



Inland Navigation Construction Selected Case Studies

**Marmet Locks & Dam
Monongahela River Locks and Dams 2, 3, 4
Olmsted Locks and Dam**

**Great Lakes and Ohio River Division
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EXECUTIVE SUMMARY

Purpose. This "white paper" was prepared at the request of the Deputy Assistant Secretary of Army for Civil Works Management & Budget during a June 12, 2007 meeting, co-chaired with the Deputy Director of Civil Works, to discuss depletion of funding balances in the Inland Waterways Trust Fund. The paper is the result of an agreement between the Deputy Assistant Secretary and the Chairman of the Inland Waterways Users Board who was accompanied by inland Navigation Industry representatives in a meeting on June 12, 2007. The intent of the report is to document project performance at three inland navigation projects and to identify lessons learned that would help to shape future navigation investment funding decisions. This paper provides three case studies which document project performance based upon consideration of many variable factors.

Case Studies Selected. The three projects selected are Marmet Locks and Dam; Monongahela River Locks and Dams 2, 3, 4; and Olmsted Locks and Dam. These are representative projects with which a comparison can be made as to how variable factors influence project outcomes.

Information Not Included in this Study. This paper analyzes only the change in cost for each project from its initial Feasibility cost to its final, or projected final, cost and tends to substantially overstate true construction cost growth. This is intentional to bring out lessons learned, but it is important to understand that true cost growth of the projects discussed in this report is generally less than demonstrated in the report, for two reasons:

(1) The initial Feasibility cost, estimated at the end of the planning phase, assumes that all engineering, real estate and construction funds will be available at the beginning of the project. This is never the case in a large project (>\$100 million). If all of the funds were available at the beginning of project design the Corps would prepare a very different project schedule and acquisition plan. For instance, if all funds were available at the outset the very large contracts would likely have been fully funded fixed price contracts giving the contractor complete flexibility to develop the most efficient construction schedule. In fact, funding constraints require the Corps to schedule the very large contracts over a number of years consistent with projected funds availability. These acquisition plans are an efficient use of available funds, but typically do not result in the most efficient construction plan. In addition, that original estimate, while it will take into account the projected price of real estate, will not account for the time to buy it. In some cases acquisition of real estate may require several years prior to construction and will appear to be a schedule delay that inflates construction cost. In fact, the initial cost estimate simply does not account for this situation. A more accurate estimate of project cost and schedule inflation would compare the updated cost estimate at the end of the engineering phase when the funding projections have been made and an acquisition plan developed with the final construction cost. This is beyond the scope of this paper, however and does not materially change the lessons learned.

(2) A second fact that may be misleading is that this report does not consider the effect of funding and constructing multiple projects along the same waterway and from the same, constrained, appropriation. Because several projects may need to be rehabilitated or recapitalized for the system to service its user base efficiently, the Corps is usually working on several projects simultaneously from the same, constrained, appropriation. In this case, while it appears that each individual project is experiencing cost growth due to inflation because each is being built at a less than efficient pace, the sum of the inflation experienced for all projects is no different than if each had been built serially, but more efficiently. For example, if 5 projects are to be constructed, each costing \$1 million with a construction period of 1 year and with funding constrained to \$1 million per year for all 5 projects, the cost of inflation is exactly the same regardless of whether they are funded “efficiently” one project at a time or “inefficiently” funding all 5 projects at \$200 thousand/year for the 5 years. Nonetheless, the analysis of inflation experienced by a group of projects being rehabilitated or recapitalized from a single, constrained appropriation is beyond the scope of this paper and not necessary to extract the lessons to be learned as they apply to individual projects.

Construction Cost Increases. Factors that contribute to construction cost growth are varied. Cost growth factors within this white paper include common engineering and construction factors typical to all projects including differing site conditions, government design changes, and omissions from the authorizing (i.e. feasibility) cost estimate. Other reasons for cost growth on these projects include schedule delays due to delayed appropriations during a Continuing Resolution Authority period (although this was only a very minor increase if any), a one-time change made to the continuing contract clause as a result of Fiscal Year (FY) 2006 legislation, and less than optimum funding. In summary, the Marmet, Monongahela River Locks & Dams 2, 3, 4, and Olmsted projects experienced 18.5%, 42.8% and 58.6% total cost growth, respectively. On the Marmet project, 33% of the cost growth was attributable to the one-time effect of changing the continuing contract clause while all other growth was caused by common engineering and construction factors. For the Monongahela River Locks & Dams 2, 3, 4 project common engineering and construction factors explain about 61% of the cost growth and less than optimal funding account for about 32%. On the Olmsted project typical engineering and construction factors account for about 69% of the cost growth and less than optimum funding caused approximately 31%.

Increased O&M Costs. There is also a residual cost impact from construction delays in that additional expenditures are incurred on O&M projects that otherwise would have been replaced by new construction. These O&M expenditures could be avoided with on-schedule construction project completions. For these case studies, Marmet does not have existing projects that would be removed; Lower Monongahela Locks and Dams 2, 3, 4 incurred \$35 million in additional O&M expense due to late completion; the impact on Olmsted Locks and Dam is estimated at \$81.5 million in added O&M expense due to late completion.

Lost NED Benefits. NED Benefits are being lost (foregone) due to the late completion of construction projects and cannot be recovered. These lost NED benefits amount to \$5.76 billion for the three projects in these case studies. For the three case studies in this paper, the graph below shows the benefits foregone. The benefits foregone are based on a

simplistic approach using the benefits contained in the feasibility studies for the projects, and therefore in some cases overstate the benefits foregone due to delays.

Issues to be Resolved. These case studies reveal the dramatic impact to the nation in the form of cost growth and lost benefits resulting from construction delays. Recognizing these issues, defining the underlying causes, and understanding the economic impacts are the first steps in seeking a resolution. Primary issues for which resolution is needed and which the case studies reveal are the following:

1. Initial Construction Schedule and Cost
2. Delayed Completion Schedule
3. Escalated Project Costs
4. Foregone National Economic Development Benefits
5. Change in the Continuing Contracts Clause
6. Fully Funded Contracts vs. Annually Funded Contracts
7. Increases in O&M Costs
8. Timeliness of Contract Awards
9. Adequate Site Investigations during Feasibility and Design Phases

Future Goals. These case studies have revealed significant inefficiencies and have fostered discussions for an improved process. The following goals of the future efficient process are offered:

1. Realistic, achievable, accurate, and risk-based cost and schedule estimating
2. Efficiently built infrastructure
3. Continued long-term project prioritization for infrastructure capital improvements
4. Commitment to optimum, timely, and appropriately disbursed funding stream to projects
5. Benefits realized ASAP
6. Uninterrupted construction start-to-finish

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1. INTRODUCTION TO CASE STUDIES

1.A. Intent.

This "white paper" was prepared at the request of the Deputy Assistant Secretary of Army for Civil Works Management & Budget during a June 12, 2007 meeting, co-chaired with the Deputy Director of Civil Works, to discuss depletion of funding balances in the Inland Waterways Trust Fund. The paper is the result of an agreement between the Deputy Assistant Secretary and the Chairman of the Inland Waterways Users Board who was accompanied by inland Navigation Industry representatives in a meeting on June 12, 2007.

The intent of the white paper was established to analyze the projects that have led to bad outcomes (e.g., cost overruns and schedule delays) and good outcomes (project completion on time and within budget). In the meeting of June 12, it was agreed that the white paper was to be a collaborative effort between the Corps and the Inland Waterways Users Board. The agreement included the objective of this analysis to glean lessons learned for improving the financial resourcing process especially analyzing the impacts of annual budgeting/funding.

1.B. Efficient Construction Goal.

Efficient construction for the Inland Navigation system is imperative and a key Corps of Engineers goal. The nation depends upon the Corps of Engineers to identify potential infrastructure investments providing waterborne commerce benefits to the nation, justify the value of a proposed project in the Federal interest, design the project for effectiveness, build the project efficiently, and operate the finished project in the nation's economic interests.

This report defines uses the term "efficient construction" as the estimated project cost and schedule at the completion of the Feasibility Study. It is important to appreciate that the estimate prepared at completion of the feasibility phase anticipates that the project will have full funding available at the outset of the project. At this point in project planning the estimators are unable to know what the funding stream might be when the project is ready for construction award. The fact is that funding for these very large projects has been constrained in recent years so that Corps districts must develop an acquisition plan that will use a constrained funding stream efficiently. In this sense, while the districts and their contractors make the most efficient use of available funds, they clearly are not able to acquire the major portions of the very large projects as efficiently or cost effectively as would be possible if all the funds were available at the outset. This fact causes the comparison of the final construction cost with the initial feasibility cost to be somewhat inappropriate because the two costs were developed using different assumptions. To be more accurate we might have used the cost estimate compared at the completion of design with known funding constraints and after the acquisition plan was developed. This would lower the magnitude of the "cost growth" but would not materially impact the lessons learned and might tend to confuse the analysis so we used the initial feasibility estimate as the starting point for cost comparison.

Efficiency goals for Navigation construction projects include the following:

1. Realize National Economic Development (NED) benefits as early after construction start as possible. Delayed completions should be avoided since NED benefits are lost (foregone) and cannot be recovered by the nation.
2. Use Federal and Inland Waterways Trust Fund allocations as efficiently as possible.
3. Avoid risks inherent with aging infrastructure by expeditious and timely replacement with the new construction project. Efficient construction with economically favorable scheduling of the new project's completion is important to avoid maintenance & operations costs of the project being replaced.

1.C. Selection of Case Studies.

This paper provides three case studies that were selected per the intent of the 12 June 2007 meeting of the ASA(CW) and the Inland Waterways Users Board. The agreed intent was expressed as follows (quoted from "Meeting minutes from Stakeholder Workshop to Discuss Revenue Options for the Inland Waterways Trust Fund"):

"Conduct a Self-Examination of the Business Process by the Corps. Compare the impacts of the current business model on both a project that has led to "bad" outcomes (e.g., cost overruns and schedule delays) and a project that has led to "good" outcomes (project completion on time and within budget).....The objective of this analysis is to glean lessons learned for improving the business model, including analyzing the impacts of annual budgeting/funding.....and ways to ensure that system needs are funded.....The team working on this should take advantage of information already available about these projects, perhaps including value engineering information.....It is therefore imperative to talk to project managers and other project personnel involved in the projects selected as examples."

The projects in the case studies are representative projects with respectively minimal and progressively severe adverse economic and disruptive impacts.

Marmet Locks and Dam project was assessed to be least impacted from the financial resourcing process. Marmet's construction of the lock received virtually ideal funding for efficient construction and the ramifications are minimal. Lower Monongahela Locks and Dams 2, 3, 4 project received less than optimum funding with impacts between Marmet and Olmsted. Olmsted Locks and Dam project involved higher risk design decisions, complex construction management challenges, and less than optimum funding. The resulting construction pattern produced delays, more costly construction, and relatively large benefits foregone.

1.D. White Paper Organization

This white paper presents the results in order of impacts assessed by the case studies: Marmet, Lower Monongahela Locks and Dams 2, 3, 4 and Olmsted Locks and Dam. Each case study is discussed for continuity with uniform sub-topics per the list below:

- A. Project Description
- B. Initial Construction Schedule and Cost
- C. Delayed Completion Schedule

- D. Mismatched Optimum Funding vs. Funding Allocation
- E. Escalated Project Costs
- F. Government Design Changes and Differing Site Conditions
- G. Foregone National Economic Development Benefits
- H. Impacts from Continuing Resolution Authority Period
- I. Fully Funded Contracts vs. Incrementally Funded Contracts
- J. Increased O&M Costs
- K. Disruptive Effects to Contractors
- L. Predictability of Workload and Workforce
- M. Budget Cycle Predictability

1.E. Factors Affecting Construction Project Cost Increases.

This white paper refers to factors which may affect construction project cost increases. The array with definitions of factors is provided in Appendix 1. Each case study refers to these factors; however only the applicable factors are discussed in each case study. Unusual material cost escalation affected all the construction projects; Appendix 2 contains information describing this unusual circumstance.

1.F. Process Improvements Already in Effect

This white paper also recognizes and describes several process improvements which have already been effected since these three case study projects were started. These are important steps implemented to reach the established goals noted above.

Multi-year optimum funding projections and construction progress rationale compiled in LRD's Navigation Five Year Development Perspective state the glide path for efficiency. This is an essential improvement supplementing year-to-year short term budgeting.

In the past the COE prepared the annual budget using a process known as ceiling based budgeting. In many cases this process did not allow a project to request the funding it needed to be constructed efficiently. In recent years, the Corps changed to a performance based budget process. This process allows for project requests and for management decisions to plan the necessary funding to enable efficient construction. Annually the projects are ranked based on the navigation performance measures.

Risk Assessment is being performed in a far more rigorous manner. This step in cost estimating and schedule planning is an essential improvement implemented during the feasibility study phase. In future projects, use of Crystal Ball (a risk analysis tool) to consider risk potentials for all feature accounts in items such as adequate funding, potential schedule growth, escalation beyond the previously assumed inflation estimates, market conditions, scope growth, etc. may be indispensable. Corroboration and/or recommended revision of the cost estimate and schedule is being performed by the Corps' Risk Assessment Center of Expertise in Walla Walla, Washington.

The Corps has implemented other project management reforms to improve the skills and knowledge of its project managers. We have developed a thorough Career Development Plan, initiated certification of skill levels of project managers and encouraged professional certification through a widely recognized international program. Importantly, we are developing risk management plans for all large projects, requiring risk-based schedule and

cost estimates and independent review of the costs and schedules. Districts will then be managing risks in accordance with their project risk management plan. All of these improvements will serve to insure that initial cost and schedule estimates account for the many uncertainties inherent in these very large projects and that the estimates are more realistic at the outset.

One of the uncertainties is clearly the funding choices. Do we fund a large number of projects at less than efficient rates or a smaller number of projects at more efficient funding rates? There can be advantages to either choice. In the future, we will be involving the IWUB more directly in these choices, far in advance of the initiation of major projects and contracts and then conveying these plans to the districts so that they have more advance notice and assurance of probable funding levels and can plan and estimate accordingly.

1.G. National Economic Development Benefits Foregone

The benefits foregone calculations are based on a simplistic approach using the benefits contained in the feasibility studies for the projects without any adjustment for benefit categories that may not be foregone during the delay period. For example, some benefit calculations include savings on future operations and maintenance and rehabilitation costs. Since the old projects that are being replaced would not be rehabilitated during the delay period, these benefits are not, in fact, foregone so that the benefits foregone are overstated.

2. MARMET LOCKS & DAM CASE STUDY



Figure 1 Photo: Marmet Locks & Dam

2.A. PROJECT DESCRIPTION.

Marmet Locks and Dam project is located in Kanawha County near Belle, West Virginia, on the Kanawha River approximately 68 miles above its confluence with the Ohio River. The project includes construction of an additional 110-foot by 800-foot lock on the right descending bank landward of the existing locks, continued use of both existing 56-foot by 360-foot lock chambers as auxiliary locks, and rehabilitation of the existing navigation dam. The hydroelectric power plant, owned and operated by American Electric power, will also remain in operation. The new lock became operational in January 2008. Remaining lock construction activities are scheduled to be completed in FY 2009. The report to support rehabilitation of the dam was initiated in FY 2008 and is scheduled for completion in FY 2009.

2.B. INITIAL CONSTRUCTION SCHEDULE AND COST

The feasibility report for navigation improvements at Marmet Locks and Dam was completed in December 1993. The Secretary of the Army transmitted a report to Congress on 24 June 1994 recommending authorization of navigation improvements at Marmet locks and Dam. Authorization was sought for the lock construction only, recognizing that authorization was not required for the dam rehabilitation component. The Marmet Lock Replacement project was initially authorized by WRDA 1996 at a total project cost of \$229,581,000. At the time of completion of the Feasibility Report, the project implementation schedule was estimated to be 11 years (lock construction in five-years).

Anticipating authorization of the project in WRDA 1994, completion of design activities and real estate acquisition were scheduled for October 1999 and the new lock chamber was scheduled to be operational in May 2004, with all lock construction completed in FY 2005. Actual authorization did not occur until WRDA 1996 and the initial appropriation of construction funding was received in FY 1998; shifting the lock chamber completion schedule four years to an online date of FY 2008 with all construction completed in FY 2009.

The Marmet lock project acquisition strategy utilized the traditional continuing contract clause with the expectation that funds would be secured as needed on an annual basis to optimally fund the project. The solicitation was not based on a known funding stream because no assurance could be provided that the project would receive optimum funding throughout the implementation period. The contract specified a completion date which was developed based on a reasonable execution of the work with adequate allowances for weather delays and unconstrained funding. The solicitation contained provisions for schedule extensions based on exhaustion of funds. Available funding for the first year was known and specified in the solicitation.

Following receipt of the contractor's proposed schedule, budget requests and capabilities for subsequent years were developed to reflect the contractor's chosen sequence, scheduling and progression of work.

Although many construction activities were on the critical path for completion within the allotted delivery date, the contractor had significant flexibility to plan non-critical path work which dramatically varied projected earnings in several years.

2.C. DELAYED COMPLETION SCHEDULE

As noted, the original scheduled project completion date at the time of actual project authorization (WRDA 1996) was FY 2006 for the lock chamber, with all construction completed in FY 2007. However, a resultant delay in appropriation of construction funding further delayed the project two years. Considering delays in project authorization and appropriation of construction funding, the present completion schedule is consistent with that originally estimated in the feasibility document. The new lock chamber was placed into service in January 2008 and all lock construction is scheduled for completion in FY 2009.

A comparison of cumulative costs between the original and current schedule is shown in Figure 2. The authorized 1 October 1995 costs were indexed to a FY2007 price level using CWCCIS (Civil Works Construction Cost Index System) composite index for comparison with the current cost estimate stream. Note that the sunk costs in the current cost estimate schedule were expensed (sunk) at a price level of the year spent.

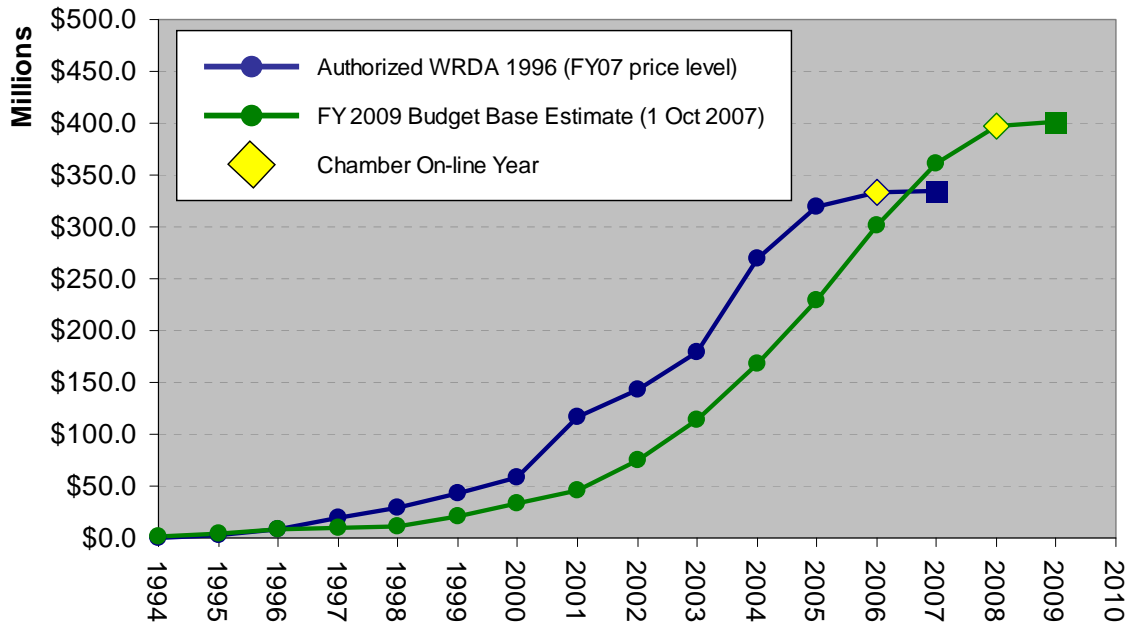


Figure 2- Marmet Cumulative Base Costs By Fiscal Year

2.D. MISMATCHED OPTIMUM FUNDING VS FUNDING ALLOCATION

Construction for Marmet began in 2002, and except for shortfalls in FY 2003 through 2005 (a period of high savings and slippage and reprogramming payback), available funds have essentially met or exceeded capability as shown in Figure 3. Savings and slippage reduced project funding by \$9.2 million in FY 2003, \$14.8 million in FY 2004 and \$8.4 million in FY 2005. While the Marmet project has been a source for reprogramming, as a whole the project has received a net plus-up of \$4.6 million in reprogramming.

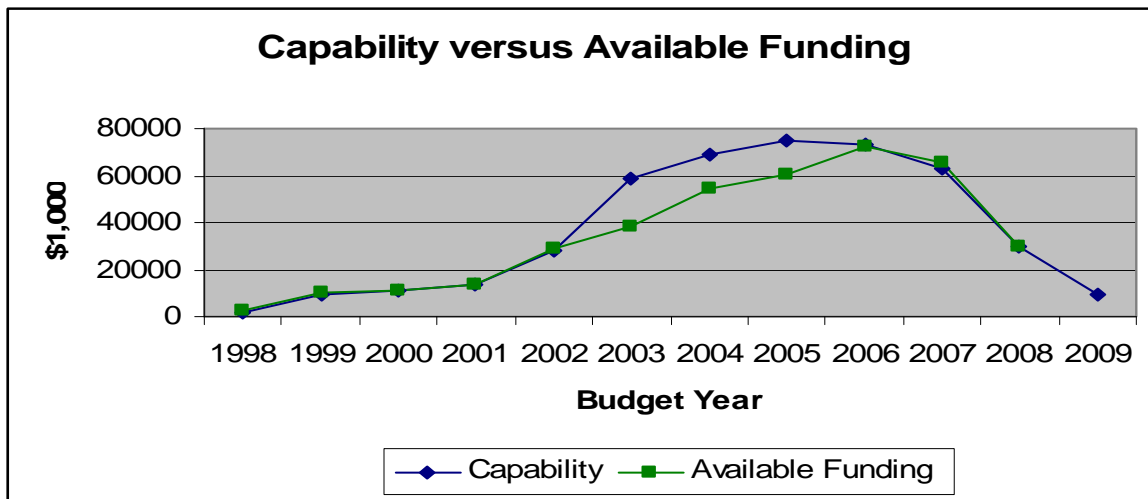


Figure 3- Marmet Capability vs. Available Funding

2.E. ESCALATED PROJECT COSTS

For a comparison, the authorized 1 October 1995 costs were indexed to a FY 2007 price level using CWCCIS composite index for comparison with the current cost estimate stream as presented in Figure 4. The difference between the authorized estimate and the current working estimate amounts to \$66.6 million which is primarily attributable to cost growth in the Locks feature account.

Construction Cost Increase Breakdown (\$1,000s)			
Feature	Authorized *	Current	Difference
Lands & Damages	\$32,613	\$27,861	(\$4,752)
Relocations	\$2,712	\$3,788	\$1,076
Dams***	\$25,000	\$25,000	\$0
Locks	\$193,951	\$285,967 **	\$92,016
Fish & Wildlife Facilities	\$4,563	\$1,980	(\$2,583)
Channels & Canals	\$0	\$178	\$178
Cultural Resources	\$1,093	\$4,321	\$3,228
Building, Grounds & Utilities	\$3,995	\$5,335	\$1,340
Perm. Operating Equipment	\$3,980	\$3,460	(\$520)
Feasibility	\$249	\$674	\$425
E&D	\$33,357	\$44,875	\$11,518
S&A	\$25,032	\$18,187	(\$6,845)
HTRW-PM	\$0	\$46	\$46
HTRW Removal	\$0	\$3,682	\$3,682
Contingency	\$33,160	\$936	(\$32,224)
PROJECT TOTAL	\$359,705	\$426,290	\$66,585
<p>* 1 October 1995 costs indexed to a FY 2007 price level using CWCCIS composite index (EM 1110-2-1304, 31 March 2000, tables revised as of 30 March 2007).</p> <p>** 05 Account Locks includes \$21.8M for incorporation of the Special Continuing Contract Clause required by Principal Assistant Responsible for Contracting Instruction Letter 2006-05 (PIL), Continuing Contracts and Incrementally Funded Contracts for Fiscal Year 2006.</p> <p>*** 04 Account Dams based on the feasibility estimate indexed to FY 2007 price level. Current estimate will be revised as necessary following completion of the ongoing major rehab report.</p>			

Figure 4 Marmet Construction Cost Breakdown

The largest single contributing factor to the project cost growth, accounting for \$21.8 million, is the result of incorporating the Special Continuing Contract Clause. In August of 2006, more restrictive guidance was issued regarding continuing contract clauses. The government implemented a contract modification to replace the traditional continuing contract clause. Under the modified continuing contract clause, the contractor no longer had the flexibility to continue work beyond available funding. Consequently, anticipating an exhaustion of funds prior to the end of the fiscal year, the contractor laid off

approximately 150 construction workers to limit earnings to available funding. The monetary impacts of these delays in 2006 were \$2.25 million and an additional \$19.60 million in subsequent years. The performance period of the contract was extended a total of 168 calendar days.

While contingencies in the costs were assumed, these were inadequate to cover discovered costs. Exact estimates of cost increase attributable to the financial resourcing process are difficult to estimate, however, it is fair to say that cost increases from the financial resourcing process in Marmet's case, have been minimal accounting for less than 1 percent of total project cost growth.

Factors which may affect the construction cost growth are varied. Appendix 1 defines the array of factors which affect cost growth. Cost growth factors include differing site conditions, Government design changes, omissions from the authorizing (i.e. feasibility) cost estimate, the Continuing Resolution Authority period disruption, the continuing contract clause, and less than optimum funding. For the Marmet project, the factors affecting the construction cost growth are shown by percentages in the pie chart Figure 5.

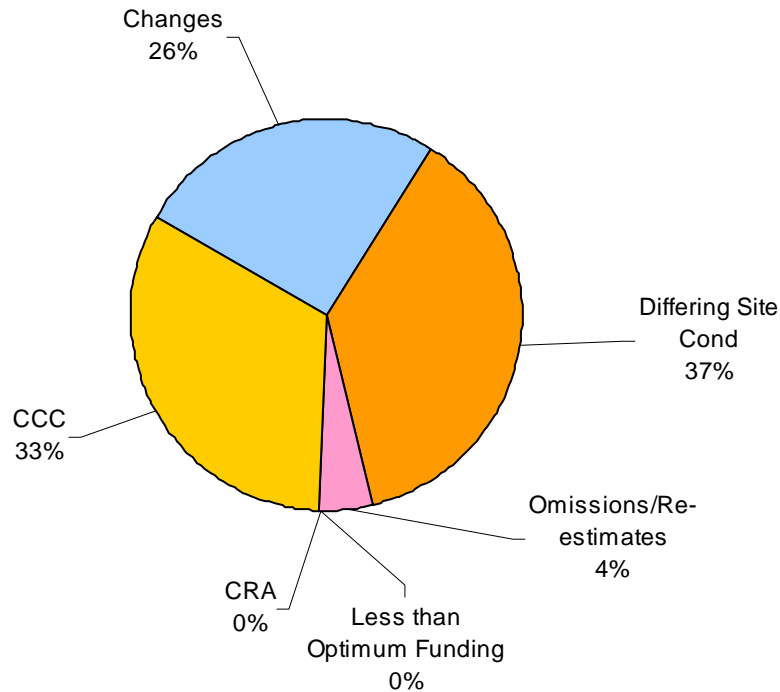


Figure 5 Marmet Cost Growth Factors Pie Chart

2.F. DESIGN CHANGES, ERRORS, AND DIFFERING SITE CONDITIONS

Most of the remaining costs are attributable to project modifications to incorporate government changes (26%), address omissions and re-estimates (4%), or address differing

site conditions (37% e.g. petroleum contaminated soil, storm sewer, etc.) encountered during construction which are part of a normal discovery process.

Relatively few Government design changes occurred during the construction because the improved designs were identified in a Value Engineering process prior to construction starting. These improvements were addressed early enough to preclude cost changes during the construction. One design change that did occur during construction happened during the main lock excavation; the contractor recommended that sheet piling be added to enhance the stability of the bank during excavation. This item did add cost.

Errors and omissions were very small impacts. The only action that could be construed as omission that did impact the cost was discovery and relocation of a storm sewer which was in alignment with the main chamber. The storm sewer was recorded on early 1900's drawings which were inadvertently overlooked during the specifications and design development. Although difficult to find on the early 1900's drawings, this may be construed as an oversight and the cost was minor addition.

Differing site conditions were discovered during construction. Despite the rigorous HTRW (Hazardous Toxic Radiological Waste) program which examined the soils, channel substrate, and all features of the pre-construction site conditions, the discovery of a contaminated area having petroleum waste within main channel did occur. Additional cost was incurred to remove the petroleum waste during construction.

2.G. FOREGONE NATIONAL ECONOMIC DEVELOPMENT BENEFITS

The Marmet Locks and Dam project is improved by providing a new 110-foot x 800-foot lock chamber, which replaces two small 56-foot x 360-foot lock chambers. By eliminating the need to perform multiple lockage operations in processing a tow through the project, the new chamber affords significant time and cost savings to users of this facility. Though the actual opening of the lock to tow operators is relatively close to the revised scheduled operation date following authorization and appropriation of construction funds, the two-year delay from the project schedule developed at the time of authorization due to delays in project authorization and subsequent delay in initial appropriation of construction funds resulted in estimated transportation benefits foregone of \$124 million.

2.H. IMPACTS FROM CONTINUING RESOLUTION AUTHORITY PERIOD

Historically, project funding during continuing resolution has been constrained by some combination of the lesser of the President's Budget, Senate and House reports or a percentage thereof. The Marmet project has been included in the budget, House mark, or Senate mark at values comparable to the expressed capability. The duration of the continuing resolution has never been of such extended duration that the planned project expenditures would exceed the continuing resolution authority. Constraints under a CRA can affect construction progress and during the continuing resolution of FY07 there was a constraint. Additionally, provisions were made for carryover and available reprogramming authority in accordance with restrictions of the FY 2006 Energy and Water Development Appropriations Act. Since ongoing project construction activities were seasonally dependent, the above calculation might have been more disruptive if the District did not have sufficient reprogramming authority to offset these nonlinear project needs.

2.I. FULLY FUNDED vs. INCREMENTALLY FUNDED CONTRACTS

The Marmet Lock Replacement project was awarded as a single incrementally funded construction contract spanning multiple years utilizing the traditional continuing contract clause. Although incrementally funding the single contract resulted in some inefficiency, considerable economy was realized by avoidance of multiple mobilizations and demobilizations associated with awarding multiple contracts. Additionally, use of a single construction contract enabled the contractor to concurrently advance construction of various project features utilizing a common workforce and supervision and administrative staffing. While excavation and site work were advanced onsite, fabrication of miter gates, valves and operating equipment were occurring offsite. Fully funding the single construction contract would have been ideal with regard to risk and schedule impacts. It would have assured the contractor's ability to resource the contract and increased his chances to successfully and aggressively perform the work. However, the use of fully funded multiple contracts that may have resulted from constrained funding would have inherently restricted the amount of work which could have been accomplished in a given year, extending the overall project implementation schedule and costs. Many construction activities, including earthwork and concrete placement are weather dependent and require multiple construction seasons to complete on large civil works navigation projects. Fully funding multiple contracts for like work would have resulted in significant program inefficiencies.

2.J. INCREASED O&M COSTS

The feasibility report concluded that the existing twin chambers would require extensive rehabilitation and major maintenance costs in order to function reliably into the future. These costs are avoided with the construction of the new lock chamber where the existing chambers will only be utilized intermittently during maintenance of the new lock chamber. The current two-year slippage has caused no additional maintenance costs to be incurred to-date; however, risk of failure and service disruptions have increased with the continued use of the existing chambers.

2.K. DISRUPTIVE EFFECTS TO CONTRACTORS

Constrained funding under the traditional continuing contract clause has proven to be disruptive to the contractor at Marmet. The FY 2004 work allowance for the project permitted an allocation of \$40,508,000 to the lock construction contract. As indicated in paragraph 2.D above, the amount of funds received in FY 2004 was considerably less than project capability and the projected contractor earnings, primarily due to high savings and slippage. During the second quarter of the fiscal year, the contractor notified the Corps that construction earnings would exceed available funds by approximately \$16 million.

Contractually, the contractor had the ability to work beyond available funds with entitlement to interest accrued on unpaid earnings. The contractor chose not to self-finance the additional work and, in order to allow critical path offsite fabrication to continue throughout the fiscal year, the contractor elected to decelerate onsite construction activities to fit within the available funding. The work deceleration resulted in layoff of construction workers in July and August of 2004. The continuing contract clause provided for an equitable adjustment in performance time for any portion of the work delayed due to the reasonable anticipation of exhaustion of funds. The subsequent analysis by the contractor of these impacts concluded that a 13-day adjustment in the contract performance period

was warranted. In addition to the effects of the layoffs and deceleration, when additional funding became available in the subsequent fiscal year, the contractor experienced difficulty hiring workers and incurred additional job training costs.

In August of 2006, as a result of the more restrictive guidance regarding implementation of the “special continuing contract clause”, the contractor no longer had the flexibility to continue work and earn beyond available funding. Consequently, anticipating an exhaustion of funds prior to the end of the fiscal year, the contractor laid off approximately 150 construction workers to limit earnings to available funding. The monetary impacts of these delays in 2006 were \$2.25 million and an additional \$19.60 million in subsequent years. The performance period of the contract was extended a total of 168 calendar days.

2.L. PREDICTABILITY OF WORKLOAD AND WORKFORCE

The Huntington District experienced considerable compatibility between projected project needs and available funding for the Marmet project resulting in a high degree of confidence in the ability to obtain optimum funding. This confidence resulted in increased predictability of workload and, consequently, workforce requirements.

2.M. BUDGET FORECAST WITHIN 18-MONTH CYCLE

The budget cycle through which Federal appropriations are requested and received is ongoing and multi-tiered. At any point in time, a budget is being executed, defended, and formulated. The many aspects of a project’s development contribute to the inherent challenges of the process. What may be applicable to the project and its progress at one point during the budgeting process may change significantly at the point of project execution and implementation.

Fortunately for the Marmet project, there has been solid experience on the part of the District’s technical representatives, support from the Navigation industry and the Congressional delegation, and a reliable funding stream through annual appropriations. Knowing with reasonable assurance that planned levels of funding will be available throughout the project’s life has improved the ability to more accurately project what funding levels are needed – even 16 to 18 months in advance of that execution year. In fact, the project schedule may be laid out to mirror construction capabilities with assurance that funding will be available. Overall, it is a formula for efficient project implementation and success.

3. MONONGAHELA RIVER, LOCKS & DAMS 2,3,4 CASE STUDY



Figure 6- Monongahela River Locks & Dams 2, 3, 4

3.A. PROJECT DESCRIPTION

The Monongahela River Project is located in southwestern Pennsylvania and was authorized for construction by the Water Resources Development Act (WRDA) of 1992 to address the deteriorated condition of navigation facilities along the Lower Monongahela River. Specific concerns were the very real risks of navigation system failure related to the poor structural condition of Dam 2, Locks & Dam 3 (L/D 3), and Locks 4 on the Monongahela River.

The project is a “two-for-three” replacement. The 100-year old fixed crest dam at Locks and Dam 2, now called Braddock Locks and Dam, was replaced with a new gated dam. The 75-year old, undersized locks at Locks and Dam 4, now called Charleroi Locks and Dam, will be replaced with larger and modernized lock facilities. With the replacement of Braddock Dam and Charleroi Locks, the 100-year old L/D 3 will be removed from the inland waterway system. Removal of L/D 3 requires adjustment of Pools 2 and 3, creating one pool from Braddock to Charleroi regulated by the new gated Braddock Dam. Although Braddock Dam (at Lock 2) was completed in July 2004, the condition and sustained operability of Locks and Dam 3, and Locks 4 (at Charleroi) remains a significant concern. Locks and Dam 3 project was built in 1907 and is among the oldest structures operating in our inland navigation system, and the most structurally deficient navigation facility on the Monongahela River.

3.B. INITIAL CONSTRUCTION SCHEDULE & COST

The Monongahela River Locks & Dams 2, 3, 4 Project (Lower Mon) was authorized for construction in 1992 at a cost of \$556.4M in October 1991 dollars. When construction began in December 1994, project completion was scheduled for December 2003 (FY 2004), a nine-year project duration. Based on the initial authorized cost and the construction completion in December 2003, the fully funded cost estimate was \$750M in October 1991 dollars.

3.C. DELAYED COMPLETION SCHEDULE

The original December 2003 scheduled completion date for the Lower Mon Project changed several times as shown in Figure 7 and detailed in the bullets below. The current completion date is September 2016 based on the most efficient schedule of remaining work. The duration of the project has grown 244 percent from 9 years to 22 years. This extended duration

translates into cost growth for the project. Figure 7 shows a comparison of cumulative costs between the original and current schedule.

- In 1997, construction completion was delayed to 2008 due to funding issues with Braddock Dam. The original acquisition strategy was modified to issue a separate contract for the abutment because funding was not available to construct the entire Braddock Dam under one contract. At the time the team worked to overcome the obstacle by considering innovative and creative solutions to recover the project schedule. The team studied and recommended in-the-wet construction for the dam in an effort to save costs and recover some time. In-the-wet was expected to save \$5 - \$15M and one year of construction time due to the concurrent construction of the dam off site while construction of the foundation was accomplished on-site.
- In 2003, the construction completion was delayed to 2013 due to cultural resource issues at Braddock, and the development of a detailed construction schedule for Charleroi. The oldest Indian artifacts in the state of Pennsylvania were uncovered at the construction site chosen to build the concrete shell for the Braddock Dam. The schedule was delayed as the team worked through the process of preserving these areas.
- The schedule was again delayed due to complications arising from condition of the existing middle wall at Charleroi and the location of the new locks within the existing footprint of the existing facility. The feasibility report assumed the middle wall could be used as part of the cofferdam to build the new facility. Detailed studies and analysis showed this could not be done without considerable expense and rebuilding of the existing wall. The team developed another innovative and creative in-the-wet construction solution to overcome the condition of the existing middle wall. When the team developed a detailed construction schedule for Charleroi locks, the schedule showed that in this case working in-the-wet was a linear process and very few features could be constructed concurrently to improve upon the schedule.
- During the 2003 – 2005 time periods, in an attempt to work within anticipated available funds, the District decided to complete Charleroi Locks construction with five separate contracts. This decision further delayed completion of the project to September 2019. Although it was understood that project costs would increase with further delays to the project, the Lower Mon Project was authorized based on the condition of the existing facilities and the District felt it was prudent to make as much progress as possible with available funds rather than wait until funding was available to complete the work within one contract. The River Wall Contract was awarded in 2004 and included a funding stream based on expected funding limitations. Although the contract could be completed in four years, the funding limitations extended this by 1 year.
- Optimum funding during the 2005 – 2007 time period has enabled the District to reconfigure the remaining work at Charleroi Locks into three contracts: The ongoing River Wall contract, the River Chamber contract (scheduled for award in

2009) and the Land Chamber contract (scheduled for award in 2012). With support from Headquarters and the office of the Assistant Secretary of the Army for Civil Works, the previous six-year delay can be reduced to three years with project completion now in 2016.

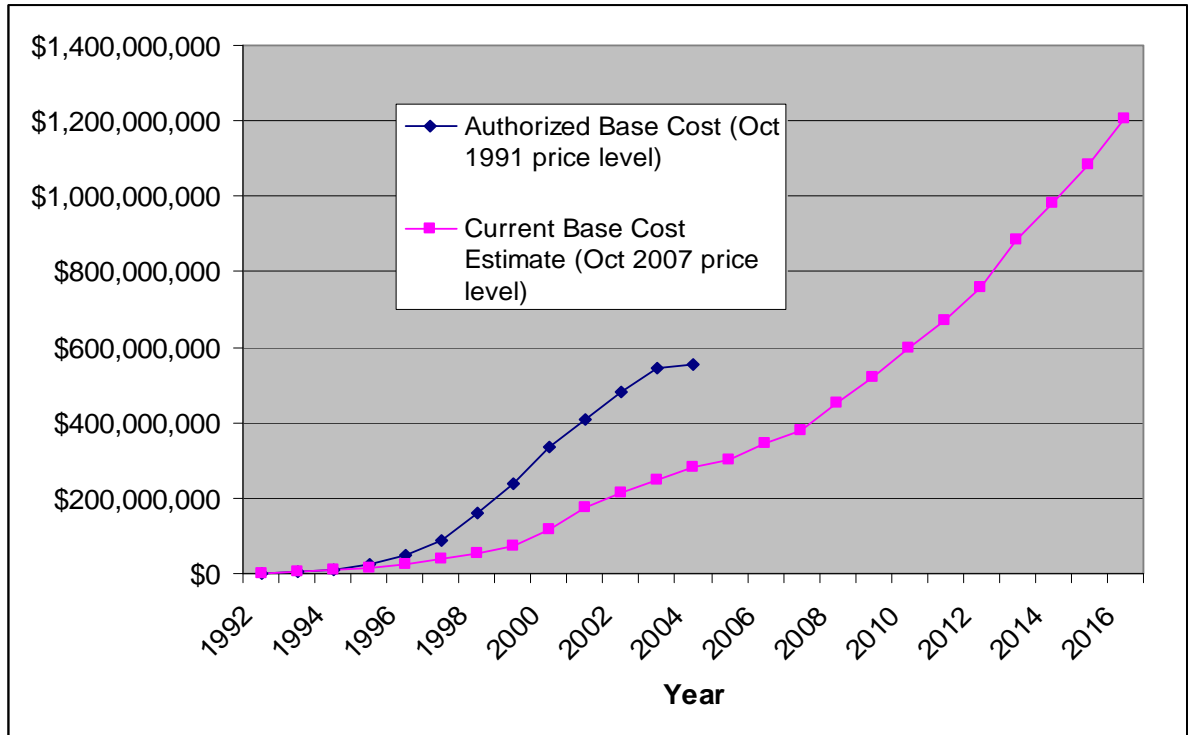


Figure 7 Lower Mon Cumulative Original and Current Completion Costs

3.D. MISMATCHED OPTIMUM FUNDING VS FUNDING ALLOCATION

Construction funding for the Lower Mon Project began in 1996 and the funding history (capability vs. work allowance) of the project is shown in Figure 8. The work allowance is shown in red and capability in blue.

The project did not receive capability (i.e. optimum funding for efficient construction) from 1996 to 2006, and it consistently received capability funding from 2006 to 2008. As a result of the project being underfunded for efficient construction, the acquisition strategy outlined in the Feasibility Report was stretched out and execution of contracts to date has been inefficient. For example, based on assumed funding in 2003, the Charleroi River Wall contract was advertised with a funding profile and all bidders developed schedules for a five-year construction period. If optimum funding was available, this contract could have been completed in 4 years.

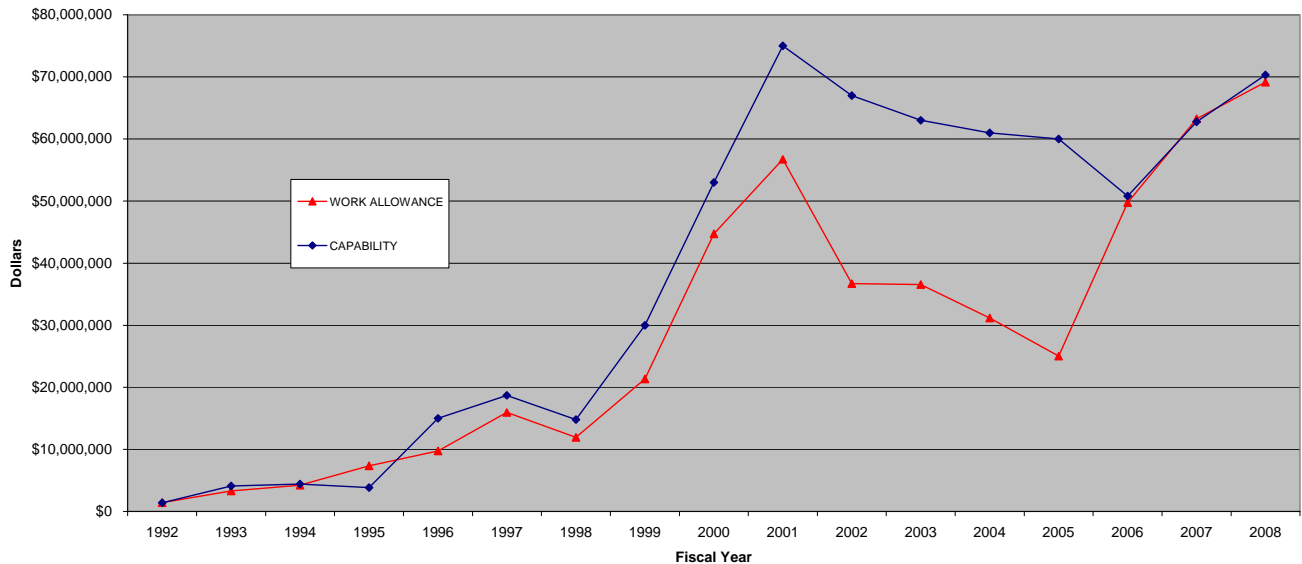


Figure 8 Lower Mon Capability vs. Available Funding

3.E. ESCALATED PROJECT COSTS

As the construction schedule has extended, project costs have escalated. For a comparison, the authorized 1 October 1991 costs of \$556.4M were indexed to a FY 2007 price level of \$844.5M using CWCCIS composite index for comparison with the current cost estimate stream as presented in Figure 9. The most recent total estimated cost of the project is \$1.206B (1 Oct 07 price level). This estimate is not yet final as the risk assessment and independent technical review are in progress and may result in adjustments to the estimate. Items contributing to the increased costs include unusual material escalations, floating plant and availability of skilled labor. Management and other level of effort activities add to the cost increases as the schedule extends.

On this basis, delays to the project to date are estimated to have increased project costs by approximately \$73M. Factors contributing to a delay in the project include the discovery of cultural resources at the Braddock Dam casting facility in Leetsdale and the construction sequence for Charleroi Locks previously described in paragraph 3.C. A portion of the delay can also be attributed to less than optimum funding. Typical cost growth factors account for 61 percent, non-typical cost growth factors account for 4 percent, and less than optimal funding accounts for 32 percent of the total cost growth. If this project is funded at the capability level in the future, it would eliminate further project cost increases due to funding constraints. The projected cost increases by construction features are shown below in the tabular chart, Figure 9.

Construction Cost Increase Breakdown (\$1,000s)			
Feature	Authorized*	Current	Difference
Lands	\$5,522	\$13,310	\$7,788
Relocations	\$61,905	\$77,730	\$15,825
Reservoir (Removal L/D 3)	\$12,053	\$10,080	(\$1,973)
Demolition	\$0	\$0	\$0
Dam	\$182,084	188,115	\$6,031
Locks	\$420,395	\$671,510	\$251,115
Fish & Wildlife Facilities	\$2,025	\$2,260	\$235
Roads	\$0	\$0	\$0
Channels and Canals (river dikes, dredging))	\$43,845	\$112,440	\$68,595
Bank Stabilization	\$7,777	\$0	(\$7,777)
Cultural Resources	\$1,752	\$2,560	\$808
Building, Grounds & Utilities	\$0	\$0	\$0
Equipment	\$606	\$570	(\$36)
Planning, Engineering & Design	\$52,340	\$60,205	\$7,865
Construction Management	\$54,148	\$66,970	\$12,822
O&M	\$0	\$0	\$0
PROJECT TOTAL	\$844,451	\$1,205,750	\$361,299
* 1 October 1991 costs indexed to a FY 2007 price level using CWCCIS composite index (EM 1110-2-1304, 31 March 2000, tables revised as of 30 March 2007). Costs exclude future inflation.			

Figure 9 Lower Mon Construction Cost Increase Breakdown

Note: Risk analysis and independent technical review for updated cost estimate are not yet complete. These numbers may require adjustment based on results.

Factors which may affect the construction cost growth are varied. Appendix 1 defines the array of factors which affect cost growth. Cost growth factors include differing site conditions, Government design changes, omissions from the authorizing (i.e. feasibility) cost estimate, the Continuing Resolution Authority period disruption, the continuing contract clause, and less than optimum funding. For Lower Mon 2,3,4 project, the factors affecting the construction cost growth are shown by percentages in following pie chart.

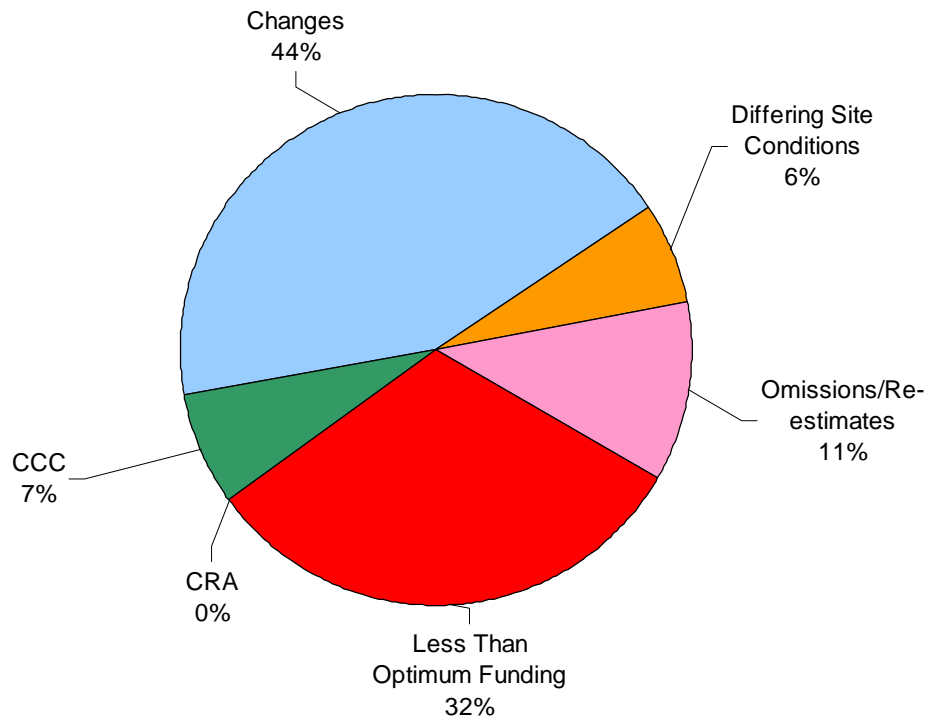


Figure 10 Lower Mon Cost Growth Factors Pie Chart

3.F. DESIGN CHANGES, ERRORS, AND DIFFERING SITE CONDITIONS

Of the cost growth, Government changes accounted for 44%, differing site conditions accounted for 6%, and omissions & re-estimates accounted for 11%.

Government changes include recognition of items that were changed at the request of the government both before and after contracts have been awarded. Items include such things as the change from conventional construction of Dam 2 to “in the wet” construction. This change resulted in unforeseen cultural resource issues at Braddock that increased the construction costs. The majority of costs include design changes at Charleroi required for in the wet construction and the increased construction costs associated with those changes.

Growth under differing site conditions includes those items that are typical to construction contracts such as changes in foundation elevations or excavations. There is a detailed accounting of these costs for completed and current construction contracts.

Growth under the Omissions and Re-estimates factor includes the costs associated with the construction sequence for Charleroi Locks. The feasibility plan included using the middle wall as part of the cofferdam. Upon more detailed design investigations, the condition of the middle wall did not support this plan. The only way to construct the Charleroi Locks is “in the wet”. This in turn does not allow for significant concurrent construction of many of the features and contributed to the delayed completion of the project. The costs associated

with the delay in completion are included in this factor. Design changes and the associated construction costs required for “in the wet” construction are captured under Government Changes.

3.G. FOREGONE NATIONAL ECONOMIC DEVELOPMENT BENEFITS

The Lower Mon Project annually controls the passage of approximately 20 million tons waterborne commerce. The location of this project in the Monongahela River is an important point of the tributary transportation in the Nation’s Navigation systems. None of the potential benefits of this project can be realized until the project is complete. Based on the current project delays of 13 years, \$1.11 Billion in NED benefits are already lost and unrecoverable for the Lower Mon project. If the project continues to be delayed the benefits lost will be exacerbated. Delayed completion of the Lower Mon Project has resulted in the second highest loss of NED benefits among all Inland Navigation System projects and continues to place increased risk on the Corps’ ability to maintain reliable navigation.

3.H. IMPACTS FROM CONTINUING RESOLUTION AUTHORITY PERIOD

Continuing resolutions can be disruptive if project funding is expected to significantly increase from one year to the next and this is usually attributable to the award of a construction contract. To date, this project has not been adversely affected by continuing resolutions, however, continuing resolutions in future years could limit the rate of execution and potentially affect contract execution, increase costs, and delay project completion.

3.I. FULLY FUNDED vs. INCREMENTALLY FUNDED CONTRACTS

The Lower Mon Project has typically used the continuing contract clause for contracts where construction has spanned more than one fiscal year. An assumption has to be made in developing these contracts as to how much funding will be available to support the contract. Funding constraints first affected the Braddock Dam Contract in 1997 when the assumed funding available was not sufficient for one large contract and as a result, L/D 2 (Braddock Dam) was constructed by two separate contracts, one for the abutment and the other for the remainder of the dam. Both of these contracts used the continuing contract clause and appropriations for the contracts were needed in each fiscal year of construction. This situation places risk on the contractor as his funding for each subsequent fiscal year is uncertain. Risk and uncertainty placed on the contractor can result in higher bids. The Lower Mon project funding profile was uncertain; because the funding was uncertain, the acquisition plan was forced to be inefficient by breaking the work into two contracts which stretched the project completion schedule by five years from 2003 to 2008.

Similarly, construction of the Charleroi Locks was planned to be issued as one contract using the continuing contract clause. Again, in 2003 funding constraints (i.e. uncertainty and less than an optimum funding profile) showed that the funding would not be sufficient to support one large contract and resulted in the decision to construct Charleroi with five separate construction contracts. Thus, an uncertain funding profile caused a re-structured acquisition plan, which extended the project completion schedule by an additional 11 years until September 2019.

Since 2006, the project has received optimum funding and the team was able to reconfigure the remaining work into three contracts, resulting in a slight recovery in the schedule to 2016. The three contracts involve the use of a continuing contract and appropriations will be needed to support this work for each fiscal year of construction. If assumptions on available funding change, the plan and completion date will again change.

A fully funded contract provides all funds needed to complete construction at the time the contract is awarded regardless of the length of construction. In this case the assumption is that the contracts do not have to be broken into small pieces to fit a funding constraint. For example, a fully funded Charleroi Locks contract would have been a \$400M - \$500M contract and all funds would have been made available when the contract was awarded. This situation would be ideal with regard to risk and schedule impacts. It assures the stability of the workforce, the contractor's ability to resource the contract and increases his chances to successfully and aggressively perform the work. Fully funding could result in lower contract prices and early completions; however, it requires a large commitment of funding within a constrained national program and large unexpended balances being carried which may not represent the most programmatically efficient use of these funds.

3.J. INCREASED O&M COSTS

The scope of the Lower Mon Project is a two for three replacement which results in the removal of Lock and Dam 3 (L/D 3) and the replacement of the Locks at L/D 4. Removal of L/D 3 was originally scheduled to begin in FY01 with completion of the project in FY04. By the end of FY08, \$11 million of O&M funding will have been invested in additional maintenance and stabilizing Dam 3. The repairs to Dam 3 are not intended as a long-term fix and will only allow the facility to remain in operation at a minimally acceptable level until the current scheduled removal date in 2013. Operational costs at L/D 3 will average \$2.0 million per year. Total O&M additional costs are estimated at \$35 million. The age and condition of L/D 3, however, could still result in unanticipated failures easily surpassing this average by a significant amount.

At L/D 4, the new locks were to be functional in FY 2003. New locks would require minimal maintenance for at least 10 years. However, maintenance at L/D 4 continues and will average \$1.2 M per year for the next 5 years. Total O&M costs due to project delays will add an estimated minimum of \$19 M. These additional costs are included in the foregone National Economic Development benefits discussed in paragraph 3.G above.

3.K. DISRUPTIVE EFFECTS TO CONTRACTORS

In 2004 the first contract to construct the Charleroi Locks was awarded, the River Wall Contract. This contract included a funding profile constraining the contractor to an expected funding stream, which would not support the most efficient construction schedule. Although not quantified, the contractor limited the construction to a constrained amount of funds available annually. The project period was stretched from four years to five years in which the contractor has additional costs including field office management, home office overhead, labor costs, and material costs for the 5th year.

Since the time the contract was awarded, optimum funding has been available. This has created an opportunity to seek a schedule adjustment from the contractor for an earlier completion date. Since the project was bid based on assumptions of less than optimal

annual funding, the contractor had to rework his schedule in an attempt to improve the completion date. Because this constitutes a change to the contract this was at a cost to the government. If funds had been known to be available at the onset of the acquisition process, the project may have benefited with a better contract proposal in terms of both price and schedule.

3.L. PREDICTABILITY OF WORKLOAD AND WORKFORCE

Budget planning begins about two years in advance making workload to workforce planning extremely challenging. During feasibility, the project team develops a plan based on optimum funding. If optimum funds are not received, the team needs to restructure the work at some risk and cost for the less efficient plan. This was the case for the Lower Mon Project in 2003 when Charleroi Locks had to be split into five separate contracts because optimum funding was not provided. When optimum funding has been received the District has been able to successfully meet project milestones.

3.M. BUDGET FORECAST WITHIN 18-MONTH CYCLE

The Project is a 2 for 3 replacement that includes pool level adjustments. The project was also authorized to relocate municipally owned facilities that were affected by the pool changes (+5 feet in pool 2, -3.2 feet in pool 3). Up through the 2009 budget cycle, the Lower Mon Project had many uncompleted components of the project. This allowed flexibility in adjusting the schedule based on the funding received. By 2009, however, most of this work will be completed or fully funded and the flexibility will no longer allow changes to be readily absorbed without significant impacts to the Charleroi Locks construction, i.e. all schedule float has been consumed.

4. OLMSTED LOCKS AND DAM CASE STUDY



Figure 11 Olmsted Locks Progress Photo without Dam

4.A. PROJECT DESCRIPTION

The Olmsted Locks & Dam project, located downstream of Locks and Dam 53 on the Illinois/Kentucky border, was authorized by the Water Resources Development Act of 1988. The proposed replacement structure will eliminate Ohio River Locks & Dams 52 & 53. The project consists of two 110-foot X 1200-foot locks adjacent to the Illinois bank, and a dam comprised of five tainter gates, 1400-foot of boat-operated wickets and a fixed weir. Locks & Dams 52 & 53 were completed in 1929 and the temporary 1,200-foot long lock chambers were added in 1969 at Locks & Dam 52 and 1979 at Locks & Dam 53. The antiquated design and age of these structures make it impossible to meet current traffic demands without significant delays. The existing structures have deteriorated structurally and are overstressed during normal operating conditions. The temporary locks at Locks & Dam 52 & 53 have significantly passed their 15-year life.

4.B. INITIAL CONSTRUCTION SCHEDULE AND COST

Based on the selected plan in the Feasibility Report (dated August 1985), Congress authorized the Olmsted project at \$775 million in the Water Resources and Development Act of 1988. The Feasibility Report assumed a seven-year construction duration starting in FY93. Building of the new Olmsted project would begin with the construction of the locks

on the Illinois shore line and proceed through the tainter gates and on across the river to the Kentucky bank. Approximately two years was estimated to be required to construct the locks. The tainter gates would be built during years three and four. The navigable pass (wicket gates) would require another two years and the fixed weir would be the final stage of construction. Once the locks and dam were completed existing L&D 52 and 53 would be dismantled. The first year that Construction General (CG) funds were appropriated was FY 1991.

Preconstruction Engineering and Design (PED) studies were authorized by Headquarters, U.S. Army Corps of Engineers (HQUSACE) following completion of the Feasibility Report. The General Design Memorandum (GDM) is the initial effort under the PED authority. The GDM was completed in 1989 and increased the construction cost estimate to \$816 million and increased the construction schedule to nearly twelve years. The revised schedule is based on more detailed engineering and the development of a critical path network analysis. The schedule assumed that the Lock construction contract would be awarded in May 1993 and concluded that the project would be operational in January 2005.

In reality the first construction contract was awarded November 19, 1992 for the Access Road and Resident Engineer's Office. The first major contract was awarded May 10, 1993 for the construction of the Lock Cofferdam.

The project management plan broke the construction of the Olmsted project into several construction projects. Prior to each phase of work an acquisition strategy meeting is held to reconfirm that we are using the correct contract vehicle, based on all the known factors, (market conditions, construction techniques, availability of qualified contractors, anticipated supportable funding stream etc) at the time. The current acquisition management plan for Olmsted shows twenty three construction contracts to complete the project. Various programs have been used to execute the work such as: Small Disadvantaged Business Set-aside, 8(a) Set-aside, negotiations, best value and conventional. Sixteen of the contracts are complete, two are under construction and five are future contracts.

Cost Engineering prepared a government estimate for each contract and the project delivery team estimated the construction duration based on the required construction techniques and the anticipated supportable funding stream.

All of the contracts on the Olmsted Project have been firm, fixed price contracts except for the dam construction contract. The dam construction contract was initially advertised as best value firm, fixed priced contract. The District received no bids for this solicitation. The feed back from the contractors as to why we received no proposals included comments such as: the innovative construction methodology, the river condition were too risky, couldn't get bonding, etc. A new acquisition strategy was prepared and approved by the Principal Assistant Responsible for Contracting (PARC). The dam contract was re-advertised as a cost reimbursable contract. Proposals were received and a contractor was selected using the best value process and awarded in January 2004.

To enable comparison of the completed project cost estimate over the years, the budget estimate has been adjusted by the construction cost index and escalated to October 2007 for the Figure 12 graph below. The amounts used for each year is the project cost estimate included in the budget request for that fiscal year. This shows a project cost estimate which was relatively stable until the FY 2005 budget was developed when the estimate jumped sharply reflecting the contractors' proposals for the dam construction. Increases after that are from several factors such as unusual market conditions, extended schedule, revised estimates, etc. all of which will be further explained later.

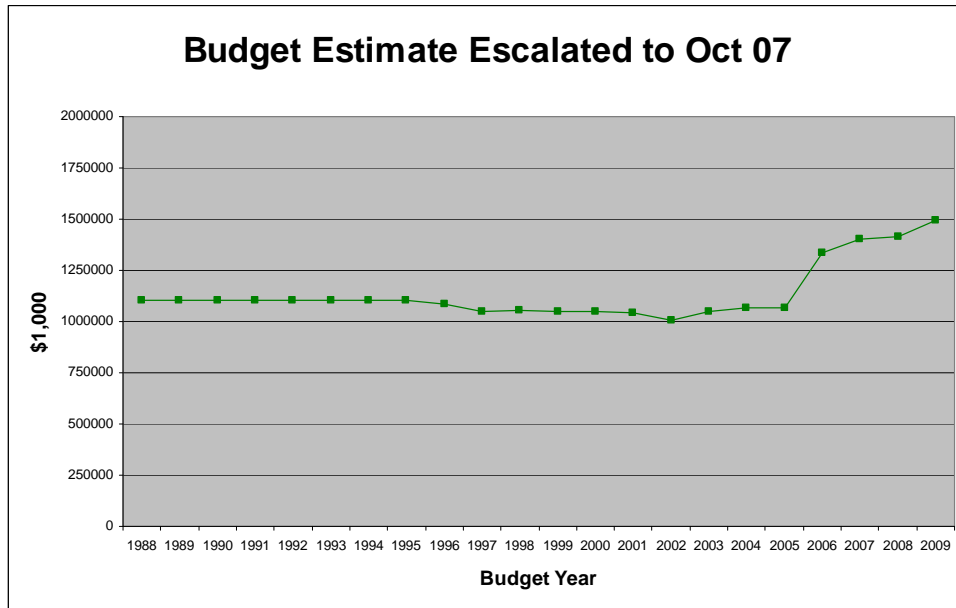


Figure 12 Olmsted Budget Estimate Escalated to Oct. 2007

4.C. DELAYED COMPLETION SCHEDULE AND COST

The current schedule shown below in red includes the actual project funding to date as well as the future optimum funding needs that would bring the locks into operation in 2016 and complete the project in 2018. The Figure 13 graph below shows the GDM optimally funded schedule in blue and compares it to the current schedule. The current schedule costs are based on the FY09 budget cycle.

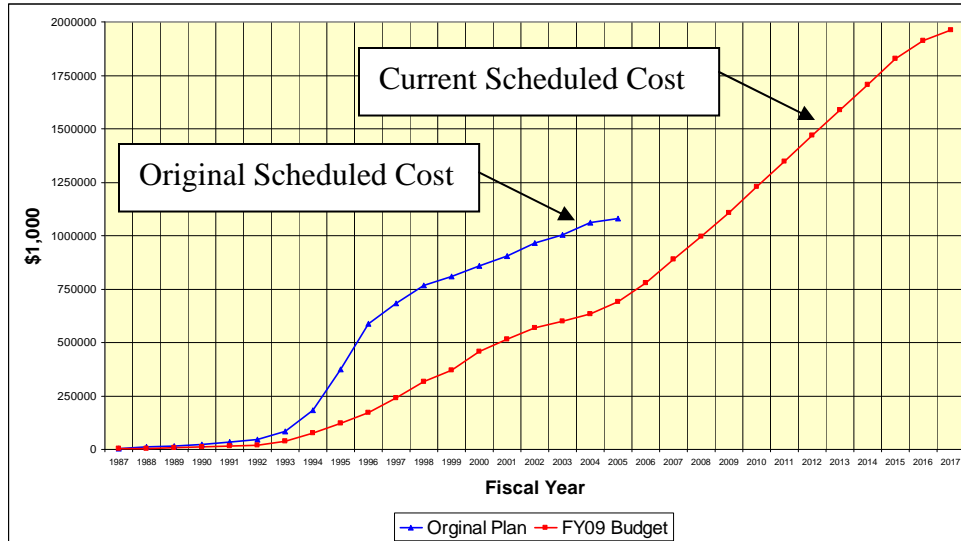


Figure 13 Olmsted Cumulative Original and Current Completion Costs

4.D. MISMATCHED OPTIMUM FUNDING VERSUS FUNDING ALLOCATION

Capability of the project expresses optimum expenditures to maximize construction efficiency. Mismatching funding allocations to less than capability can cause inefficient construction practices with resultant increased construction costs.

Before a project receives its annual funding allocation several steps are involved. The President submits his annual Budget to Congress with recommended funding amounts. Congress considers the President's recommended amounts and prepares the Energy and Water Development Appropriations Bill, which may include adjustments to the amounts. Congress then submits the Bill to the President for approval. In most years the amount listed by project is reduced by savings and slippage, which in some years was sufficiently large as to adversely affect the construction schedule, and in some years a rescission amount is applied. After these adjustments are applied a project receives its initial work allowance.

Another factor that affected the Olmsted project was reprogramming. Prior to FY 2006 the Corps of Engineers was focused on expenditures. When a project was not able to expend its funding allocation for the current fiscal year funding was moved to a project that could expend the funds. In some cases funding was moved to another project to support a higher priority project as determined by upper management to maintain progress. Reprogramming was an effective tool used to execute the Construction General appropriation using logic that reprogramming might cause a delay in one project but it prevented a greater loss in another project. Reprogramming was curtailed significantly starting in FY06 in accordance with the Energy and Water Development Appropriations Act and accompanying Committee Reports.

From FY 1992 thru FY 1999, \$67 million was moved off the Olmsted project; from FY 2000 thru FY 2002, \$91.3 million was moved back into the project; and from FY 2003 through FY 2005, \$47.2 million was moved off the project for a net change since Construction General Appropriations began for the Olmsted project of a \$22.9 million loss.

Approximately \$20.6 million was moved to the Mc Alpine project to cover its funding shortfalls.

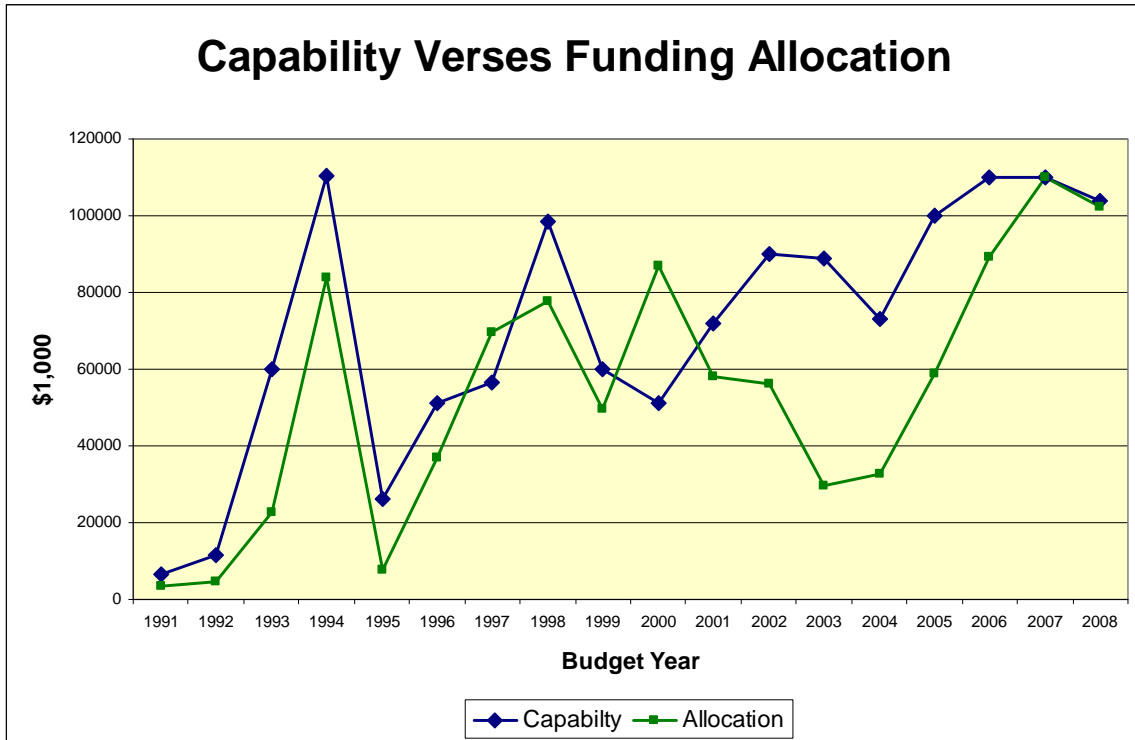


Figure 14 Olmsted Capabilities vs. Funding Allocation

The Figure 14 graph shows the optimum funding (capability) vs. the actual funding received (funding allocation). As evident in this graph the Olmsted project was significantly under funded from 2001 thru 2006.

Performance based budgeting, which replaced the previous Corps practice of ceiling based budgeting, has had a significant, favorable impact on Olmsted’s progress. Since performance based budgeting started, the Olmsted project has been recognized for the value of investment as a National Priority Project and progressed in the President Budget at its optimum funding level in FY 2007 thru FY 2009.

4.E. ESCALATED PROJECT COSTS

As the duration of the construction schedule increased, project costs have escalated as well. The most recent total estimated cost of the project is \$1.99 billion (1 Oct 2007 price level) with completion scheduled in year 2018, an increase of \$736 million above the original estimate.

The table in Figure 15 summarizes all the cost by feature of work and shows the current estimate by feature as well as the difference in each feature. The column labeled “Authorized” is the 1988 authorized amount of \$775 million inflated to October 2007. The process used to inflate the authorized costs to the current 1 October 2007 price level is outlined in ER 1105-2-100 Appendix G, Amendment 1 dated 30 June 2004, pages G-64 to G-78. In summary the ER says to inflate the cost using the following:

1. The construction components of the authorized cost are updated using historical feature inflation factors as illustrated in the Civil Works Construction Index System (CWCCIS), EM 1110-2-1304 dated 30 September 2007, pages A-7 to A-19.
2. The real estate components of the authorized cost were updated to account for historical inflation based on changes to the Consumer Price Index, not seasonally adjusted, U.S. city average, based period 1982-84 equaling 100, as displayed by the U.S. Department of Labor, Bureau of Labor Statistics.

With a delayed completion schedule, unexpected material escalation may drive cost increases. The chart shown in Appendix 2 from the US Department of Labor, Bureau of Labor Statistics shows a steady increase in construction materials until 2004. After 2004 construction materials increased significantly more than in the past. Some portion of these cost increases may have been avoided by executing the construction following a more efficient schedule.

With the scheduled completion extended, the construction management and engineering during construction resources are extended similarly. Thus the cost of this feature of work increased. The original estimate for construction management was \$48.5M and the current estimate is \$95.8M; this had a \$55.4M increase on the overall project cost. Similar increases were incurred in the Planning, Engineering and Design (PED) costs.

Feature	Authorized*	Current	Difference
Lands	\$494.0	\$6,056.0	\$5,562.0
Relocations	\$4,399.6	\$1,594.0	-\$2,805.6
Demolition L&D 52&53	\$6,188.4	\$12,610.0	\$6,421.6
Dam	\$611,467.7	\$933,065.0	\$321,597.3
Locks	\$496,544.6	\$442,271.0	-\$54,273.6
Fish & Wildlife Facilities	\$0.0	\$11,692.0	\$11,692.0
Roads	\$964.0	\$3,173.0	\$2,209.0
Channels (river dikes)	\$11,481.8	\$26,942.0	\$15,460.2
Bank Stabilization	\$1,518.6	\$7,722.0	\$6,203.4
Cultural Resources	\$0.0	\$3,210.0	\$3,210.0
Building, Grounds & Utilities	\$2,438.9	\$36,017.0	\$33,578.1
Equipment	\$12,232.5	\$42,015.0	\$29,782.5
Planning, Eng. & Design	\$58,780.7	\$114,136.0	\$55,355.3
Construction Management	\$48,512.1	\$95,777.0	\$47,264.9
O&M	\$0.0	\$4,011.0	\$4,011.0
Contingencies	\$0.0	\$250,709.0	\$250,709.0
PROJECT TOTAL	\$1,255,022.9	\$1,991,000.0	\$735,977.1

Figure 15 Olmsted Feature Cost Comparisons (\$1,000s)

Figure 16 is a pie chart which displays the factors causing the \$736 million total cost increase as percentages of the total project cost increase. Appendix 1, “Factors Affecting Project Cost Increases” contains the definitions for the seven factors shown in the pie chart.

Factors which may affect the construction cost growth are varied. Appendix 1 defines the array of factors which affect cost growth. Cost growth factors include differing site conditions, Government design changes, omissions from the authorizing (i.e. feasibility) cost estimate, the Continuing Resolution Authority period disruption, the continuing contract clause, and less than optimum funding.

Typical cost growth (including differing site conditions, Government design changes, and omissions from the authorizing cost estimate) occurs on most projects and the Corps manages the changes in accordance with the project management plan. This is the biggest share of the increase for the Olmsted project accounting for approximately 69% or approximately \$508.6 million.

Non-typical cost growth (Continuing Resolution Authority period disruption costs and the continuing contract clause impacts) occurs outside of the Corps’ control or could not be anticipated thus were not included in the feasibility cost estimate. These factors collectively are relatively minor for the Olmsted project costing the project less than \$1 million or approximately 0.1%. The Olmsted Dam contract contains the true CCC and funding is provided annually based on the appropriation for that fiscal year. In FY 2006 all contracts that contained the true CCC had to be changed to the special CCC or converted to a fully funded contract. The Olmsted Dam contract was granted a waiver and was not required to modify the dam contract to incorporate the special CCC.

Less than optimum funding causes project cost increases and schedule delays. In the case of the Olmsted L&D over the years the lack of optimum funding resulted in delayed contract awards and increased contract durations to conform to the funding received thus the cost increased. The delay in constructing the Olmsted dam shifted the work to a time with unusual escalation thus even more cost increases. The total cost of less than optimum funding is approximately \$226.5 million.

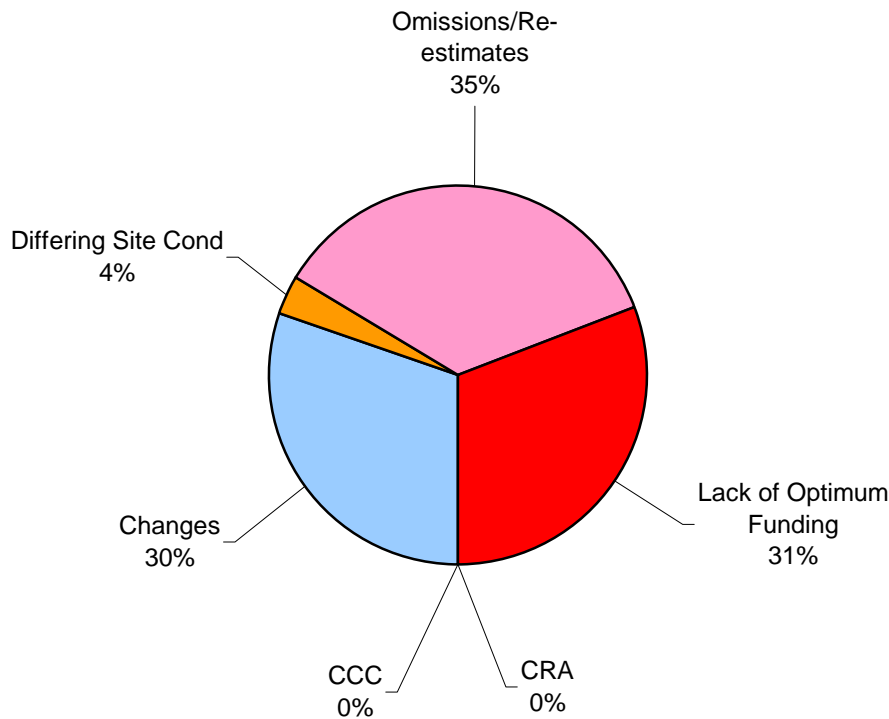


Figure 16 Olmsted Cost Growth Pie Chart

4.F. DESIGN CHANGES, ERRORS, AND DIFFERING SITE CONDITIONS

Of the cost growth, Government changes accounted for 30%, differing site conditions accounted for 4%, and omissions & re-estimates accounted for 35%. There were changes during design and construction to deal with subsurface unknowns, environmental influences (floods, hurricanes, etc.), changes in laws, the economy, errors, and omissions.

Differing Site Conditions

The Project is located in an area which complicated the design and construction efforts. One of these complications was the presence of artesian water pressures which had to be understood and then accounted for in design and construction. The artesian pressures were different depending on the natural layers of foundation material. These pressures made designing for dewatering a lock or dam element more difficult and required more foundation piles for that load condition. It was necessary to understand the natural site conditions more precisely and how they varied from one location to another.

The foundation design was complicated even more than has been noted above by difficult driving conditions. Earlier construction at Locks and Dam 53, just upstream of the Olmsted Project, had revealed the difficulty in driving foundation piles to the depth required to safely resist applied loads. At Feasibility Report stages of design, the foundation piles were to be auger cast to help address this known difficulty. However, the extreme seismic loads and the need to provide as much flexibility in the foundation system as possible led to the need to switch to steel H-piles in lieu of the auger cast piles. The problems required more intensive pile test programs, gathering more data while driving the

test piles, and more sophisticated analysis of the test data. This knowledge was then applied to the design of the foundations for all of the Locks and Dam structures. The site condition difficulties were exacerbated when an active slide was observed during monitoring of the Illinois bank at the site of the locks. Defining the extent of the slide problem and determining the best solution required much additional effort. These problems have also added to the effort required to design and build the boat mooring area and the pre-cast yard and marine launching facility to move the very large shells from the pre-cast yard to the river.

Another differing site condition dealt with the construction of the Spare Gate Storage Facility, additional material had to be removed in order to get access to the facility above that shown on the bid documents.

Omissions and Re-estimates

1. Additional Real Estate Costs

The land required for the boat ramp, spoil area, and mitigation lands were not included in the scope at project authorization. Initial plans were to relocate the Village boat ramp to Lock and Dam 53; however, it was determined that a new site had to be acquired. The Cooperative Agreement between Kentucky Department of Fish and Wildlife Resources (KDFWR) and Department of the Army required the acquisition of approximately 2,000 acres for mitigation. Due to a requirement included in the Supplemental EIS spoil material from the river can not be disposed of in the river thus an upland disposal area was acquired.

2. Gate Prototype Facility

Due to the unique nature of the Olmsted navigable pass section of the dam, it was deemed necessary to construct a full size operating model of the wicket gates. At that time, the wicket gates were to be hydraulically raised and lowered and were to be a part of the 2,200-foot long navigable pass/flow regulation dam. This test allowed the function and durability of the operating equipment as well as allowing various materials to be tested. The facility added a construction cost of \$19.0 million dollars. Additional costs were added to PED to run the testing program and to evaluate results. Additionally demolition of this facility was not included in the original estimate.

3. Dam Construction Contract Re-baseline – The dam contract is a cost reimbursable contract. The contractor's proposal was prepared in 2003 and included costs for normal escalation through the proposed contract completion date. Under this type of contract the contractor gives the government his best effort to construct the facility for the proposed cost. As the details of constructing the Olmsted dam have developed the contractor has determined that he under estimated or omitted cost for some activates yielding an increase in his estimate to complete. In addition since the award of this contract, there has been much higher than anticipated escalation that has caused significant cost increases beyond normal escalation. Factors such as hurricanes, war, fuel prices, and changing patterns in world trade, e.g., growth in demand for concrete in China, have affected market conditions. Factoring these market conditions into a major construction contract like this yields very large estimated cost increases. Due to the nature of this contract, the government rather bore responsibility for these cost increases, rather than the contractor. Therefore, the large cost increase does not necessarily indicate that the cost estimate developed during PED was faulty.

Funding constraints have forced changes in the design/construction sequence of the dam. In an attempt to stay within the anticipated funding, the Olmsted PDT reduced the size of the precast yard and increased the number of low water seasons for setting the shells in the river.

4. Environmental Considerations in Recommended Changes

An Environmental Assessment/Finding of No Significant Impact was prepared to address the in-the-wet construction methodology not covered in the EIS. This document was completed and circulated to the public in June 2002. In the course of complying with the National Environmental Policy Act and all other laws and regulations governing impacts of the Locks and Dam Project, a mitigation plan was developed and approved by state and federal agencies. A Cooperative Agreement between the Corps of Engineers and the Kentucky Department of Fish and Wildlife Resources was signed in September 1992. This agreement led to the construction of facilities on Ballard Wildlife Management Area providing water management capabilities on 1,400 acres and provision to fund annually the Department's cost for monitoring construction related impacts to the bald eagle and migratory waterfowl. Compliance with Section 7 of the Endangered Species Act resulted in the design and installation of a sediment scour and deposition system in the Ohio River. As a result of continued operation and maintenance problems with the system, a review of observed data both from the system, diver monitoring surveys, hydrographic mapping of river bottom conditions by St. Louis District, computer modeling of impacts by the U.S. Geological Survey, and changes in construction techniques, the U.S. Fish and Wildlife Service and the Louisville District agreed to revise compliance with Section 7 such that the scour and sediment monitoring system was removed from the downstream area. (It is still used to monitor the same conditions around the actual construction site and other such construction sites in streams.) The Corps now provides funding to support research, propagation, and monitoring of freshwater mussels, including threatened and endangered species, especially those that would be impacted by the Project. Annual diver and hydrographic monitoring surveys also continue. These requirements and/or activities were not originally anticipated as neither the bald eagle nor any endangered mussels were known to occur at the Project site prior to the late 1980's.

5. River Dikes

Model studies which were accomplished throughout the design period indicated that dikes were needed to facilitate navigation into and out of the lock chambers and to help control sedimentation around the Locks and Dam. These rock structures were tested in the model facilities and were determined necessary to produce desired conditions. The construction of these dikes will not be executed until the dam construction is complete.

6. Illinois Bank Stabilization

The geologic history of the Olmsted Project site is very complex. The region has been subjected to uplift, subsidence, and tectonic movement. After approval of the Feasibility Report Plan, an intensive geotechnical investigation program was initiated. This included, in part, additional borings to determine the makeup and strengths of the existing materials at the Olmsted site. A program to monitor movement of the relatively steep Illinois bank was also put in place. This monitoring indicated that an active slide existed in both the upper and lower Illinois bank at the site of the locks. Dewatering this area to allow construction of the locks would produce an unacceptable condition. As additional

information was gathered, and as input for the design solution was received from numerous outside expert consultants, the recommended solutions progressed from stone columns in the GDM Supplement to a “mass excavation” alternative presented in the Foundation DM#5 Supplement. This solution involved excavating approximately one million cubic yards of material from the upper slope and approximately 600,000 cubic yards of material from the lower slope. It also necessitated acquisition of an abandoned clay mining pit adjacent to the site to allow spoiling unsuitable material. About 1.5 million cubic yards of engineered fill material was then required to construct the service building mound. The service mound serves as a buttress to strengthen the Illinois bank slide repair and will serve as the future location for the Olmsted service facilities. The service mound is greatly increased in size compared to the structure envisioned in the Feasibility Report. Costs associated with these changes were reflected in the Lock DM#7 with a cost estimate of \$18,443,000 (October 91) for Bank Stabilization; none was included in the Feasibility Report. The bank stabilization work was accomplished in the lock cofferdam construction contract.

7. Cultural Resource Preservation

No funds for historic structures or archaeological resources encountered at the Olmsted Project were included in the original estimates of cultural resources work. The early Olmsted cultural resources consultation/studies examined various portions of the Project site and identified both historic structures and archaeological resources. As none of these were deemed to be significant, no further coordination or development of mitigation strategies was required. It was noted in the EIS that full compliance with the National Historic Preservation Act would be completed after Project authorization. This was because there were a few cultural resources issues identified by the Illinois and Kentucky State Historic Preservation Officers that still needed to be addressed. None of the identified issues had to do with L&D 52 and 53 or the associated land-based structures.

Cultural resources requirements changed when, during 1987 - 1988, L&D 52 and 53 were both identified as historic properties and it was determined that the Olmsted Project would have an adverse effect on them. The identification of these historic resources was not foreseen. Lock and Dams 52 and 53 were not identified as a cultural resources issue by the Feasibility Report (1985) or by the Chief's Report (August 20, 1986). They were not identified until July 1988 as eligible resources that would be adversely affected by the Olmsted Project. They were officially recognized as eligible resources with the signing of Consensus Determination of Eligibility forms on November 17, 1988 the same day that the Water Resources Development Act of 1988 was approved.

Ways to mitigate the adverse effect of the Project on the historic structures will be addressed in a Memorandum of Agreement (MOA). Seven actions to mitigate the adverse effects are currently being discussed but have not yet been finalized.

8. Miter Gate Storage Yard

After authorization of the Olmsted Project, the Louisville District procured a large “Gate Lifter” crane which altered the way that the lock miter gates will be maintained. This equipment now allows the large gates to be lifted intact from the chamber for repairs, painting, and other maintenance, thus minimizing the negative effect of those actions on the navigation traffic. To fully utilize this procedure, a gate storage facility was needed which

would allow setting the gate leaves on a facility located on an area of the river bank that was reachable with the massive load.

A spare set of miter gates was fabricated as part of the lock construction contract. In order to properly store these gates and to have them ready to replace an operating gate, the spare has been assembled and hung on a pier accessible to the river. The storage facility was not included in the feasibility estimate.

9. Buildings, Grounds and Utilities

The cost for Buildings, Grounds, and Utilities increased from \$1.2 million in the Feasibility Study to \$24.5 million currently (excluding the Gate Storage Facility). The Feasibility Report Plan included only an Operations Building and a Service Building. The complexity of the site and the additional facilities which are required to operate and maintain the Locks and Dam were the reasons for the increase. The final plan includes an Administration / Visitor Center which is designed to energy-saving standards, a Visitor Overlook with parking and other facilities, as well as a service/maintenance building and a storage building. The current plan includes a Resident Engineer's Office which will be converted to a facility to store and repair elements of the dam. There were added costs to provide for an esplanade along the locks and for added grounds facilities to accommodate the extensive floating plant. This area also allows access and a wharf-type facility to load and off-load wickets and other elements of the dam that would be needed during semi-routine maintenance of the dam. The mooring area also complicated the slide repair efforts. The cells served to strengthen that area of the hillside.

10. Feature Code 20, Permanent Operating Equipment

Equipment which is required to operate the Locks and Dam increased from that in the Feasibility Report Plan. This increase was necessary to provide the wicket lifter barge and towboat to raise and lower the navigable pass wickets, maintenance bulkheads, washdown barge to safely and efficiently clean the lock walls after being inundated each high water season, and other miscellaneous equipment. The Feasibility Report Plan required only a small tender and barge which is still required and has already been procured.

11. Planning, Engineering & Design and Supervision & Administration

The feasibility estimate did not include the PED efforts nor the S&A efforts for the above requirements and thus these estimates have been increased.

12. Maintenance of Completed Work

Portions of the Project were completed in 2001 such that it became necessary to add maintenance staff to take care of the completed work. Until the project is opened for navigation traffic and is operated and maintained by Operations Division, the Olmsted Project is responsible for funding maintenance of the completed work. This cost was not included in the feasibility estimate. Currently, it is estimated that the O&M account will begin paying these costs in FY12.

13. Risk Management (Contingencies)

Remaining Project contingencies were developed primarily from two calculated methods/sources. The first method/source is a straightforward contingency percentage applied to the running Estimated Contract Cost for each of the remaining features of work yet to be awarded. In accordance with UFC 3-700-02A, a contingency percentage of 5% was deemed applicable based upon the types of remaining work, significant design development, and minimal apparent risk. It is noted that this assessment was performed concurrently with a construction estimate “update” for all the remaining project contracts.

The second method/source, and more significant in magnitude, is the calculated contingency for the on-going Dam Contract. Given the unique pricing characteristics of the cost-reimbursable contract vehicle, which was used to award the Dam Contract, the Project Delivery Team (PDT) decided to build upon the ongoing Risk Management Program employed at Olmsted as part of the Construction Management activities. This Program established Government-Contractor teams to identify risk items and quantify their probability of occurrence and associated cost impact. This exercise yielded a weighted point estimate of approximately \$295,047,000 in potential contingency costs associated with the identified risk items with the largest being “craft productivity” followed by “funding stream interruption.” After further discussion with the PDT, it was agreed that some of the identified risk items could be mitigated in advance and some, by their nature, had an overlapping effect such as “impact to schedule.” Therefore, each team was tasked with going back and assessing each individual risk item based upon this criteria by application of “mitigation” and “schedule” discount factors yielding a new overall contingency point estimate (most likely) of \$195,294,000.

After briefing MG Riley and ASA (CW) Woodley on 14 June 2007, it was recommended that the new Cost Risk analysis – which was to be implemented Corps-wide 1 October 2007 – be applied to this effort as well, and that Walla Walla Cost Estimating Design Center of Expertise (DX) be brought on-board to perform the analysis. Walla Walla’s subsequent review recommended the concept and application of an 80% certainty factor be applied to the calculated forecasted values developed from the LRL inputs yielding an expected value of \$223,500,000 (80% confidence level). It is noted that this certainty factor has been established by practice as no formal guidance has been published to date. It is also noted that the DX had no objection to the structured approach proposed by LRL to recognize risk items and derive the remaining contingency allowance on this basis. After LRL’s review of the DX’s input/comment and discussions with Senior Leadership, the PDT recommend adopting \$223,559,000 as the forecasted amount for the remaining Dam Contract contingency value used in this request.

Also included in the contingency total are funds for the bulkhead claim as well as contingencies on non-contract work such as the cultural resources, construction management, and planning engineering and design activities. The total increase in contingencies is estimated at \$237,405,000.

Government Design Changes and Construction Modifications

Government design changes did occur. Government changes include recognition of items that were changed at the request of the government. The changes on the awarded contracts to date can be classified as \$117,139,879 for design changes, \$22,607,431 for differing site

conditions, a savings of \$644,285 through the Value Engineering Contractor Proposals, and \$47,290,067 paid in contractor claims.

The cost increases are further explained in the following paragraphs. Since the initiation of construction, there have been \$298,072 in contract modifications associated with the access road and Resident Engineer's Office; \$16,402,254 in contract modifications associated with the slide repair and cofferdam; \$50,655,795 in contract modifications associated with the locks; \$13,595,334 in contract modifications associated with the approach walls; \$3,890,782 in contract modifications associated with the prototype; \$297,344 in contract modifications associated with the water management facilities at Ballard Wildlife Management Area; \$14,628 in contract modifications associated with the boat ramp; \$470,785 in contract modifications associated with the maintenance and operating bulkheads; \$3,153,117 in contract modifications associated with the spare gate storage facility; \$500,703 in contract modifications associated with the down stream mooring cells; and \$344,493,516 in dam modifications.

4.G. FOREGONE NATIONAL ECONOMIC DEVELOPMENT BENEFITS

\$4.5 billion NED benefits are already unrecoverable for Olmsted. If further delays occur (such as unforeseen weather conditions, higher than normal river conditions during the low water season, the contractor fails to execute the work, less than optimal funding is received, etc.), the benefits foregone will be exacerbated. The location of this project in the lower Ohio River annually controls the passage of approximately 94 million tons of waterborne commerce. This location is one of the most crucial points in the Nation's Navigation systems to attain efficiency enabling an optimum contribution to the Nation's economic development. None of the potential benefits of this project can be realized until the project is complete. Olmsted's completion delay has caused the highest loss of NED benefits among all Inland Navigation System projects. Figure ES1 in the Executive Summary shows that Olmsted accounts for the highest loss of benefits to the Nation of all (not just the three in this case studies paper) inland Navigation construction projects to date.

4.H. IMPACTS FROM CONTINUING RESOLUTION AUTHORITY PERIOD

If the new fiscal year begins under a Continuing Resolution, providing funds timely to obligate to the contract is paramount. At the beginning of FY 2007, the Execution of the Annual Civil Works Program Circular restricted the amount of funding that could be obligated to a contract containing the continuing contract clause. This constrained funding during the first quarter of FY 2007 and caused the shut down of field construction activities for almost three months. Besides the usual effects on the project of delays and added cost, there are other impacts. The projects cannot be instantly stopped or started. When funds are short, the project must start slowing down at least a month in advance to tidy everything up for the complete shut down. When funds do become available it is not an instant return to full production. These types of "stop and starts" greatly impact the execution of the project. The Execution Circular has been revised and funding at the start of FY08 did not restrict the contractor's performance.

4.I. FULLY FUNDED vs. INCREMENTALLY FUNDED CONTRACTS

Fully funded contracts would have assured the stability of the workforce, the contractor's ability to resource the contract and increase his chances to perform the work on or ahead of schedule. Since there is no assurance of the amount of funding each fiscal year on an annually funded contract the contractor's tend to pace their work to assure no work stoppages. This methodology does not encourage early completions.

Typically when working in the river there are certain ideal stopping points for construction from the end of one construction season until the beginning of the next construction season. Funds must match the amount of work anticipated to be completed each season; otherwise, the completed work is subject to damage by high water. On the Dam contract the design for these construction stopping points from season to season was changed (four to six seasons) to match the total funding anticipated for the year. Two low water construction seasons were added to the dam contract for the in-river work and the associated cost. Since the number of shells needed for a season was reduced we were able to reduce the size of the precast yard.

4.J. INCREASED O&M COSTS

Olmsted locks were completed and now must be maintained until the locks become part of the O&M budget currently estimated for FY 2012. Maintenance started in late FY 2001 when the locks were substantially complete. The Olmsted Locks maintenance cost is estimated at \$440K annually for locks only. For the 10 years until Olmsted is complete, this cost totals approximately \$4.4 million.

Locks and dams 52 and 53, which are being replaced by the Olmsted Project, must be operated and maintained until Olmsted is completed. These two antiquated structures require maintenance funds that could have otherwise been spent on other existing projects which are expected to have a long remaining service life. Instead, the O&M budget continues to be responsible for L/D 52 and 53. Due to Olmsted not being completed by the optimum original year 2005 and now projected to 2016 to complete the dam construction (overall project completion 2018), L/D 52 and 53 are expected to impose a burden to the O&M budget, totaling \$77.1 million for this period.

The total O&M cost (Olmsted locks plus L/Ds 52 & 53) which is attributable to delays caused by Olmsted L&D not coming on line as currently scheduled is estimated at \$81.5 million. These additional costs are included in the foregone National Economic Development benefits discussed in paragraph 4.G above.

4.K. TIMELINESS OF CONTRACT AWARDS

While funding allocations generally lagged behind project capabilities in the initial years, sufficient funding was provided to execute the project through FY 1998. Since FY 1998, appropriations have lagged further behind the capabilities of the project. The Olmsted project has experienced cost overruns or escalation on the four critical path contracts that could have been started early or constructed faster but for the constrained funding. Funding constraints have affected and delayed the timely award of contracts, which then caused the award amounts to escalate.

The bidders for the dam were required to submit a schedule and funding stream with the proposal. The mobilization costs in the initial years of the contract were so great and could not be supported with the funding stream being provided at the time in the budget process. An amendment was sent to the bidders and limited the funding in FY 2004 to \$17.5 million and \$80 million thereafter. This increased the contract duration and increased the estimated cost to construct the dam. This funding expectation was not met in FY 2004 or FY 2005 thus the project was extended two years and budget was increased \$52 million.

Each year this contract is not properly funded generally results in additional delays to the contract due to the sequence of the work. The work in the river for the Olmsted Dam construction is very linear with few dual paths. Thus, any delays are generally critical in nature.

4.L. PREDICTABILITY OF WORKLOAD / WORKFORCE

Because of constrained funding we have lost key technical personnel to other projects and other contractors. People generally do not like waiting around to begin work; they get discouraged and leave. Constrained funding affects the morale of the entire team (Contractor and Corps).

4.M. BUDGET FORECASTING

A significant challenge is planning the work in the out years. On long term contracts the schedule must include the construction activities for the entire contract period. It is difficult to reliably plan the work budget two years out much less four or five years. Decisions are made about when to purchase equipment and how large to build; the precast yard is an example. These decisions are based on an anticipated but uncertain funding stream. The next year when that anticipated funding stream is not recognized (either more or less funding) the previous decisions appear to then be wrong.

Uncertain funding stream for construction causes assumptions to be made for funding streams, and construction decisions which must be made often result in construction cost increases. Decisions are made with the best information available at the time based on one set of funding assumptions. Once implemented the die is cast and very little can be done to change the original implemented decisions without schedule and cost impacts.

5. SUMMARY AND CONCLUSIONS

5.A. Summary of Completed Task.

The study identifies and quantifies the time and cost impact of various factors on three representative inland waterways projects. While not all inclusive, the case studies provide some good insights on areas where time and cost escalation might be mitigated with improvements in management practices.

Each of the sections within the three case studies reveals lessons learned; these lessons are summarized concisely for each section below. The facts presented in this white paper support the conclusions as summarized.

1. Initial Construction Schedule and Cost. The initial schedule and cost of the project are based on the presumption of optimum funding. The starting date of construction depends upon the initial appropriation date and assumed authorization of construction funds. Improvements in the Feasibility level estimates for cost and schedule could have recognized risks in the schedule and cost would have been included in the Feasibility estimate. A Risk Analysis performed during the Feasibility Study should consider the effects of less than optimum funding. In future projects, the Corps has mandated the use of cost risk software to consider risk potentials for all feature accounts in items such as adequate funding, potential schedule growth, escalation beyond the OMB forecasts, market conditions, scope growth, etc. In addition, all estimates undergo Independent Technical Reviews and oversight by the Cost Engineering Center of Expertise for Civil Works in Walla Walla, Washington.

2. Delayed Completion Schedule. Delays in the project completion are expected if the funding is not provided in accordance with multi-year optimum funding schedules; the delay may be several years beyond the duration stated in the original project feasibility report.

3. Escalated Project Costs. Project costs will escalate as the projects are delayed; both management costs and construction costs will rise, and may be very significant with long delays in project completion.

4. Foregone National Economic Development Benefits. The NED benefits foregone have been shown to be in the billions of dollars for the large inland Navigation construction projects; the benefits are lost (foregone) when completions are delayed for any reason.

5. Continuing Contracts Clause Change. The change from the “Traditional” Continuing Contracts Clause to the “Special” Continuing Contracts Clause contributed to project cost increases.

6. Fully Funded Contracts vs. Incrementally Funded Contracts. Fully funded contracts improve the Government’s and the contractor’s ability to provide adequate resources to perform the contract and increase the probability that the work will be performed as planned. Annually funded contracts will force inefficient construction since year to year funding levels are not assured.

7. Increases in O&M Costs. O&M costs for the projects being replaced will continue to increase if the older projects have to be maintained past their economically viable life. O&M funding must be applied to sustain the viability of the projects being replaced if the new project's completion is not realized on time.

8. Timeliness of Contract Awards. Less than capability funding has affected and delayed award of contracts which then caused award amounts to escalate.

5.B. Issues to be Resolved.

These case studies revealed the dramatic impact to the nation in the form of cost growth and lost benefits resulting from construction delays. Recognizing these issues, defining the underlying causes, and understanding the economic impacts are the first steps in seeking a resolution. Primary issues for which resolution is needed and which the case studies reveal are the following:

1. Initial Construction Schedule and Cost
2. Delayed Completion Schedule
3. Escalated Project Costs
4. Foregone National Economic Development Benefits
5. Change in the Continuing Contracts Clause
6. Fully Funded Contracts vs. Annually Funded Contracts
7. Increases in O&M Costs
8. Timeliness of Contract Awards
9. Adequate Site Investigations during Feasibility and Design Phases

5.C. Future Goals.

These case studies revealed significant inefficiencies and fostered discussions for an improved process. The following goals of the future efficient process are offered for consideration:

1. Continued long-term project prioritization for infrastructure capital improvements.
2. Program management of the funding to ensure that priority projects are constructed efficiently.
3. Commitment to an appropriate schedule and project funding stream throughout the project life.
4. Realistic, achievable, accurate, and risk-based estimates of project costs and schedules at the completion of the Feasibility report.
5. Improve project management during design and construction to ensure efficient, cost effective project completion and uninterrupted construction start-to-finish.
6. Realizing project benefits as predicted in the Feasibility report and as scheduled from the point of initiation of design and construction.
7. Efficiently build infrastructure.

APPENDIX 1: FACTORS AFFECTING PROJECT COST INCREASES

Purpose: The following factors may increase construction costs in excess of the authorized project cost. The definitions and examples provided herein are intended to define these factors.

Continuing Resolution Authority Impacts – This item includes the amount the project could potentially be increased by the disruptive effects of the Continuing Resolution period before an annual appropriation is enacted. These costs cannot be estimated in the feasibility stage before authorization.

- Efficient construction may be restrained during a Continuing Resolution; this restraint has the effect of precluding efficient construction and may result in increased construction cost and time.
- Historically, project funding during Continuing Resolution has been constrained by some combination of the lesser of the President's Budget, Senate and House reports or a percentage thereof. This may or may not impact construction.
- The duration of the Continuing Resolution has not been of such extended duration that the planned project expenditures would exceed the continuing resolution authority.
- During the extended continuing resolution of FY 2007, additional guidance restricted project funding to 90 percent of the lesser of the value provided in the House or Senate Report allocated by a linear daily calculation.
- Although Continuing Resolution Authority (CRA) restricts the appropriation to the previous year and not restrictive by project per se, the CRA may be disruptive if project funding is expected to significantly increase in the budget year. If the project funding needs are on an uphill trend typically occurring near the beginning of a project, an increase in the project funding may be constrained to the previous year. Results of the constraint in this case will inhibit the efficient construction funding and may preclude an efficient contract award.

Government Design Changes and Contract Claims – This item includes the amount caused by design changes issued by the Government to be reasonable and prudent to improve the finished project in the Federal interest, which may be a VECP (Value Engineering Change Proposal), a request for equitable adjustments, or contractor claim.

Differing Site Conditions – This item includes the amount caused by post-award discovery of field conditions which were not indicated in the design documents such as subsurface conditions, utilities, river conditions, etc.

Lack of Optimum Funding – This item includes the amount caused by inefficient contracting resulting directly from the project not receiving its capability funding (i.e. less than optimum funding). Factors which forced contracting delay in the advertisement and/or award or forced extension of the contract performance period beyond the authorization and are solely attributable to less than capability funding include the following:

- Limited funding to efficiently accomplish a particular construction phase.

- Limited funding to efficiently fabricate, assemble, or install facilities used in the construction process.
- Limited funding to efficiently maintain the contractor's work force per the contractor's efficient construction schedule.
- Forced reduction to less efficient contract acquisition strategy (increased in the number of contracts above the original plan).
- Increase in contract management for keeping the contractor & government staff on site.
- Extending real estate acquisitions created after the authorized construction project period.
- Forced contract work scope increases solely attributable to changed conditions after the authorized contract period expires; this includes ancillary equipment and services necessitated due to conditions which did not exist during the authorized project construction period and which not have been costs incurred by the Government.
- Unusual Escalation - This item includes the project cost increase forced by abnormal or unusual cost escalation after the authorized construction project period. Delays to contract awards and lack of funding to construct on an efficient schedule pushed the contract into a timeframe, which witnessed significant increases in market conditions (war, fuel prices, hurricanes, steel, cement, etc.). These increases would have been avoided if the contract was awarded earlier per the construction authorized schedule and had performance not been further delayed by less than optimum, capability funding. Examples of these unusual market conditions which cause escalation beyond the original assumptions substantiating the authorized project cost estimate may include the following:
 - The contractor was delayed in mobilizing the necessary equipment to construct the project and forced to mobilize during a time when it was more expensive to lease plant including barges and cranes.
 - Competition amongst bidders may be minimal due to market conditions. A premium may be associated with fewer bidders, project location, risk, etc.
 - The heavy demand in the civil construction market maybe a factor in the number of available contractors within the region.

Continuing Contract Clause – The traditional continuing contract clause allowed a contractor to continue work after funds were exhausted in the current fiscal year. Continued work by the contractor was financed by the contractor and interest was paid by the Government when funds became available. The continuing contract clause was revised to prohibit the contractor from continuing work when funds are exhausted as a result of language in the FY 2006 Energy and Water Development Appropriations Act. This could result in termination of the contract if additional funds cannot be made available. The year-to-year funding risk for the contractor is much higher under the revised version, which translates to higher contract costs.

Omissions/Re-estimates – This item includes the amount for any impact from omissions from the feasibility report to the currently approved project. Examples of this may include the following:

- The feasibility study construction contract duration was underestimated and resulted in a cost increase.
- The design omitted feature(s) requiring different support items not included in the cost estimate.
- In the case of a cost reimbursable contract, the contractor prepared and submitted with his bid an estimated cost for construction; however, as work progressed the actual cost accumulated in excess of the cost estimate. The contractor prepares Variance Reports on these changes and the resulting increases or decreases were included under this item.
- Equipment salvage may include the amount for equipment purchased under a cost reimbursable contract which would become government property, and exceeded with compensation if not needed, at the project's completion. Under these case studies, this is a unique factor for Olmsted construction only. The contractor deducted the salvage value from his bid, assuming that the money raised by the sale of the equipment would reduce the contract amount. Initially the Government must provide the funds to pay for this equipment and when the equipment is exceeded there may or may not be any funds returned to the project.
- Increased mitigation which was discovered after the authorized construction project period.

APPENDIX 2: MATERIALS COST ESCALATION

The below chart from the US Department of Labor, Bureau of Labor Statistics shows a steady increase in construction materials until 2004. After 2004 construction materials increased significantly more than in the past.

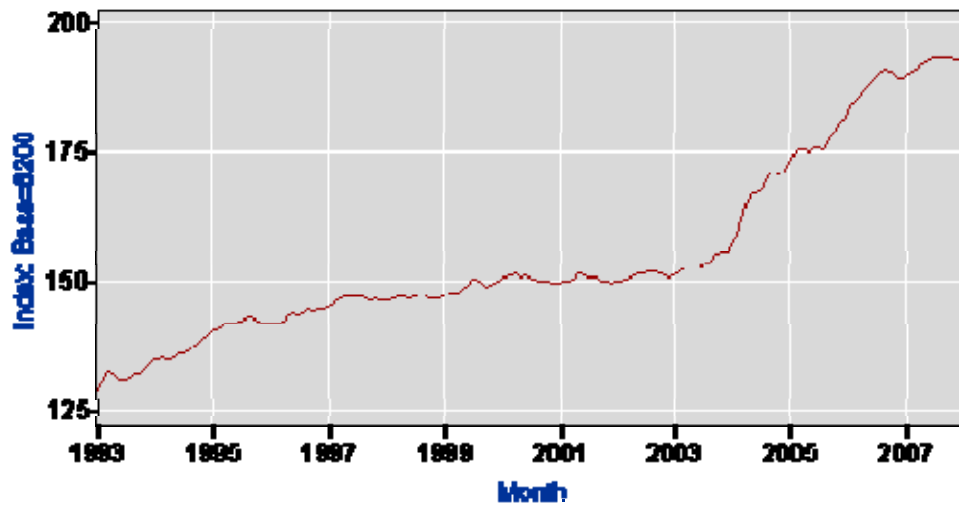


Figure A1 Materials and Components for Construction

(Above figure extracted from Bureau of Labor Statistics Data on March 24, 2008)