *REPEALED BY SEC 3091, WRDA 2007*
   g. Water Resources Development Act of 2007 (PL 110-114, 8 Nov 2007), SEC. 3091. SAULT SAINTE MARIE, MICHIGAN.

3. **Section 902 Limit on Project Cost:**

a. Authorized project cost: (FY08 price level)	$341,714,000
b. Price level increases from date of authorized cost: *	$122,900,000
c. Current cost of modifications required by law:	none
d. 20% of line 3a:	$68,343,000
e. Maximum project cost limited by Section 902:	$532,957,000

4. **Current Project Cost Including Inflation during Construction: *** ** $1,030,670,000

5. **Computation of Percentage Increase:**

a. Current Estimate: (Line 4)	$1,030,670,000
b. Less total of lines 3a, b, and c:	$464,614,000
c. Subtotal:	$566,056,000
d. Percentage increase: (line 5c/3a)	66%

6. **Explain cost indexes used in 3b; whether national or regional for real estate, and single state or two state average for construction:**
Construction cost were updated for historical inflation according to "05-Locks" CWBS Feature Account indices listed in EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) 30 September 2017. This project has no real estate costs, thus no rent index is required.

7. **Explain increases in 3c; Legislation requiring the modification, and how accommodated:** Not Applicable

8. **Explain reason for cost changes other than inflation:** Design improvements and refinements, not all of which resulted in increases in costs, include: revised cofferdam design and in-the-dry excavation, shifting of look footprint to accommodate vertical lift gate emergency closure,, vertical lift gate emergency closure, revised north wall design, concrete facing in and around intake valves, culvert through cofferdam, relocation of project laydown areas, revised design for filling/emptying system, and Davis/Sabin closure plan refinement. Details of the specific changes and associated cost impacts are detailed in the New Soo Lock Post Authorization Change Report.

9. Explain any changes in benefits and provide current BCR:
The 2018 Validation Study (VS) includes two key changes for benefits. The first is the inclusion of reliability engineering data as described in Section 4.1. The second is the valuing of unmet demand. In previous efforts, all tonnage was assumed to move via overland routes during a Poe Lock closure. In the 2018 VS, it is recognized that in the event of a sufficiently long Poe Lock closure iron ore tonnage would become stranded (unmet demand). The VS places a value on the stranded tonnage which results in the *Unmet Demand Transportation Costs* benefit. Outcomes from the VS include that the new lock construction would result in an average annual benefit of $96.6 million at an average annual cost of $32.8 million, producing an average annual net benefit of $63.8 million and a benefit to cost ratio (BCR) of 2.94 at the current discount rate.

10. Provide detailed explanation of the status of the project:
Costs spent to date on the project are $32,153,151. This includes construction of two cofferdams in the Sabin Lock at approximately $4M and downstream channel deepening at approximately $7.1M. The remaining funds were utilized for feasibility, PED activities including geotechnical exploration and testing, stability analyses, construction sequencing analysis, ERDC's physical model of the filling and emptying system, a ship simulation study to refine the lock alignment for safe transits, coordination with historic preservation agencies, and S&A activities.

Currently, a Validation Study and Post Authorization Change Report are scheduled for completion in June 2018. The approval of these documents will allow the project to be considered for inclusion in the 2020 Federal Budget.

* Line 1e from Table G-4, less the authorized cost
*** Line 1b from Table G-4

Sources

Cost Estimate:

Cost MCX ATR Cert for LRE PN 112425 Soo Locks MRR - 2018_02_20

Expenditure Inputs:

MFR-SooCertOfSunkConstrCosts_2018-02-16-CELRE-PPM

Table G-1 (ER 1105-2-100 Appendix G)									
CWCCIS Index(s)									
				Index	Yearly Inflat Rate	Cumul Inflat Rate	Cumul rate to Begin FY	One Half rate of Infl FY	Tot Allow Inflat for FY
Item		(b)	(c)	(d)	(e)	(f)	(h)	(i)	(j)
Date of Price Level			10/1/2007						
Authorized Estimate			341,714	710.710		1			
First Fiscal year			FY 08		-0.0129		1	0.993528	0.9935276
1st Qtr, 2nd yr		FY 09		701.510		0.98706			
Second Fiscal year			FY 09		0.02564		0.98706	1.012822	0.9997116
1st Qtr, 3rd yr		FY 10		719.500		1.01237			
Third Fiscal year			FY 10		0.04093		1.01237	1.020466	1.0330866
1st Qtr, 4th yr		FY 11		748.950		1.05381			
Fourth Fiscal year			FY 11		0.01997		1.05381	1.009987	1.06433
1st Qtr, 5th yr		FY 12		763.910		1.07485			
Fifth Fiscal year			FY 12		0.01615		1.07485	1.008077	1.0835362
1st Qtr, 6th yr		FY 13		776.250		1.09222			
Sixth Fiscal year			FY 13		0.02368		1.09222	1.011839	1.1051484
1st Qtr, 7th yr		FY 14		794.630		1.11808			

Table G-1 (ER 1105-2-100 Appendix G)									
CWCCIS Index(s)									
				Index	Yearly Inflat Rate	Cumul Inflat Rate	Cumul rate to Begin FY	One Half rate of Infl FY	Tot Allow Inflat for FY
Item		**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(h)**	**(i)**	**(j)**
Seventh Fiscal year			FY 14		0.01039		1.11808	1.005197	1.1238902
1st Qtr, 8th yr		FY 15		802.890		1.1297			
Eighth Fiscal year			FY 15		0.00989		1.1297	1.004945	1.1352872
1st Qtr, 9th yr		FY 16		810.830		1.14087			
Nineth Fiscal year			FY 16		0.02825		1.14087	1.014127	1.1569909
1st Qtr, 10th yr		FY 17		833.740		1.17311			
Tenth Fiscal year			FY 17		0.02256		1.17311	1.01128	1.1863418
1st Qtr, 11th yr		FY 18		852.550		1.19958			
Eleventh Fiscal year			FY 18		0.02		1.19958	1.009999	1.2115701
1st Qtr, 12th yr		FY 19		869.600		1.22357			

Table G-3 (ER 1105-2-100 Appendix G)
Authorized Cost Increase Computation

FY		Current Project Cost		Current Sched (%)		Authorized Cost Sched			Auth Cost Inflat	
	Total	Constr	R.E.	Constr	R.E.	Constr	R.E.		Constr	R.E.
	(a)	(b)	(c)	(d)	(e)	(f)	(g)		(h)	(i)
FY 02	$2,283.22	$2,283.22	$0	0.248	0.00	$845.82	$0.00		$845.82	$0.00
FY 03	$1,802.96	$1,802.96	$0	0.195	0.00	$667.90	$0.00		$667.90	$0.00
FY 04	$1,861.81	$1,861.81	$0	0.202	0.00	$689.71	$0.00		$689.71	$0.00
FY 05	$1,942.96	$1,942.96	$0	0.211	0.00	$719.77	$0.00		$719.77	$0.00
FY 06	$93.45	$93.45	$0	0.010	0.00	$34.62	$0.00		$34.62	$0.00
FY 07	$608.30	$608.30	$0	0.066	0.00	$225.35	$0.00		$225.35	$0.00
FY 08	$1,474.52	$1,474.52	$0	0.160	0.00	$546.23	$0.00		$542.70	$0.00
FY 09	$4,099.79	$4,099.79	$0	0.444	0.00	$1,518.76	$0.00		$1,518.33	$0.00
FY 10	$12,779.64	$12,779.64	$0	1.385	0.00	$4,734.20	$0.00		$4,890.84	$0.00
FY 11	$2,443.31	$2,443.31	$0	0.265	0.00	$905.12	$0.00		$963.35	$0.00
FY 12	$259.46	$259.46	$0	0.028	0.00	$96.12	$0.00		$104.14	$0.00
FY 13	$264	$264	$0	0.029	0.00	$98	$0		$107.96	$0.00
FY 14	$97	$97	$0	0.011	0.00	$36	$0		$40.44	$0.00
FY 15	$65	$65	$0	0.007	0.00	$24	$0		$27.18	$0.00
FY 16	$504	$504	$0	0.055	0.00	$187	$0		$215.95	$0.00
FY 17	$1,574	$1,574	$0	0.171	0.00	$583	$0		$691.92	$0.00
FY 18	$0	$0	$0	0.000	0.00	$0	$0		$0.00	$0.00
Balance to complete	$890,279	$890,279	$0	96.514	0.00	$329,803	$0		$403,535	$0
Total	$922,432	$922,432	$0	100.00	0.00	$341,714	$0		$415,821	$0

Table G-4 (ER 1105-2-100 Appendix G)

MAXIMUM COST INCLUDING INFLATION THROUGH CONSTRUCTION

FY 18 - Thousands Dollars (000's)

Line 1		
a.	Current Project estimate at current price levels:	$922,432
b.	Current project estimate, inflated through construction:	$1,030,670
c.	Ratio: Line 1b / line 1a	1.1173
d.	Authorized cost at current price levels:	$415,821
(Column (h) plus (i) from table G-3)		
e.	Authorized cost, inflated through construction:	$464,614
(Line c x Line d)		
Line 2	Cost of modifications required by law:	$0
Line 3	20 percent of authorized cost:	$68,343
.20 x (table G-3, columns (f) + (g)		
Line 4	Maximum cost limited by section 902:	$532,957
Line 1e + line 2 + line 3		