
Hamilton County MSD Monitor

Cost Certainty Analysis of SI Alternative

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METRO WBE ASSOCIATES INC.



Hatch Mott
MacDonal

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1. Introduction

The Board of County Commissioners (BoCC) has stated that in implementing the Final WWIP ¹, compliance with the Consent Decree and applicable law, improvement of water quality particularly near homes and parks, financial solvency of MSD, protection of the MSD ratepayer's ability to pay for services, ongoing MSD financial transparency, and cost-saving innovation are key Board priorities. The BoCC indicated that projects managed by MSD, to the greatest extent practicable within the limits of applicable law, should be planned, designed and constructed in all circumstances "on or under budget". The term "budget" in this case refers to the projected costs listed in the Final WWIP ².

Thus cost certainty is an extremely important aspect of all projects and strategy brought forth by MSD to meet the objectives of the Final WWIP. MSD has recently requested that the County explain "cost certainty". This report articulates the Hamilton County Monitor's (Monitor) analysis of cost certainty issues related to the SI alternative as presented by MSD to the BoCC in Spring 2012 and made public by MSD in mid-2012 ³.

While there are numerous programmatic elements that translate to cost (schedule compliance, water quality, etc.) we have focused on two principle concerns: Costing Methodology and the CSO Volume Reduction Estimate. The purpose of this document is to serve as the means through which the County provides direction to MSD on how its current proposals may be supplemented or enhanced to provide for greater confidence in their level of cost certainty related to these two areas. Our primary concerns relate to:

1. Costing Methodology:

- a. A departure from industry standard practice occurred. The contingency methodology lacks the application of a project risk assessment process that recognizes unique risks for each project and assigns a contingency commensurate with such a risk assessment.
- b. An analysis of the overall confidence level of the stated cost of the program (v. projects) has not been performed.
- c. Significant costs were not included in the current cost estimate.
- d. Inconsistencies were noted within and between projects related to the inclusion of costs for amenities not mandated by the Final WWIP.
- e. Some estimates were based on assumptions inconsistent with industry standards.

2. CSO Volume Reduction Estimate:

- a. The SI Alternative is relying on estimates and modeling supported by little to no direct local data.
- b. The limited data that has been relied on to prove performance does not appear to directly support the current effectiveness assumption used by the SI Alternative.
- c. No potential shortfall replacement costs have been provided based on a sensitivity analysis to provide for instances of the program not being as effective as assumed.

1. Introduction

- d. Reduced effectiveness rapidly increases the cost per gallon uncertainty of the SI Alternative.

This report is structured in five components. This Executive Summary defines the purpose and structure of the report and gives an overview of the findings. The second section of the report contains the substantive text related to the Monitor's analysis and two resulting areas of concern related to certainty of cost. The review criteria for each area of concern are explained and the findings presented in detail based on the review criteria. **The third section articulates potential options for addressing the mitigation or avoidance of cost uncertainty.** The fourth section contains brief descriptions of other potential areas of cost uncertainty concerns. Lastly, attachments referenced within the document are included. At the end of each section are the footnotes related references within that section.

Footnotes:

¹ Final WWIP means the WWIP, November 2009, as prepared by USEPA.

² Board of County Commissioners resolution, July 18, 2012

³ Lower Mill Creek Partial Remedy – Alternatives Evaluation Preliminary Findings Report <http://projectgroundwork.org/projects/lowermillcreek/community.htm>

2. A. Costing Methodology

REVIEW CRITERIA

In order to have confidence in the SI Alternative cost/budget estimates there must be a rational and consistent application of industry best practices for determining and accounting for the uncertainties inherent in the individual projects, and the program (collection of projects).

To identify uncertainties related to project and program costs the SI Alternative was evaluated against the following parameters associated with appropriate cost/budget development:

1. Budget Development
 - a. Project level risk analysis
 - b. Program level confidence analysis
2. Completeness
3. Consistency of cost accumulation across projects within the program
4. Certainty of Estimates

Other review criteria included MSD's adherence to their own internal cost accumulation policies and accuracy of cost accumulation. No significant concerns were noted related to these items.

FINDINGS

Several issues were noted related to the review criteria which add to the level of cost uncertainty associated with the SI Alternative. **The County's most significant issues with cost uncertainty relate to project level risk analysis and program level confidence analysis.**

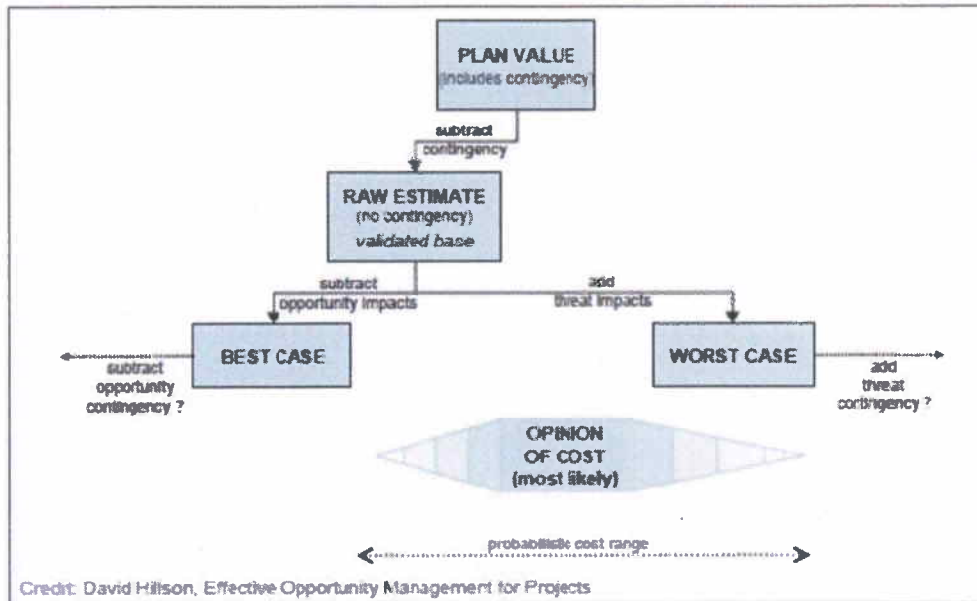
BUDGET DEVELOPMENT

Project Level Risk Analysis

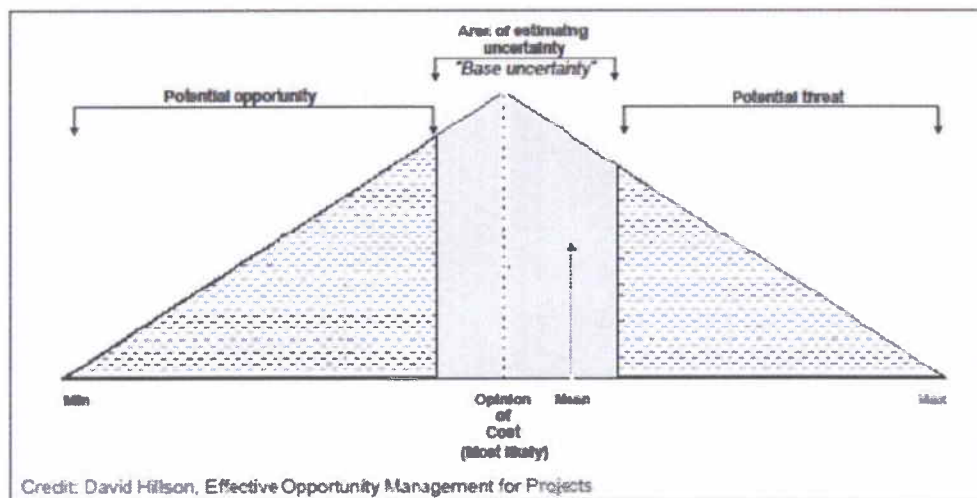
The cost estimate preparation for the individual projects of the SI Alternative program followed costing protocols as represented by MSD to the Monitor on February 23, 2012. The protocols were developed by a committee of both MSD staff and consultants trained in industry cost estimating practices.

However **an important departure from industry standard practice was the lack of a project risk assessment process** whereby time and cost related risks to each project were identified, evaluated and valued. This project risk assessment process typically results in a reasoned, justifiable contingency value to be applied to each project based on its unique characteristics ¹. MSD's protocols do not include this approach. The SI alternative project budgets simply include a 10% contingency value added to the total construction cost of each project. This policy introduces a significant lack of confidence in the aggregate of project cost estimates that make up the SI Alternative total cost estimate. Industry practices recognize the variability associated with a project cost estimate (see Figures 4-2 and 4-3 below) and there are techniques available to develop a reasonable range of costs for a given project.

2. A. Costing Methodology



Creating a probabilistic estimate
Figure 4-2



Regions of an estimate
Figure 4-3

2. A. Costing Methodology

Each project is unique, and has its own set of potential opportunities and risks associated completing the project within its estimated cost. Therefore a risk assessment process should be used on each project to identify the risks, evaluate them as to probability of occurrence and the impact to the project cost if it does occur. Under this approach major cost drivers are identified and management strategies prepared. Based on this analysis, a contingency value would then be recommended. Decision makers could then determine whether the contingency value provides a satisfactory confidence level or whether a different amount should be approved.

Typically the larger the project, the more uncertainty regarding its cost estimate. Described below in the Program Estimate section are more sophisticated risk assessment methods. These should be considered for larger projects as well. For example, the U.S. Army Corps of engineers requires that a sensitivity and risk analysis using the Monte Carlo simulation method be used on every civil works project that has a total project cost estimate of \$40 M or more, and strongly recommends these techniques be used on smaller projects that are considered to have significant risk factors.¹⁵

Program Level Confidence Analysis

In addition to the uncertainty introduced by the project estimate process described above, there is a range of costs that represents the confidence level surrounding the reported SI Alternative total program cost of \$317 M. The greatest program risk is if the various projects of the SI Alternative do not perform as predicted related to reducing CSO overflow. **An analysis on the overall confidence level of the stated cost has not been performed.** The individual projects are assumed by the SI Alternative to perform as designed.

The risk factors that should be considered for each project (see chart below), should also be considered for the program as a whole. **Consideration should be made of the potential of the projects not performing as designed or assumed. This would include the concern expressed in the next section of this report related to the certainty of the CSO Volume Reduction Estimate.** Property acquisition delays, local construction industry shortfalls in capacity to support the schedule of projects or regulatory issue delays are other examples of risks to be considered. A risk analysis should be performed for the entire SI Alternative collection of projects in order to determine the significant risks to successful plan completion and the possible cost and schedule impacts that can develop. The potential cost of these risks should be evaluated and presented to decision makers for consideration. Ultimately, a program contingency must be identified so that sound decisions can be made, and the potential program cost can be appropriately planned.

2. A. Costing Methodology

- **Real Estate**
 - Property Acquisition
 - Relocation
 - Condemn
 - Eminent Domain
- **Public Utilities**
 - Analysis and Coordination
 - Agreements
 - Relocation
- **Financial**
- **Politics**
 - Internal/External
- **Environmental**
 - Environmental Impact Studies
- **Historical Significance**
 - Protected Lands
 - Archaeological
 - Structures
- **Contract phasing and packaging**
 - Scope of Work
 - Bid Process/Labor
 - Integrating Construction Packages
- **Community impacts and public perception**
- **Public hearing**
 - Marketing/Communication
 - Safety and Security
- **Material, Equipment and Construction Techniques**

Federal Transit Agency Project Management Handbook, 2009

There are two components of capital program budget development that have not been demonstrated in the MSD cost estimates: **Sensitivity Analysis and Risk Analysis**. The absence of these considerations results in cost uncertainty.

Quoting from the Federal Office of Management and Budget Guidance for Government Auditors¹⁰:

"For management to make good decisions, the program estimate must reflect the degree of uncertainty, so that a level of confidence can be given about the estimate. Quantitative risk and uncertainty analysis provide a way to assess the variability in the point estimate. Using this type of analysis, a cost estimator can model such effects as schedule slipping, missions changing, and proposed solutions not meeting user needs, allowing for a known range of potential costs. Having a range of costs around a point estimate is more useful to decision makers, because it conveys the level of confidence in achieving the most likely cost and also informs them on cost, schedule and technical risks."

Sensitivity Analysis

Cost estimating, especially during the planning and early design phases of a project, is inherently imprecise since there may be many unknown or less than fully vetted project elements. In the absence of facts, assumptions must be made to support the cost estimate. In recognition of this, a sensitivity analysis should be performed on the estimate in order to gain an appreciation for those project cost elements that have the highest probability for inaccuracy, and thus can ultimately impact the accuracy of the project cost estimate.

*"Perform the sensitivity analysis: Once the estimate is developed, **decision makers want and need to know how sensitive the total cost estimate is to changes in the data input**. Therefore, a sensitivity analyses is performed to identify the major cost drivers for the estimate. Sensitivity analyses determine how the different ranges of estimates effect the estimates. Cost drivers are those variables that when changed in value, create the greatest changes in cost. Generally many initial assumptions made in the early phases of a*

2. A. Costing Methodology

project's definition will, in later phases, be found to be inaccurate.”¹⁰

Risk Analysis

The Federal Office of Management and Budget (OMB) Capital Programming Guide⁹ requires risk analysis as a primary component of a capital project decision template. The OMB cites as the basis for their program budget approach the three basic texts noted in the footnotes^{11, 12, 13}:

“Risk management should be central to the planning, budgeting, and acquisition process. Failure to analyze and manage the inherent risk in all capital asset acquisitions may contribute to cost overruns, schedule shortfalls, and acquisitions that fail to perform as expected. For each major capital project (investment), a risk analysis that includes how risks will be isolated, minimized, monitored, and controlled may help prevent these problems.”

*The OMB requires that an evaluation of each project/program risk be conducted in order to gain an appreciation for the potential cost and schedule impacts of each risk, and how that risk will be managed. **The result of the risk analysis is an additional cost value that is added to the project cost estimate creating a “Risk-adjusted Program Cost” and a “Risk-adjusted Schedule”.***

“Risk analysis is the process of examining each identified risk issue or process to refine the description of the risk, isolate the cause, and determine the effects. The cost of a risk event occurring can be quantified by determining its expected value (probability X impact). These costs must be included in cost estimates.”

Contingency Reserve

Recognizing the imprecise nature of a program estimate in its preliminary design phase, a contingency reserve is often added to a program budget. Federal guidelines indicate the following:

“Develop Contingency Reserve: Based on the confidence level, a contingency allowance is used to cover the items of cost which are not known exactly at the time of the estimate.”

Simulation models are typically used to develop the confidence intervals around a program cost estimate. Using the results from the Risk and Sensitivity Analyses, the simulation develops probabilistic values for cost and schedule impacts due to the risks that are the primary cost and schedule drivers. Using the results of this process, decision makers can determine how much cost risk is acceptable. See an example of a cost probability curve below, Figure 16.²

