Improving Water Utility Capital Efficiency

Subject Area: Management and Customer Relations
Improving Water Utility Capital Efficiency
About the Water Research Foundation

The Water Research Foundation (formerly Awwa Research Foundation or AwwaRF) is a member-supported, international, 501(c)3 nonprofit organization that sponsors research to enable water utilities, public health agencies, and other professionals to provide safe and affordable drinking water to consumers.

The Foundation’s mission is to advance the science of water to improve the quality of life. To achieve this mission, the Foundation sponsors studies on all aspects of drinking water, including resources, treatment, distribution, and health effects. Funding for research is provided primarily by subscription payments from close to 1,000 water utilities, consulting firms, and manufacturers in North America and abroad. Additional funding comes from collaborative partnerships with other national and international organizations and the U.S. federal government, allowing for resources to be leveraged, expertise to be shared, and broad-based knowledge to be developed and disseminated.

From its headquarters in Denver, Colorado, the Foundation’s staff directs and supports the efforts of more than 800 volunteers who serve on the board of trustees and various committees. These volunteers represent many facets of the water industry, and contribute their expertise to select and monitor research studies that benefit the entire drinking water community.

The results of research are disseminated through a number of channels, including reports, the Web site, Webcasts, conferences, and periodicals.

For its subscribers, the Foundation serves as a cooperative program in which water suppliers unite to pool their resources. By applying Foundation research findings, these water suppliers can save substantial costs and stay on the leading edge of drinking water science and technology. Since its inception, the Foundation has supplied the water community with more than $460 million in applied research value.

Improving Water Utility Capital Efficiency

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FOREWORD

The Water Research Foundation (the Foundation) is a nonprofit corporation that is dedicated to the implementation of a research effort to help utilities respond to regulatory requirements and traditional high-priority concerns of the industry. The research agenda is developed through a process of consultation with subscribers and drinking water professionals. Under the umbrella of a Strategic Research Plan, the Research Advisory Council prioritizes the suggested projects based upon current and future needs, applicability, and past work. The recommendations are forwarded to the Board of Trustees for final selection. The Foundation also sponsors research projects through the unsolicited proposal process; the Collaborative Research, Research Applications, and Tailored Collaboration programs; and various joint research efforts with organizations such as the U. S. Environmental Protection Agency (EPA), the U. S. Bureau of Reclamation, and the Association of California Water Agencies.

This publication is a result of one of these sponsored studies, and it is hoped that its findings will be applied in communities throughout the world. The following report serves not only as a means of communicating the results of the water industry’s centralized research program but also as a tool to enlist the further support of the nonmember utilities and individuals.

Projects are managed closely from their inception to the final report by the Foundation’s staff and large cadre of volunteers who willingly contribute their time and expertise. The Foundation serve a planning and management function and awards contracts to other institutions such as water utilities, universities, and engineering firms. The Foundation’s funding for this research effort comes primarily from the Subscription Program, through which water utilities subscribe to the research program and make an annual payment proportionate to the volume of water they deliver. Consultants and manufacturers subscribe based on their annual billings. The program offers a cost-effective and fair method for funding research in the public interest.

A broad spectrum of water supply issues is addressed by the Foundation’s research agenda: resources, treatment and operations, distribution and storage, water quality and analysis, toxicology, economics, and management. The ultimate purpose of the coordinated effort is to assist water suppliers to provide the highest possible quality of water economically and reliably. The true benefits are realized when the results are implemented at the utility level. The Foundation’s trustees are pleased to offer this publication as a contribution toward that end.

David E. Rager
Chair, Board of Trustees
Water Research Foundation

Robert C. Renner, P.E.
Executive Director
Water Research Foundation
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The research team wishes to express its sincere appreciation to the 28 utilities and their staff members who provided the research team with significant assistance during the study:

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Tampa (FL) Bay Water  Northeast Ohio Regional Sewer District
Beaver (AR) Water District  San Jose (CA) Municipal Water System
American Water (NJ)  East Bay (CA) Municipal Utility District
Falls Church (VA), City of  Los Angeles (CA) Bureau of Sanitation
Singapore Public Utilities Board  Hampton Roads (VA) Sanitation District
Dallas (TX) Water Utilities  Passaic Valley (NJ) Water Commission
Zone 7 (CA) Water Agency  District of Columbia Water and Sewer Authority
Aqua America, Inc. (PA)  Wilmington (DE) Department of Public Works
Longmont (CO), City of  Beaufort (SC) Jasper Water & Sewer Authority
Seattle (WA) Public Utilities  San Francisco (CA) Public Utilities Commission
Long Beach (CA) Water Department  Suffolk County (NY) Water Authority
Norfolk (VA) Department of Utilities  Washington Suburban (MD) Sanitation Commission
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Woonsocket (RI) Department of Public Works & Administration

A special note of thanks goes to the Construction Industry Institute for its extensive assistance in providing out-of-industry best practices to this project and Kathy Pape of Aqua America for providing us with information related to capital intensity.

We would like to thank the utility staff members at Howard County, Beaver Water District and the Washington Suburban Sanitation Commission (WSSC) who helped us test our survey and capital efficiency model.

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EXECUTIVE SUMMARY

THE SITUATION

Beginning shortly after the turn of the century and extending to 2040, the water utility sector will see a rapid increase in capital needs due to replacement of aging infrastructure, regulatory requirements and growth needs. This growth in capital needs is being exacerbated by a number of forces, which are not expected to abate anytime soon, that is increasing capital costs at a rate above the growth in capital needs. Although the US EPA has forecasted that, with expected efficiency improvements, the growth in capital needs will result in annual rate increases of three percent above the rate of inflation, a continuation of present trends will most likely result, in the intermediate to long term, in annual rate increases higher than that forecast by EPA.

STUDY OBJECTIVES

The study objectives were to examine best practices in capital programs from within and without the water industry, examining capital efficient program development and management, as well as individual project implementation, within the following framework:

A) Building a Capital Program
B) Implementing Capital Projects
C) Managing a Capital Program

STUDY METHODOLOGY

The study team employed a methodology that consisted of the following:

- **Literature Search** – a wide variety of sources were utilized to identify best practices, conduct research into capital intensity, 20 year Capital Needs and similar issues
- **Utility Survey** – a utility survey was conducted to identify the range of in-house capabilities, the extent of use of best practices, major problems (as seen by utilities), use of benchmarks and metrics and other issues
- **Focus Groups** – groups were formed around specific issues including risk allocation in contracts, non- and light construction alternatives and problems encountered
- **Interviews** – a large number of one on one interviews were conducted with utilities, A/E design firms and contractors to discuss specific issues that arose during the research
- **Pilot Tests** – the drinking water and wastewater cost models were piloted at a number of utilities; the scenario planning approach was piloted in a workshop held at the June 2007 American Water Works Association (AWWA) Annual Conference and Exposition (ACE) in Toronto and, in expanded form, at the 2008 ACE in Atlanta.
STUDY FINDINGS

Some of the initial study findings included:

- The water sector is one of the most capital-intensive sectors. Capital intensity is the ratio of net asset value to operating revenues, or the number of dollars in plant required to generate a dollar of revenue. The water sector is substantially more capital intense than other regulated industries such as electric, gas and telecom and about 20 times more capital intensive than the Standard and Poors (S&P) 500. Near-term trends indicate that capital intensity is increasing.

- The 20 year Capital Needs estimate developed every four years by the US EPA began a sharp climb at about the turn of the century – an increase of 67% over four years following 8 flat years. An analysis of the underlying factors behind this climb indicates that capital needs will continue to increase until 2040. Although EPA has estimated that with efficiencies this increase will result in annual rate increases of 3% above the rate of inflation, an analysis of trends indicates that, if current trends continue, annual required rate increases will climb well above the 3% increment forecasted by EPA.

- These increased capital needs include replacing aging infrastructure (56% of current needs are for transmission and distribution), regulatory requirements and growth.

- An analysis of current trends in construction costs indicate that recent construction cost increases are the result of a number of factors, including:
  - Rising raw material costs resulting from rapidly increasing demand from such countries as China and India.
  - Supply-demand issues (too many projects chasing too few contractors)
  - Personnel shortages at contractors, particularly skilled construction workers
  - Energy cost increases
  - Other increases affecting the job site such as workmen’s comp costs increases
  - Risk aversion by various participants in the process including sureties

- Some cost increases were attributed to the water utility sector – risk averse contracts, failure to update cost estimates, insufficient training, political influence causing oversizing of facilities, and poor contractor relations.

- The study team identified three sources of capital program best practices:
  - The California Multi-Agency (CMA) CIP Benchmarking Study
  - The Construction Industry Institute (CII), and
  - The Lean Construction Institute (LCI)

- The California Multi-Agency (CMA) CIP Benchmarking Study is a study undertaken by seven of the largest municipalities in California. The 32 best practices identified in their reports are consensus best practices, basically, the result of informed expert opinion. The projects studied were programs and projects carried out by municipal agencies (about 85% of water utilities are municipal utilities) and the best practices are applicable to both the program and project level. (See Appendix A.)

- The Construction Industry Institute (CII) is a membership organization composed almost entirely of private sector members. CII uses a validation process to accept a
practice as a Best Practice.  CII currently has 14 validated Best Practices. CII best practices are project oriented.  (See Appendix B.)

- The Lean Construction Institute seeks to bring the Toyota “lean production” process to construction.
- The research team produced a crosswalk between the CMA consensus best practices and the validated best practices of CII on the last page of Appendix B.
- A best practice audit was developed by the project team based on the CMA consensus best practices and administered to a group of utilities including both publicly owned and privately owned and one international utility.
- Based on the in-house capabilities identified in the survey, the study identified three types of utilities – delegators (utilities who have most of their capital program conducted by contractors), balanced (utilities that perform part of their capital program with in-house resources), and full service (utilities with substantial in house capabilities).
- The survey identified that most utilities have some room for improvement, with full service utilities demonstrating better overall practices than delegators and balanced utilities.
- The two largest problems identified by surveyed utilities were rising material costs and affordability.
- After affordability, project timing (50%) and project selection (39%) were the next ranked needs.
- The predominant form of capital delivery was design-bid-build as reported by 93% of all respondents.
- The use of benchmarks and metrics was mixed. The most commonly used benchmarks were program actual to budget (dollars) and actual to planned (schedule). Less than 50% of surveyed utilities reported using other metrics such as target cost percentages for such items as claims, change orders etc. Better performing utilities appeared to use more and more varied benchmarks and metrics.
- Half the utilities in our survey reported being short handed in their capital program and experiencing difficulty in finding new hires.
- One utility panel, as well as our case studies, indicated that one of the biggest cost drivers (possibly the single largest one) is the risk averse nature of municipal utility contracts which place most or all of the risk on contractors.

**CONCLUSIONS**

The research indicates that water utilities are entering a prolonged period of rising capital costs. Other sectors appear to be more active in pursuing capital efficiencies. Water utilities could improve by improving their use of best practices, benchmarks and metrics, use of non-construction and lighter construction alternatives (due to the rapidly rising cost of construction materials), improving the project definition and selection process and considering alternative project delivery methods. The utility survey and interviews with utilities indicate that the need for improved capital program management and effectiveness is recognized; however, awareness of how to proceed and tools for doing so is limited.
Case studies of utilities that had achieved substantial improvement in their capital programs demonstrated the following characteristics:

- A focus on implementing best practices
- Improved project selection and prioritization methods, some incorporating asset management
- A focus on uniformity in such areas as uniform project management systems, standardized specifications etc. These were pursued due to succession concerns as well as for efficiency reasons.
- A focus on being a “client of choice” by meeting and working with their contractor pool to identify and improve on areas of conflict
- A focus on becoming an “employer of choice” by focusing on recruitment. Retention and succession issues

In the area of capital project selection and prioritization utilities may be facing a changing paradigm. A continuation of the trends identified earlier in this document and what we have identified from interviews with leading edge utilities, points to the following:

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<tr>
<th>Item #</th>
<th>Old Paradigm</th>
<th>New Paradigm</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Fix it before it breaks</td>
<td>Run to failure</td>
</tr>
<tr>
<td>B</td>
<td>Capital is cheaper than O&amp;M</td>
<td>It can be cheaper to fix some things quickly than to replace them</td>
</tr>
<tr>
<td>C</td>
<td>Make sure we have enough capacity; redundancy is safer and smarter and a good capital investment</td>
<td>Small can be beautiful (keep capacity utilization high); redundancy by itself is not a justification for capital expenditures</td>
</tr>
<tr>
<td>D</td>
<td>Take your time, be methodical</td>
<td>Time is money; faster and leaner will provide better result</td>
</tr>
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Efforts to improve contracts are ongoing within the industry. Useful standard contracts are available and being used by some utilities.

RECOMMENDATIONS

Utilities should aggressively pursue a capital efficiency improvement program. This effort could be initiated with a program best practice audit. Depending on the results of that audit, the improvement program could consist of:

- Incorporation of capital program best practices. This would include implementing post project completion reviews as part of a program of continuous improvement.
- Increased use of benchmarking and metrics.
- More formalized project identification, selection and prioritization methods. This should include examination of non-construction alternatives and lighter construction alternatives.
• Review their posture with respect to risk, both in contracting and in project oversight and management.
• Take steps to become a “client of choice”
• Take steps to become an “employer of choice.”

To facilitate these recommendations the research work product consists of a written report and a model designed to assist the utility in conducting their improvement program.

DESCRIPTION OF THE REPORT

The report is a written description of the research effort containing background research, the best practice survey and its results, case studies, results of our panels and interviews, identification of sources of such information as best practices, benchmarks and metrics, contract terms and other useful information.

DESCRIPTION OF THE TOOLKIT

The toolkit is designed to facilitate a utility capital program improvement effort and consists of the following four files:

• Capital Efficiency Model
• Drinking Water Cost Model
• Wastewater Cost Model
• Project Readiness Index

The Capital Efficiency Model contains most of the components of the capital program improvement effort. The following is a list of the tabs in the capital efficiency model:

• Introduction to the model
• A description of the industry problem
• Utility type identification
• Program best practice audit
• Best practice comparison chart
• Opportunities for improvement
• Performance measures
• Water CIP framework
• Updated water CIP
• Proposed water projects
• Proposed water CIP
• Wastewater CIP framework
• Updated wastewater CIP
• Proposed wastewater projects
• Proposed wastewater CIP
• Non & Light Construction
The drinking water and wastewater cost purpose is to provide utilities with a rough order of magnitude cost for a collection of projects. They were developed using a single national cost escalation index and you are advised to read the sections of this report which identify ways in which you can gauge your local situation so that you can make appropriate adjustments to the results of this model. These models are not intended to replace an engineering study or to be used as the basis for a borrowing.

The project readiness index is a modified product developed by the authors of this report specifically for water utilities. It is based on CII’s Project Definition Readiness Index™. It consists of 107 elements in three tracks – engineering, financial and project. In the cell next to each element is an embedded questionnaire. As utilities answer the questionnaire, they will arrive at a score that indicates how ready a project is to go forward.

FUTURE RESEARCH - IMPROVED DECISION MAKING TECHNIQUES

Improved decision making techniques was defined as a need in both the survey and in discussions with various groups. There are two major and somewhat related avenues of research in this area:

Application of Neuroeconomics to Capital Decision Making

There has been a great deal of recent research on how people weigh various factors in the process of making decisions. Many of the recent findings have applicability to capital decisions – the bias to be risk averse, the tendency to overweight rare but extreme events, the overweighting of recent occurrences, etc. In addition to recent findings in this area, a related area would include exercises to improve the ability to assign probabilities to potential events, developing ranked weightings from a large group of criteria etc.

Application of Advanced Construction Research to the Capital Process

The Construction Industry Institute is continuing to pursue various aspects of construction research. Some areas that CII is researching include:

- Optimizing the value of construction in front end planning
- Optimizing engineering value in projects
- Estimating as a competency in capital projects
- Information integration to improve capital project performance
Additionally, CII expects that a Lessons Learned Program will be validated as a new best practice in the second half of 2008.

OTHER RESEARCH PROJECTS

The following is a list of other research projects that should be considered for further review and development:

- Training for non-engineering decision makers, specifically elected officials, Boards of Directors etc.
- Becoming a client of choice. This will become increasingly important as the nation’s construction activity (to repair and improve infrastructure) increases.
- Gauging local conditions. This would be a good project to involve the Association of General Contractors (there is already a joint AGC-AWWA committee). In analyzing some projects with high bid premiums, we identified a number of counterintuitive situations. In many cases breaking a project down into smaller, separate pieces would have produced a lower overall cost (by allowing more bidders and reducing the need for bidders to add layers of subcontractors as a risk reduction move).
- Capital program benchmarking and metrics. CII has recently started a job site benchmarking program.
- Application of lean construction techniques (possibly teaming with the Lean Construction Institute) to make the job site more productive, and reduce both cost and schedule. A related area that could be bundled with this is the Rapid Reduction in Project Cycle Time. This is an area being investigated by CII.
- Change management. CII has been developing a structured process for moving towards best practices. A project could adapt these techniques to the Water sector.
CHAPTER 1
INTRODUCTION

In 2005, the research planning process of the Water Research Foundation recognized capital efficiency as an important issue for the future of the water and wastewater industry, resulting in the funding of the research in this report. Its prominence as a critical issue for utilities to address is the result of the following trends:

- Capital costs at most utilities are exceeding annual operations and maintenance costs
- Capital costs were expected to increase with the introduction of new regulations and the need to replace aging infrastructure
- The conviction that, similar to the results demonstrated in the last decade for operational efficiency and best practices, that water utility capital efficiency could be significantly improved through a thorough understanding of the fundamental principles of capital project and program management, the identification and usage of best practices, and the usage of innovative project implementation methods.

Reinforcing this recognition, as noted in the project team’s proposal, were the realization by many utilities that project costs were significantly outpacing engineer’s estimates due to a combination of factors, including:

- Rising raw materials costs
- Increasing project complexities and interdependencies
- Succession issues at utilities and contractors (particularly with skilled craft workers)
- Supply-demand imbalances (too many projects being put out to bid at the same time)
- Risk-averse actions taken by sureties and other participants in the capital process.

RESEARCH APPROACH

The Water Research Foundation (the Foundation) issued a request for proposals suggesting a research approach which included case studies and/or other research techniques available to best identify current practices from within and outside of the water industry. The Foundation further requested that capital efficient program development and management, as well as individual project implementation, be studied and suggested the following framework:

A) Building a Capital Program
B) Implementing Capital Projects
C) Managing a Capital Program

The project team’s research approach included the following:

- **Literature Search** – a wide variety of sources were utilized to identify best practices, conduct research into capital intensity, 20 year Needs and similar issues
• **Utility Survey** – a utility survey was conducted to identify the range of in-house capabilities, the extent of use of best practices, major problems (as seen by utilities), use of benchmarks and metrics and other issues

• **Focus Groups** – groups were formed around specific issues including risk allocation in contracts, non- and light construction alternatives and problems encountered

• **Interviews** – a large number of one on one interviews were conducted to discuss specific issues that arose during the research

• **Pilot Tests** – the drinking water and wastewater cost models were piloted at a number of utilities; the scenario planning approach was piloted in a workshop held at the June 2007 Annual Conference and Exposition in Toronto.

**STUDY WORK PRODUCTS**

The product deliverables of the Capital Efficiency research consists of two primary products – the research report and the capital program model.

The research report documents the research project itself. Included here is research into the problem, identification of best practices (at the program and project level), survey results from 28 participating utilities, case studies, a scenario planning approach for program improvement that an individual utility can use, and additional information on capital efficiency and improvement.

The capital program model is designed to assist an individual utility in building, implementing and managing its capital program. Used sequentially, the model provides a systematic pathway by which the utility may establish and manage its capital program in a comprehensive and integrated manner. Model elements sequentially address the following:

• Identifies the sources of future capital needs

• Allows the utility to identify which type it is from a capital program standpoint (this is necessary for the next step)

• Provides a program best practice audit and self scoring methodology tailored to utility type

• Provides capital program benchmarks at the utility, program and project level

• Provides a framework for developing and building a capital program

• Provides a capital program cost updater to either update the cost of an old master plan or capital improvement program (CIP) or to refine an old plan through such measures as updating a multi-year capital program to mid-point of construction

• Provides a cost estimator to either estimate a CIP or to compare an old CIP to a new cost estimate

• Provides a checklist of non- and light construction alternatives. Since capital costs have been increasing at a much faster pace than operations and maintenance (O&M) costs, some of these alternatives may now be preferable from both a cost and sustainability standpoint

• Provides a set of project prioritization and selection tools

• Provides capital program best practices from our study partner, the Construction Industry Institute
• Provides a Project Readiness Index calculator. This is essentially a very detailed checklist and scoring tool that identifies the level of readiness at different points in the project development process. It can help identify areas in need of further study. This tool is also the vehicle for a post project lessons learned effort (all of the highly capital efficient utilities we surveyed conducted the post project reviews as part of their continuous improvement program)

• Provides risk reduction and fair risk allocation tools

• Provides links to useful web sites

• Provides a list of indexes used in the model

All of the products have been tested or vetted in a variety of ways. As with any Water Research Foundation project, regularly submitted reports were reviewed by the Project Advisory Committee. Some of the model elements (Cost Comparator, Project Readiness Index etc.) were tested at utilities. Other elements were reviewed through an informal network of utility and consultant personnel.

ADDITIONAL WORK PRODUCT

One of the surprises for the research team was the extent to which succession issues affected the project. Although we were aware of the generational change that the utility industry is going through, we did not expect it to have such an early or substantial impact on utility engineering staffs. Half of the utilities we surveyed reported shortages in their staff and difficulties in hiring replacement engineers. These staffing and workload issues were a major factor in the low utility participation in the survey and the difficulty in gathering utility recruits for pilot programs. We have added a section on succession issues as a result.

OTHER FOUNDATION PROJECTS

There are a number of other Foundation projects that can improve utility capital efficiency. We have attempted to avoid replicating other work; the reader is urged to look into the following Foundation projects in Table 1.1 for additional insights into improving capital efficiency:
Table 1.1
Other Foundation studies that provide additional insight into improving capital efficiency

<table>
<thead>
<tr>
<th>Number</th>
<th>Report Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>4097</td>
<td>Optimizing Information Technology Solutions for Water Utilities</td>
</tr>
<tr>
<td></td>
<td>Will identify the drinking water industry's highest priority IT needs and</td>
</tr>
<tr>
<td></td>
<td>create a road map for research to meet those needs. Will also identify the</td>
</tr>
<tr>
<td></td>
<td>types of IT products and services most needed in the industry. Will review</td>
</tr>
<tr>
<td></td>
<td>the current state of IT in the drinking water industry, followed by a</td>
</tr>
<tr>
<td></td>
<td>workshop at which IT experts and managers representing all functional areas</td>
</tr>
<tr>
<td></td>
<td>within water utilities will identify current and emerging issues, focus on</td>
</tr>
<tr>
<td></td>
<td>areas that would be strengthened by research, and develop a prioritized,</td>
</tr>
<tr>
<td></td>
<td>proactive research agenda.</td>
</tr>
<tr>
<td>4098</td>
<td>Performance and Life Span of Polyethylene Wrap Materials for Ductile Iron</td>
</tr>
<tr>
<td></td>
<td>Pipe</td>
</tr>
<tr>
<td></td>
<td>Will evaluate and predict the long-term performance and life expectancy of</td>
</tr>
<tr>
<td></td>
<td>PE wrap material used to protect DI pipe from external corrosion. Will</td>
</tr>
<tr>
<td></td>
<td>evaluate and/or develop performance evaluation and accelerated material life</td>
</tr>
<tr>
<td></td>
<td>testing methods for PE wrap materials. Will complement the ongoing Foundation</td>
</tr>
<tr>
<td></td>
<td>Project 3036, &quot;Long Term Performance of Ductile-Iron Pipe.&quot; Will produce</td>
</tr>
<tr>
<td></td>
<td>results that ought to form a sound basis for asset management decisions and</td>
</tr>
<tr>
<td></td>
<td>future rehabilitation program spending levels. Research partner: CSIRO.</td>
</tr>
<tr>
<td>4108</td>
<td>Data Requirements for Condition Assessment of Buried Water Infrastructure</td>
</tr>
<tr>
<td></td>
<td>Management</td>
</tr>
<tr>
<td></td>
<td>Will define data elements required for condition assessment of buried assets</td>
</tr>
<tr>
<td></td>
<td>for a number of expected management approaches. Will create and test a</td>
</tr>
<tr>
<td></td>
<td>standardized framework for data structure. Research partner: WERF.</td>
</tr>
<tr>
<td>4111</td>
<td>Case Studies of Best Practice and Innovation in Asset Management - GWRC</td>
</tr>
<tr>
<td></td>
<td>Each collaborative partner will develop short case studies of water</td>
</tr>
<tr>
<td></td>
<td>utilities that exhibit best practices or innovation in asset management.</td>
</tr>
<tr>
<td></td>
<td>The Foundation will develop five case studies of drinking water utilities</td>
</tr>
<tr>
<td></td>
<td>in N. America. Water Research Commission (S. Africa) will compile the water</td>
</tr>
<tr>
<td></td>
<td>and wastewater case studies from the collaborative partners (representing</td>
</tr>
<tr>
<td></td>
<td>five countries) into a Compendium of Best Practice and Innovation in Asset</td>
</tr>
<tr>
<td></td>
<td>Management. The GWRC will allow the participating organizations to publish</td>
</tr>
<tr>
<td></td>
<td>the final report. Research Partner: GWRC. To be completed in 2007.</td>
</tr>
<tr>
<td>4127</td>
<td>Methodology for Cost and Benefit Valuation in Asset Management Decision</td>
</tr>
<tr>
<td></td>
<td>Support - GWRC</td>
</tr>
<tr>
<td></td>
<td>Will develop an electronic-based methodology to balance maximal service</td>
</tr>
<tr>
<td></td>
<td>performance of assets with minimal cost of ownership. Will evaluate</td>
</tr>
<tr>
<td></td>
<td>benefits, compare direct and indirect costs, determine present value,</td>
</tr>
<tr>
<td></td>
<td>allow for triple bottom line accounting, and value risks for failure.</td>
</tr>
<tr>
<td></td>
<td>WERF has contracted this project to GHD. Research Partner: GWRC.</td>
</tr>
<tr>
<td>4085</td>
<td>Setting Water Utility Investment Priorities: Assessing Customer Preferences</td>
</tr>
<tr>
<td></td>
<td>and Willingness to Pay</td>
</tr>
<tr>
<td></td>
<td>Will develop more robust tools to better characterize customer input to</td>
</tr>
<tr>
<td></td>
<td>utility investment priorities. Will review survey approaches for</td>
</tr>
<tr>
<td></td>
<td>eliciting accurate customer preferences, will describe how such tools have</td>
</tr>
<tr>
<td></td>
<td>been used in public decision-making, and will test the tools in water</td>
</tr>
<tr>
<td></td>
<td>utility customer surveys. Also will develop a handbook that provides</td>
</tr>
<tr>
<td></td>
<td>guidance to utilities and their vendors on designing, implementing, and</td>
</tr>
<tr>
<td></td>
<td>analyzing customized &quot;willingness to invest&quot; surveys for typical utility</td>
</tr>
<tr>
<td></td>
<td>investments.</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Number</th>
<th>Report Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>4002</td>
<td><strong>Asset Management Research Needs Roadmap</strong></td>
</tr>
<tr>
<td></td>
<td>Will develop a well-referenced white paper on asset management. Will convene and organize an asset</td>
</tr>
<tr>
<td></td>
<td>management experts workshop of 30 participants representing water and wastewater utilities, non-</td>
</tr>
<tr>
<td></td>
<td>governmental research organizations, international experts, professional consultants, academics,</td>
</tr>
<tr>
<td></td>
<td>and regulators to discuss and develop a multi-year research needs roadmap on asset management related</td>
</tr>
<tr>
<td></td>
<td>topic areas.</td>
</tr>
<tr>
<td>4013</td>
<td><strong>Sustainable Infrastructure Management Program Learning Environment (SIMPLE), Version 1.1</strong></td>
</tr>
<tr>
<td></td>
<td>Will modify the existing wastewater-specific asset management website SIMPLE launched by WERF,</td>
</tr>
<tr>
<td></td>
<td>with drinking water content to create SIMPLE, version 1.1. SIMPLE, Sustainable Infrastructure</td>
</tr>
<tr>
<td></td>
<td>Management Planning and Learning Environment, is a guidance manual, with limited user interaction</td>
</tr>
<tr>
<td></td>
<td>via the chat room and a question and answer section. Over time, more interactive tools may be</td>
</tr>
<tr>
<td></td>
<td>added. Research partner: WERF.</td>
</tr>
<tr>
<td>3126</td>
<td><strong>Life Expectancy of Field and Factory Applied Cement-Mortar Linings in Ductile-Iron and Cast-Iron</strong></td>
</tr>
<tr>
<td></td>
<td>Water Mains</td>
</tr>
<tr>
<td></td>
<td>Will predict the time to failure and determine the mechanisms of failure of both field- and factory-</td>
</tr>
<tr>
<td></td>
<td>applied cement-mortar lining (CML). Will develop a procedure/protocol to predict remaining life and</td>
</tr>
<tr>
<td></td>
<td>identify modes of failure of CML in ductile-iron and cast-iron water mains. Research partner:</td>
</tr>
<tr>
<td></td>
<td>CSIRO.</td>
</tr>
<tr>
<td>3048</td>
<td><strong>Condition Assessment Strategies and Protocols for Water and Wastewater Utility Assets</strong></td>
</tr>
<tr>
<td></td>
<td>Will develop, in two phases, measures and metrics and then protocols for assessing asset condition</td>
</tr>
<tr>
<td></td>
<td>and performance in water and wastewater utilities. Research partners: USEPA and WERF. WERF will</td>
</tr>
<tr>
<td></td>
<td>publish a report that will be available to Foundation subscribers.</td>
</tr>
<tr>
<td>2879</td>
<td><strong>Long-Term Performance Prediction for PVC Pipes</strong></td>
</tr>
<tr>
<td></td>
<td>Reviews existing and proposed accelerated material life testing methods that can be applied to</td>
</tr>
<tr>
<td></td>
<td>buried PVC pipes. Also examines field performance of PVC pipes that have been in service for 30 to</td>
</tr>
<tr>
<td></td>
<td>40 years. Develops life expectancy methodologies to enable utilities to predict the long-term</td>
</tr>
<tr>
<td></td>
<td>performance of PVC pipes, focusing on the structural, hydraulic, and water quality impact</td>
</tr>
<tr>
<td></td>
<td>characteristics that can be expected from the long-term use of PVC pipes. Research partner:</td>
</tr>
<tr>
<td></td>
<td>CSIRO. Published in 2005.</td>
</tr>
<tr>
<td>2848</td>
<td><strong>Asset Management Planning and Reporting Options for Water Utilities</strong></td>
</tr>
<tr>
<td></td>
<td>Provides tools and options that drinking water utilities can use to identify overall asset</td>
</tr>
<tr>
<td></td>
<td>management needs and develop specific asset management strategies. <em>Includes a CD-ROM.</em> Published</td>
</tr>
<tr>
<td></td>
<td>in 2006.</td>
</tr>
<tr>
<td>2849</td>
<td><strong>Strategic Planning and Organizational Development for Water Utilities</strong></td>
</tr>
<tr>
<td></td>
<td>Develops an overall strategic planning framework, incorporating various corporate level strategies</td>
</tr>
<tr>
<td></td>
<td>and business tools that can be customized by individual utilities to respond to their specific</td>
</tr>
<tr>
<td></td>
<td>customer needs. In CD-ROM format only. Published in 2004.</td>
</tr>
</tbody>
</table>

(continued)
Table 1.1 (Continued)

<table>
<thead>
<tr>
<th>Number</th>
<th>Report Name</th>
</tr>
</thead>
</table>
| 2745   | Development of a Strategic Planning Process  
Develops an overarching strategic business plan that integrates ongoing utility planning activities including asset management, capital improvement planning, integrated resource planning, competitiveness enhancement, and revenue enhancement. Adopts portfolio management techniques that provide a unifying decision framework because they consider investments with multiple attributes, risks, and requirements. Tailored Collaboration partner: Board of Water Supply, City and County of Honolulu. Published in 2003. |
| 462    | Financial and Economic Optimization of Water Main Replacement Programs  
Analyzes the economic planning, asset management planning, and accounting issues surrounding a long-term capital-intensive program of installing the next generation of pipeline infrastructure. Uses case studies to identify alternative policies and practices that optimize infrastructure maintenance and replacement programs. Published in 2001 |

HOW THE OBJECTIVES WERE MET IN THE STUDY

Table 1.2 identifies RFP requirements and where each issue is addressed in either the report or the toolkit:

<table>
<thead>
<tr>
<th>Issue</th>
<th>Report</th>
<th>Toolkit</th>
</tr>
</thead>
</table>
| Fundamental principles and innovative techniques | -Chapter 7 – Capital Efficiency Information Sources (Best practices)  
-Chapter 12 - Case studies in Capital Program Improvement | Capital Program Best Practice Audit                 |
| Capital program management techniques           | -Chapter 6 - Capital Efficiency Survey  
-Chapter 7  
-Chapter 8-Capital Program Benchmarks and Metrics | Best Practice Audit  
Project Readiness Index                                  |
| Business case analysis                          | -Chapter 9 -Project selection and prioritization, -Chapter 12 – How to improve your Utility Program (particularly Seattle Public Utility case study) | Project Cost Estimator  
Project selection and prioritization templates            |
| Cost effective capital project implementation elements | -Chapter 10-Project Readiness, Adjusting for local conditions  
-Chapter 11-Alternative Project Delivery  
-Chapter 12 - Case studies in Capital Program Improvement | Project Readiness Index  
Post project completion reviews                            |

(continued)
<table>
<thead>
<tr>
<th>Issue</th>
<th>Report</th>
<th>Toolkit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best practices</td>
<td>-Chapter 6 –Best practice Survey -Chapters 7-Information sources -Chapter 8- Benchmarks</td>
<td>Best Practice Sources Best Practice Audit Benchmarks</td>
</tr>
</tbody>
</table>

**Building A Capital Program**

<table>
<thead>
<tr>
<th>Issue</th>
<th>Report</th>
<th>Toolkit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best Practice Fundamentals</td>
<td>-Chapter 6 –Best practice Survey -Chapters 7-Information sources -Chapter 8- Benchmarks</td>
<td>Best Practice Sources Best Practice Audit Benchmarks</td>
</tr>
<tr>
<td>Prioritized and affordable</td>
<td>-Chapter 9- Project Prioritization and Selection</td>
<td>Selection and Prioritization Techniques Cost Comparator</td>
</tr>
<tr>
<td>Business case analysis</td>
<td>-Chapter 9- Project Prioritization and Selection - Chapter 12 -Case Studies in Improvement</td>
<td>Selection and Prioritization Techniques</td>
</tr>
</tbody>
</table>

**Implementing Capital Projects**

<table>
<thead>
<tr>
<th>Issue</th>
<th>Report</th>
<th>Toolkit</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP fundamentals for individual and coordinated projects</td>
<td>-Chapter 6 –Best practice Survey -Chapters 7-Information sources -Chapter 8- Benchmarks -Chapter 10-Risk</td>
<td>Best Practice Sources Best Practice Audit Benchmarks PRI Risk Reduction Template</td>
</tr>
<tr>
<td>Innovative techniques</td>
<td>-Chapter 12 – Improving Your Program (Case studies) -Chapter 7 Lean Construction</td>
<td>Non-Lite Construction PRI Post Project Completion Reviews Risk Reduction Template</td>
</tr>
</tbody>
</table>

**Managing the Program**

<table>
<thead>
<tr>
<th>Issue</th>
<th>Report</th>
<th>Toolkit</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP fundamentals for managing and implementing</td>
<td>-Chapter 6 Best Practice Survey -Chapter 7 – Best Practice Sources -Chapter 10 Risk</td>
<td>Best Practice Sources Best Practice Audit Benchmarks PRI Risk Reduction Template Non-Lite Construction</td>
</tr>
</tbody>
</table>
CHAPTER 2
CAPITAL INTENSITY

The term *capital intensity* is used to describe the level of assets (property, plant and equipment) required to support a business in the generation of revenues. Put another way, *capital intensity* (the ratio of assets to revenues) represents the net dollar amount of assets needed to generate one dollar of revenues. Capital intensity will vary significantly from industry to industry and from company to company. Key drivers of capital intensity include the nature of the industry, the effectiveness and efficiency of the capital process, the degree of vertical integration, and the price charged per unit of output delivered by the capital facilities.

The following discussion will show that water and wastewater utilities are among the most capital intensive business entities. Businesses that are highly capital intensive “must develop effective decision and control processes over capital spending and asset management. Key process controls include review of proposed expenditures to ensure business and economic justification, reviews to monitor project implementation, post audits, physical control over existing assets, and identification and disposal of underutilized assets” (Alexander 2006). Businesses with high capital intensity must also reflect these conditions in the long term pricing of the product or service provided or face significant issues with the financing implications for the replacement or expansion of services over time.

DATA SOURCES

The following analysis is based on the data sources and sample sizes summarized below:

- 2005 National Association of Clean Water Agencies (NACWA) survey (138 utilities)
- 2006 American Water Works Association (AWWA) rate survey (sample size 265)
- 2004 American Water Works Association/Raftelis Financial Consulting (AWWA) survey (sample size 265 utilities)
- Associated Utility Services (AUS) utility reports
- Standard & Poors (S&P)

COMPARATIVE CAPITAL INTENSITIES

The following discussion defines the ratio of net asset value to annual operating income as its measure of capital intensity. Identifying that water utilities are among the most capital intense industries is an important precursor in conveying the importance of achieving capital efficiency to water utilities. Figure 2.1 on the following page summarizes relative capital intensities and is a composite of calculations performed by the project team and Ms. Kathy Pape of Aqua
In Figure 2.1, the S&P industrials include data from 498 of the S&P 500 (two were not included due to limited data). Table 2.1 presents the number of utilities represented in the bars 3 through 5 in Figure 2.1 (bar 6 is the average of bars 3 through 5 and, thus contains 123 utilities):

**Table 2.1**

<table>
<thead>
<tr>
<th>Number of utilities represented in bars 3 through 6 in Figure 2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Large IOU Water</strong></td>
</tr>
<tr>
<td><strong>Electric</strong></td>
</tr>
<tr>
<td><strong>Combined electric and gas</strong></td>
</tr>
<tr>
<td><strong>Gas Distribution</strong></td>
</tr>
<tr>
<td><strong>Telephone</strong></td>
</tr>
</tbody>
</table>

* Included in electric bar 4

It is interesting to note that other regulated industries (electric, gas and telephone) have significantly lower capital intensities. This may be due (as noted on the previous page) to the nature of the industry. However, it is interesting to note that investor owned utilities (IOUs) have lower asset to revenue ratios than municipal utilities. When this was presented to the EPA Expert Workshop on Full Cost Pricing (November 1-3, 2006, East Lansing Michigan), state utility regulators and representatives from IOUs opined that this better performance by IOUs was due to:
1. IOUs have to meet the “used and useful” test on capital additions and are thus constrained from oversizing.

2. Capital additions are made from owner’s equity. A large portion of capital improvements made by municipal utilities is debt funded through rates.

3. CIP approvals are made by commissions and staffs that review many utility CIPs; municipal utility reviewers are only familiar with that one utility

This issue was discussed in a panel of utility managers drawn from our Utility partners. Our municipal utility panel was not surprised, noting as possible factors:

- Pressure from elected officials to build plant that might not meet the cost-benefit test or the “used and useful” test as applied by regulators
- The oversizing of municipal facilities
- Risk averse contracts mandated by owner governments

**ADDITIONAL COMPARISONS BETWEEN MUNICIPAL UTILITIES AND IOUs**

The previous discussion dealt with the differences in ratios between municipal utilities and IOUs. However, the problem with ratios is that an unusually different value in either the numerator or denominator can throw off comparisons (another way of saying this is that maybe IOUs look better because their rates are substantially higher, thus lowering the ratio). If this were the case, one would expect to see it in such ratios as net plant per person served and operating revenue per person served. Table 2.2 presents this comparison using the 2004 NAWC data for IOUs and 2006 AWWA rate survey data for municipal utilities:

<table>
<thead>
<tr>
<th>Type of Utility</th>
<th>Investor Owned</th>
<th>Municipal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Plant/person served</td>
<td>$690</td>
<td>$756</td>
</tr>
<tr>
<td>Operating Revenue/person served</td>
<td>$168</td>
<td>$116</td>
</tr>
</tbody>
</table>

In this comparison, the advantage of the IOU narrows because of the higher revenue per person. This higher revenue per person reflects that IOUs have some costs that municipal utilities do not have (taxes) and likely reflects that the average NAWC utility is smaller than the average utility in the AWWA survey. Another potentially useful comparison is to compare operations and maintenance cost per account. This would be a check on the capital/O&M tradeoff (i.e., less money being expended on capital in exchange for a higher level of operations and maintenance). Unfortunately, the AWWA survey data did not permit the calculation of this rate. Instead, we went to the 2006 AWWA benchmarking survey (64 water only utilities). Table 2.3 presents this comparison on the following page:
Table 2.3
Comparison of O&M expense per account for investor-owned and municipal utilities

<table>
<thead>
<tr>
<th>Type of Utility</th>
<th>Investor Owned</th>
<th>Municipal</th>
</tr>
</thead>
<tbody>
<tr>
<td>O&amp;M $/account</td>
<td>$322</td>
<td>$269</td>
</tr>
</tbody>
</table>

Thus, while it initially appeared that IOUs were much less capital intensive than municipal utilities and therefore possessed significant cost of service advantages, that advantage is somewhat offset by the higher level of revenues and the way they handle the O&M/capital tradeoff. Further complicating this analysis is the “snow flake to tap” responsibility and capital investment consequences for major municipal utilities such as Seattle’s watershed reservoir system, San Francisco’s Hetch-Hetchy System for reservoirs and 200+ mile transmission line, and New York City’s Catskill. Often, the IOU system is able to obtain its raw water supply from these systems and thus avoid this area of capital investment.

Differences in capital intensity could also result from differences in practices. Although our survey sample (discussed in Chapter 6) was too small to draw firm conclusions, IOUs tend to score better than municipals in the following areas:

- Planning
- Design
- Consultant selection
- Use of performance measures

The project team’s experience with Asian utilities is that they are also less capital intense. While there are many reasons for this, Asian utilities seem to be more open to alternative contracting methods and to incorporate lessons learned into their capital process. For example, the Shanghai Water Assets and Operations Division (this is not a division, but the actual name of the utility) incorporates into the capital process a planned for and funded post mortem at the end of each project in which they identify what went well, what didn’t, and how the process should be changed in the future to improve the process. As is the case with Singapore, Shanghai’s process also includes an evaluation of the optimum procurement methodology for each project.

Is The Capital Intensity of Water Utilities Rising?

If utilities were not able to raise rates to match the increased rate of capital expenditures (a problem for utilities when capital costs increase rapidly), we would expect to see asset to revenue ratios increasing. From 2004 to 2006 (based on more than 200 utilities as surveyed for AWWA for its annual Water and Wastewater Rate Survey), the average asset to revenue ratio for
the same utilities increased by 3.8%. This shows that while capital costs are increasing, rate increases are not keeping up.

**Can O&M Cost Reductions Offset (for rate purposes) Capital Intensity Increases?**

The National Association of Clean Water Agencies (NACWA) has been surveying a similar group of wastewater utilities asking similar questions every three years since the early ‘80s. The following summarizes the same utility O&M cost increases (or decreases) for three year intervals for a nine year period (shown by the year of the data, surveys are published one year later):

- From 1995-1998 (1999) ……………..-10.8%
- From 1998-2001 (2002)………………..+9.4%
- From 2001-2004 (2005)………………..+13.4%

There does not appear to be a comparable set of data for water utilities, however it is possible to calculate likely O&M costs from the AWWA rate survey data. From 2004 to 2006, the average O&M increases outpaced revenue increases (26% vs. 24%).

**CONCLUSION**

The key conclusions to be drawn from this analysis are:

- Water and wastewater utilities may be the most capital intensive sectors of the economy
- Highly capital intensive businesses must be efficient in their capital process and related decision making
- Other regulated utilities consisting of plant and distribution networks (electric, gas and telephone) are significantly less capital intensive
- IOUs are less capital intensive although their apparent advantage is somewhat offset by higher revenues per person served and higher O&M costs per person served
- Differences in practices (e.g. redundancy, reserve capacity, maintenance standards and practices, project planning & delivery methods, contracting requirements) may also account for differences in capital intensity
- Capital intensity has been rising for water utilities
- After years of O&M efficiency improvements, O&M cost increases are now outpacing inflation

The bottom line is that, being extremely capital intensive, water utilities must strive to become more capital efficient. It appears that improving practices may be one way to improve capital efficiency.
CHAPTER 3
TWENTY-YEAR CAPITAL NEEDS

In the previous chapter we identified that becoming capital efficient is extremely important to water utilities because they are so capital intensive. In this chapter, we discuss the forces that will be increasing the level of capital expenditures for the next few decades.

US EPA’S 20 YEAR CAPITAL NEEDS SURVEY

The US EPA conducts a 20 year Capital Needs Survey every four years in an attempt to estimate for policy makers the infrastructure expenditure needs of this sector. A similar effort is also performed for wastewater agencies. The report is typically issued two years after the date of the data itself, so the 2003 Needs Survey was issued in 2005; the 2007 Needs Survey, ongoing as this is written, will be published in 2009.

The 2003 EPA Needs Survey showed an increase of 67% from the previous two needs surveys, which had stayed relatively flat, as shown below in Figure 3.1:

![Trends in EPA Twenty Year Capital Needs](image)

Figure 3.1 Trends in EPA twenty year capital needs

The reasons for this increase and a look into the future can be found in the U.S. EPA Document “The Clean Water and Drinking Water Infrastructure Gap Analysis” (EPA 2002). The capital needs distribution of the U.S. drinking water systems is shown in Figure 3.2 on the following page:
Figure 3.2 Distribution of capital needs by water infrastructure category

The largest portion of the water industry capital needs is in the transmission and distribution system network. Using detailed data from a 20-city study of the distribution of pipes, based on the age of the pipes, pipe material and other factors, the following curve in Figure 3.3 was developed in an AWWA study, Dawn of the Replacement Era - Reinvesting in Drinking Water Infrastructure (AWWA 2001), to project annual replacement needs:

Figure 3.3 Projected annual replacement need - T&D
This curve was developed using a simplified aging model and a normal distribution of expected life based on date of installation. Life expectancies in the model range from 50 to 160 years. While this projection of capital needs is not perfect, it is interesting to note that the area under the curve for the period 2020 to 2040 is approximately three times the area for the 2000 to 2020 period. The capital costs, in actual dollars, will obviously increase significantly more than this three times multiple as inflation and cost pressures continue to drive up the cost of the pipes and their installation.

A look at Figure 3.2 and Figure 3.3 explain the increase in the 2003 Capital Needs, since it was the first performed after the expected acceleration in distribution system replacement as displayed in the projection. With transmission and distribution system replacement needs exceeding 50% of total needs, the cost implications for future years will continue to show significant increases. One would also expect that the 2007 Capital Needs survey currently being conducted, would develop even higher capital replacement costs than the 2003 results as measured in absolute dollar costs. However, the increase from 2003 to 2007 in non-inflation adjusted dollars is anticipated to be only slightly above the increase from 1999 to 2003.

THE 2007 TWENTY-YEAR CAPITAL NEEDS SURVEY

To estimate what the 2007 survey might produce we interviewed capital projects manager from the Utility Advisory Group (UAG) formed to assist and advise this research (the UAG is a committee of utilities that provide feedback and input on the direction of the study, as well as participate in some of the pilots and other research activities). Most reported that bid prices were exceeding the engineer’s estimate. Their analysis was that bid prices were higher because of:

- Rapidly rising raw materials prices
- Supply-demand issues – more jobs being put out to bid to a static number of contractors, some of whom are facing skilled worker shortages
- Conservative bidding either in the form of higher contingency allowances, stacking of subcontractors (in some cases these contingency increases were being driven by sureties)

To compare this anecdotal information, we reviewed the pace of construction activity as well as changes in the costs of materials and components for construction. In the first 11 months of 2006 (viewable at www.census.gov/constructionspending), the dollar value of water supply construction increased by 10%. Unfortunately, the producer price index (PPI) for materials used in “other heavy construction”, as distinguished from street and highway, residential and non-residential building (viewable at www.bls.gov/ppi) increased as recently as last August at an annualized rate of 10%, meaning that the overwhelming majority of the increase in water construction reflected increased materials prices. Taking into account the other comments we received from our UAG, it is likely that, in terms of actual assets put in the ground, the water industry was actually losing ground on the needed recapitalization of the water industry.

Construction industry personnel we interviewed point to an additional problem. They contend that there are insufficient replacements for the skilled construction trade workers who are retiring. Some members of our UAG identified instances where contractors were unable to field complete construction crews for this reason. Similarly, the generational turnover in the
water utility sector will have some impact on capital efficiency, as the unique, anecdotal and tacit knowledge retirees have is lost. Chapter 5 will discuss this issue in more detail.

THE RATE IMPLICATIONS OF TWENTY-YEAR NEEDS

The EPA, in the 2003 Needs Survey, estimated that the higher 20-Year Needs meant that rates would have to increase at twice the rate of inflation (EPA 2005). They factored into their estimate increased efficiency levels. In order to test out this forecast, we developed a simplified financial model to project out to 2030. This simplified model assumed a 50/50 distribution between Capital and Operations and Maintenance (O&M) (roughly the NACWA distribution). We assumed O&M increases of 1% above the rate of inflation (roughly what has been the case recently) through 2010. From 2011 to 2020, to reflect the transition from Baby Boomers to Millennials and the anticipated engineering shortage, we assumed that O&M would increase at 2.5% above the rate of inflation as wages are increased to attract people from a limited labor pool. After 2020, O&M increases were reduced to the rate of inflation. Capital was increased to reflect increases in transmission and distribution systems replacement (about 7.5% increases each year). Although actual construction inflation has been in excess of 10% we kept inflation at 3% to allow for occasional economic downturns. The 100 indexed dollar reflects revenue requirement at 100% in 2003 with estimated inflation through 2030. Therefore, revenue requirements in 2011 are projected to be 200 or twice the 2003 level. The resulting cost projection is shown in Figure 3.4 below:

![Projected Revenue Requirements](image)

**Figure 3.4 Projected revenue requirements**

Another key issue to examine is where will the greatest rate impact come from – O&M or capital? Since capital currently represents a slightly larger percentage of the average utility’s revenue requirement than O&M, a 1% capital efficiency improvement should have a slightly
better impact on rates than a 1% efficiency increase in O&M. However, going forward two factors come into play:

1. Substantial O&M efficiency improvements have been realized in the past 15 years while the era for capital efficiency improvements may be just starting. The recent increase of O&M costs relative to inflation may indicate that the capacity for O&M efficiency improvements has been mostly played out. On the other hand we appear to be at a relatively early point in capital efficiency improvements with early adopters of asset management reporting sizeable savings.

2. Capital needs and expenditures will be growing faster than O&M at least through 2040, so that a given percentage efficiency increase in capital will produce increasingly more rate benefits than a similar percentage efficiency increase in O&M.

The following graph in Figure 3.5 shows the effect on rates of a continuation of current trends for capital and O&M versus an assumed 3% annual inflation rate. After 2010, comparable efficiency improvements will yield a greater rate of improvement if achieved on the capital side rather than on the O&M. A review of the case studies and out-of-industry experience (see Chapter 13, among others) indicate that there is more opportunity for efficiency improvements in capital than in O&M.

![Figure 3.5 Revenue requirement growth under current O&M and capital trends](image-url)
CHAPTER 4
THE UTILITY MANAGER’S VIEW OF THE CAPITAL PROBLEM

Interviews with utility capital program managers produce a very similar set of capital program cost drivers:

- Rising raw material costs
- Supply-demand issues (too many projects chasing too few contractors)
- Personnel shortages at contractors
- Risk aversion by various participants in the process

The following sections will examine each of these and explore whether they are short term or long-term problems.

RAW MATERIAL COSTS

When it comes to materials of construction, we are now living in a global economy. Two very populous countries are going through concurrent building booms, which are driving up the costs of materials of construction. Figure 4.1, below, shows how much of the world’s resources are being consumed by one of those countries – China. Within a ten-year period, China’s use of raw materials doubled:

![Chinese Raw Materials Consumption as Percentage of Total World Demand](chart)

Source: Wall Street Journal Graphic

Figure 4.1 Chinese raw materials consumption as a percentage of total world demand
Rising raw materials costs can increase capital costs in two ways:

- In cost plus arrangements, these increases are passed through
- In fixed price bids, contractors must prudently anticipate the extent to which these costs will continue to rise through to the completion of construction. The result is a substantial increase in raw materials costs whether it actually happens or not

**SUPPLY DEMAND ISSUES**

Since a majority of the water sector’s capital costs are attributable to replacements of post World War II infrastructure, it is reasonable to expect that other sectors will be going through the same replacement process. Additionally, a recent high profile bridge failure may accelerate some of this construction. Housing will go through booms and occasional busts (the current downturn and foreclosure experiences at the end of 2007 are the latest example) but can be expected to rebound with the economy in the long term. Demographics (the move to senior housing) and energy (the move away from sprawl) are additional housing drivers that will assist and accelerate the rebound.

**PERSONNEL SHORTAGES**

A number of utilities are beginning to experience capital program personnel shortages, as the generational turnover in utility personnel progresses. More than half of the utility surveyed by this study reported shortages in their engineering department. These shortages are the result of retirements and difficulties in hiring replacements – a number of studies have documented that as demand for engineers is increasing the output of new graduate engineers is dropping. This affects utilities in two ways – engineers have to manage more programs (the New York City case study is a good example – see Chapter 13) leading to reduced oversight and the important tacit knowledge that leaves with retirees, which impacts design decision making.

Personnel shortages are also evident at the job site. The nation’s complement of skilled construction workers is beginning to retire and there are insufficient young trainees to replace them. This became evident following Katrina as a number of utilities in the Southeast reported job stoppages due to inability to field complete construction crews.

**RISK AVERSION**

Many utilities continue to utilize capital program and contracting approaches that were established in another era (abundant construction & design labor, relatively stable prices, and a risk-shifting paradigm that insulated the utility from exposures, but with acknowledged additional cost & schedule implications). Usage of these paradigms now have utilities paying significant premiums for guaranteed costs and schedules where excessive risks are shifted to the contractor or design firm. In many instances, the contractor is required to accept risks over which the contractor has no control. In response, these firms have added significant “cost premiums” as their response for dealing with the increased risks being transferred or assigned.

Fortunately, these trends and their implications are being identified and revisions to the long established paradigms are emerging. Examples include the following:
• Meeting with contractors to identify steps needed to become a “client of choice” (see Chapter 12 for some examples)
• Absorbing raw material cost increase risk (this also results in keeping the savings in the event of raw material price reduction)
• Reducing insurance costs for small contractors through the use of Wrap Insurance
• Becoming more flexible in the use of Alternative Project Delivery
CHAPTER 5
A BROADER VIEW OF THE PROBLEM

The previous chapter took the utility manager’s view of the capital problem. In this chapter, we take a broader view, incorporating viewpoints from the multiple stakeholders in this process—utilities, A/E firms, contractors and others. During the study, we conducted a number of meetings with interested groups and conducted interviews with individuals involved in/interested in the process. The following is a distillation of these discussions by broad topic area.

RISK

A common theme during our kickoff meetings and with a focus group of utility managers was the role of the municipal utility contract in increasing costs. The standard contract terms of utilities that are owned by governments (i.e., City/county departments etc.) place so much risk with contractors that knowledgeable bidders add substantial contingency amounts to cover future additional contractually related costs. Those utility managers that would hazard a guess estimated that these contracts (as opposed to a contract that would fairly balance risk between the owner and contractor) could escalate costs by up to 25%. Some of our case study utilities that had meetings with their contractors received similar feedback and estimates. While it may be comforting for the utility, its owner, and legal counsel to transfer all risk to contractors, it is highly unlikely that the cost of doing so (in higher and/or fewer bids) is adequate compensations for the increased level of comfort. Also, there are some areas where governmental entities (85% of all water utilities) have substantially less risk liability than private sector contractors. Bottom line: excessive risk transference (to contractors) actually increases overall risk and costs.

A related problem is the role of sureties in producing higher bids. A series of natural disasters have hurt surety’s profitability affecting the number of bids and the size of the bids on utility projects. One of the utilities we spoke to received no bids on one project because bidders were unable to receive the required bonding from their sureties due to the surety’s concerns about the contract terms. In other cases, we have found that sureties have been requiring increased contingencies (up to 30%) before they would bond bidders.

In addition to the cost implications from the excessive assignment of cost effective risk to the contractor, municipal utilities tend to be risk averse in making capacity related decisions. While this is understandable (the penalty for under sizing is greater than the reward for correctly sizing utilities—some managers insist that there is no reward for correctly sizing) low capacity utilization is expensive, particularly when bricks and mortar costs are rising as fast as is currently the case.

CONTRACTORS’ VIEW

Contractors that were interviewed produced the following groups of reasons listed here (many variations of previously presented factors were identified by the interviews):
• Energy costs have spiked significantly
• Insurance and bonding rates have gone through the roof
• Lack of skilled workers
• Global material demand exceeding supply
• Experiencing an inter-related global economy
• Domestic material production not keeping up
• War on terror and natural disasters
• China and India
• Stringent government agency regulations
• Delayed site inspections and plan reviews
• Bad initial budgets
• Higher workmen’s comp costs
• Difficulty in finding reliable subs

As a generalization, these interviews also developed the theme that experienced contractors and their sub pool are generally all busy and have the luxury of being selective. There are plenty of good public and private projects to choose from out of the overall group of projects. Contractors will favor those with the fairest contracts and the likelihood of higher profits and more predictable workload. Some contractors listed some additional reasons why municipal utilities are not the most attractive customers:

• Slow payment of invoices
• Design is never finalized
• Slow to respond to requests for information (RFIs)

COST ESTIMATION

When construction cost inflation was relatively mild, identifying how inflation would affect a multi-year CIP might not have been a high importance issue. However, when construction cost inflation is in the double-digit area with higher spikes in some sections of the country, paying attention to the impact of cost increases and how cost estimation is carried out is extremely important. One utility, which experienced bids coming in at a multiple of the engineer’s estimate, evaluated their procedures and identified the following problems:

• Cost estimates were infrequently updated. This lead to a failure to account for construction market escalation and did not allow errors in previous estimates to be corrected.
• Overly preliminary designs were used as the source for cost estimates. In some cases no engineering design had been done.
• Cost estimates were generated prior to site selection. When site conditions are not taken into account, costs cannot be accurate.
• Contingency amounts were not risk adjusted. This becomes a problem during high inflation periods.
• Cost estimates were not inflated to the midpoint of construction but rather provided in today’s dollars.

POLITICAL/GOVERNANCE

Many municipal utilities are governed by boards which consist of political appointees (sometimes elected members) or by city councils resulting in the potential for a high level of political considerations in decision making. Utility managers noted:

• Politicians can force the building of non-cost effective facilities (based on location, sizing or other non-economic considerations)
• Without the discipline imposed by the regulated utility’s “used and useful” requirement, it is easier to overbuild
• Politicians can severely delay projects resulting in inflationary cost increases
• Indecisive politicians may ask that “another card be turned over,” i.e., asking that something else be taken into consideration or that additional data be gathered. This increases project cost due to the resulting delays, but also places value on an element that may have little or no relevance to the project, thus weakening decision-making.

PROCESS MANAGEMENT

Both across and within utilities there is a great deal of variability in how the capital process is managed. Many utilities follow the “project manager is king” approach in which each project manager runs things their own way. This increases overall capital project and program costs due to the variability in approaches and processes, as well as presenting succession problems because of the high levels of tacit knowledge associated with this approach. Overall, there is a surprising lack of the use of benchmarks and metrics in the process. There is also a lack of commitment to continuous improvement – most utilities do not go through a lessons learned process following project completion. The focus on high visibility projects (regulatory, growth related etc.) leads to smaller projects “staying under the radar” and rarely being reviewed. As a result, small projects that cost too much and take too long are the inevitable result when assessed over time. Many utilities develop their CIPs without considering resourcing, resulting in insufficient or improperly staffed project teams. Less than half of the utilities surveyed invest 1% (Carter 2007) of their total project budget for labor/wages in training. A Construction Industry Institute study on construction industry craft training in the US and Canada (2007) documented that investing a target of 1% in training would produce:

• An 11% productivity improvement in capital projects
• Absenteeism cost decrease of 15%, and
• Injury decrease of 26%

CONTRACTOR RELATIONS

Many utilities follow a low bid selection rule because of their internal rules or to avoid litigation from disgruntled bidders. Over time, this reduces the quality of the bids received. A
related problem is that many utilities do not incorporate rewards for previous good work into their selection criteria. The procedures used by some utilities limit the field of desired bidders. Many small firms (MBEs and WBEs) complain of the excessive costs associated with prequalifying annually to be able to bid on projects. Lack of reasonable assistance and an overly adversarial approach to conflicts are cited by contractors. Many municipal utilities have a reputation as slow payers, creating problems for smaller, less capitalized firms (in many cases this is not the utility’s fault, as many governments require that money handling be under the control of the Finance Department – a separate agency).

JOB SITE

Surveys performed as part of Project Cornerstone show that only 25% of the time on site is being spent at high productivity. Some of the causes of low productivity include:

- Waiting for necessary materials or equipment (poor job site logistics)
- Over processing (i.e., excessive inspection)
- Process changes during design
- Incomplete design at start
- Slow RFI response time
- Owner or owner’s rep not available to sign permits
- Excess inventory on crowded site
- Excessive defects and rework

(Project Cornerstone was a study jointly funded by B&V and the Building and Construction Trades (AFL-CIO) that was completed in 2005. The Building and Construction Trades was an original partner in the study but the study is no longer available to the public.)
CHAPTER 6
CAPITAL EFFICIENCY SURVEY

Part of the research study included surveying utilities to get an assessment of the degree of organizational capabilities and capital program practices. A survey was conducted to determine the following:

- The range of water utility capital capabilities
- The extent of water utility capital program Best Practices
- The use of capital benchmarks and metrics and the resulting range of values
- Other Information such as problems encountered, major needs etc.

The basis for the survey instrument was the California Multi-Agency CIP Benchmarking Study. The complete survey instrument for this project is presented in Appendix C. The number of completed survey responses was below expectations, due in part to a surprisingly high level of succession issues encountered by participating utilities during the course of the study. One of our participating utilities went through two changes at the top during the study period; half of the respondents complained of inadequate staff and difficulty in hiring replacements. However, many of those who took the survey found it useful and volunteered that they gained some useful ideas and insights during the process. The following sections present the major results of the survey.

SURVEY SAMPLE

Only 28 completed surveys were received. The low turnout was related to a high level of turnover (many of the utilities in our Utility Advisory Group experienced retirements during the course of the project and others experienced a combination of both a retirement and a reassignment) and low staffing levels (half of our utilities reported being short of engineering staff and many complained of difficulties in finding new hires). The distribution of utilities by type is presented below in Table 6.1:

<table>
<thead>
<tr>
<th>Utility Type</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public-Enterprise Fund</td>
<td>46.4%</td>
</tr>
<tr>
<td>Public – Non enterprise fund</td>
<td>3.6%</td>
</tr>
<tr>
<td>Public-Independent Authority</td>
<td>42.9%</td>
</tr>
<tr>
<td>Investor Owned</td>
<td>7.1%</td>
</tr>
</tbody>
</table>

The percentage of investor owned in our sample is about one-half the percentage found in the population of water utilities.
UTILITY INFORMATION

Table 6.2 summarizes the range of population served, staffing levels, and various financial information for our survey participants (i.e. the sample):

Table 6.2
Survey respondent utility information profile data

<table>
<thead>
<tr>
<th>Utility Information</th>
<th>Low</th>
<th>Median</th>
<th>High</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Served</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail</td>
<td>50,000</td>
<td>770,000</td>
<td>15,000,000</td>
<td>1,787,151</td>
</tr>
<tr>
<td>Wholesale</td>
<td>0</td>
<td>250,000</td>
<td>3,700,000</td>
<td>894,254</td>
</tr>
<tr>
<td>Staff Size</td>
<td>34</td>
<td>210</td>
<td>7,000</td>
<td>994</td>
</tr>
<tr>
<td>Net Asset Value</td>
<td>57,847,532</td>
<td>559,440,366</td>
<td>5,899,581,161</td>
<td>1,161,165,499</td>
</tr>
<tr>
<td>Annual Revenues</td>
<td>6,300,000</td>
<td>122,000,000</td>
<td>1,410,894,217</td>
<td>208,513,029</td>
</tr>
<tr>
<td>Outstanding Debt</td>
<td>12,720,000</td>
<td>480,664,987</td>
<td>2,300,000,000</td>
<td>652,014,655</td>
</tr>
<tr>
<td>Annual Debt Service</td>
<td>1,231,342</td>
<td>13,700,000</td>
<td>219,500,000</td>
<td>47,184,631</td>
</tr>
<tr>
<td>Five-Year (5) CIP</td>
<td>10,000,000</td>
<td>279,500,000</td>
<td>2,907,815,000</td>
<td>630,705,127</td>
</tr>
</tbody>
</table>

CAPITAL INDICATORS

Performance indicators related to capital plant were used. Table 6.3 summarizes the key capital indicators for the survey sample:

Table 6.3
Summary of survey respondent capital indicators data

<table>
<thead>
<tr>
<th>Capital Indicators</th>
<th>Low</th>
<th>Median</th>
<th>High</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Intensity Ratio</td>
<td>2.95</td>
<td>5.86</td>
<td>20.35</td>
<td>5.57</td>
</tr>
<tr>
<td>Outstanding Debt as % of assets</td>
<td>6%</td>
<td>47%</td>
<td>155%</td>
<td>56%</td>
</tr>
<tr>
<td>5 yr. CIP %Net Asset Value</td>
<td>9%</td>
<td>44%</td>
<td>320%</td>
<td>61%</td>
</tr>
<tr>
<td>5 yr. CIP %Outstanding Debt</td>
<td>17%</td>
<td>94%</td>
<td>699%</td>
<td>98%</td>
</tr>
</tbody>
</table>

UTILITY CAPITAL CAPABILITIES

Not only was it important to gauge how utilities measured for capital related performance indicators, it was also important to determine what kind of internal capabilities each possessed. The survey used the list of in-house project delivery services shown in Table 6.4, on the following page, to categorize utilities:
Table 6.4
Percent of survey respondents with specific in-house project delivery capabilities

<table>
<thead>
<tr>
<th>Available In-House Project Delivery Services</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
<td>100%</td>
</tr>
<tr>
<td>Design</td>
<td></td>
</tr>
<tr>
<td>Architectural</td>
<td>18%</td>
</tr>
<tr>
<td>Structural</td>
<td>46%</td>
</tr>
<tr>
<td>Mechanical</td>
<td>46%</td>
</tr>
<tr>
<td>Electrical</td>
<td>54%</td>
</tr>
<tr>
<td>Civil</td>
<td>82%</td>
</tr>
<tr>
<td>Instrumentation &amp; Control</td>
<td>61%</td>
</tr>
<tr>
<td>Materials pre-qualification</td>
<td>54%</td>
</tr>
<tr>
<td>Geotechnical</td>
<td>25%</td>
</tr>
<tr>
<td>Construction Management (CM)</td>
<td>93%</td>
</tr>
<tr>
<td>Survey</td>
<td>39%</td>
</tr>
<tr>
<td>Real Estate</td>
<td>46%</td>
</tr>
<tr>
<td>Estimating</td>
<td>71%</td>
</tr>
<tr>
<td>Environmental</td>
<td>54%</td>
</tr>
<tr>
<td>Scheduling</td>
<td>68%</td>
</tr>
<tr>
<td>Inspection</td>
<td>86%</td>
</tr>
<tr>
<td>Compliance(testing &amp; lab)</td>
<td>43%</td>
</tr>
</tbody>
</table>

Based on the survey responses, it appeared appropriate to separate utilities into three classes:

- **Delegators** – these are utilities with limited in-house capabilities (0 to 4 capabilities) that rely largely on consultants. Examples of Delegators from our survey sample include Beaver Water District and Long Beach, CA.
- **Balanced Utilities** – these are utilities with 5 to 9 in-house capabilities. Typically, they will rely on consultants for major efforts such as treatment plants and large pump stations, but are capable of undertaking medium to small projects. Examples include Howard County Bureau of Utilities and the City of Norfolk, VA.
- **Full Service** – these are utilities with more than nine in-house capabilities. While they generally have a complete capability ranging from design all the way through to project completion, they may still contract out very large projects. Examples are Seattle Public Utilities, San Francisco PUC, and East Bay MUD.

Figure 6.1 summarizes the distribution of utilities by class in our sample on the following page:
Figure 6.1 Distribution of survey respondents by type

BEST PRACTICES

Figure 6.2 summarizes the level of practices compared to best practices by utility class (best practice is a score of 5):

Figure 6.2  Best practices survey score by utility class
USE OF BENCHMARKS AND METRICS

The level of use of benchmarks and metrics was mixed. The most commonly used metrics were “actual to budget” and “actual to planned (schedule)” which was used by 93% of respondents. Other metrics were more rarely used; the range of values and extent of use is summarized below in Table 6.5 and Table 6.6:

<table>
<thead>
<tr>
<th>Metrics</th>
<th>All</th>
<th>Full Service</th>
<th>Balanced</th>
<th>Delegators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual to Budget Ratio</td>
<td>68.0%</td>
<td>78.6%</td>
<td>45.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Actual vs. Planned (Schedule)</td>
<td>78.6%</td>
<td>85.7%</td>
<td>63.6%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Table 6.6

Range of average targets for certain capital project measures

<table>
<thead>
<tr>
<th>Metrics</th>
<th>All</th>
<th>Full Service</th>
<th>Balanced</th>
<th>Delegators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change Order %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>5.3%</td>
<td>4.4%</td>
<td>5.8%</td>
<td>10.0%</td>
</tr>
<tr>
<td>High</td>
<td>9.3%</td>
<td>7.2%</td>
<td>9.7%</td>
<td>25.0%</td>
</tr>
<tr>
<td>Claims %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>1.0%</td>
<td>0.0%</td>
<td>5.0%</td>
<td>NA</td>
</tr>
<tr>
<td>High</td>
<td>4.0%</td>
<td>3.8%</td>
<td>5.0%</td>
<td>NA</td>
</tr>
<tr>
<td>Design Cost %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>7.6%</td>
<td>7.8%</td>
<td>7.4%</td>
<td>NA</td>
</tr>
<tr>
<td>High</td>
<td>12.9%</td>
<td>13.0%</td>
<td>12.8%</td>
<td>NA</td>
</tr>
<tr>
<td>CM Cost %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>6.8%</td>
<td>7.3%</td>
<td>6.0%</td>
<td>NA</td>
</tr>
<tr>
<td>High</td>
<td>9.8%</td>
<td>10.9%</td>
<td>8.0%</td>
<td>NA</td>
</tr>
</tbody>
</table>

ALTERNATIVE PROJECT DELIVERY

The predominant form of project delivery was design-bid-build, used by all respondents. For most, it was the only method utilized. Relatively few utilities reported experience with Alternative Project Delivery approaches and methods. Table 6.7, on the following page, summarizes the percentage of utilities that have used various forms of project delivery:
Table 6.7
Use of alternative project delivery approaches and methods

<table>
<thead>
<tr>
<th>Delivery Methodology</th>
<th>All</th>
<th>Full Service</th>
<th>Balanced</th>
<th>Delegators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design-bid-build</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>CM/GC (CM at risk)</td>
<td>10.7%</td>
<td>7.1%</td>
<td>18.2%</td>
<td>0.0%</td>
</tr>
<tr>
<td>PM/GC (PM at risk)</td>
<td>3.6%</td>
<td>0.0%</td>
<td>9.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Design-Build</td>
<td>32.1%</td>
<td>14.3%</td>
<td>63.6%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Other</td>
<td>21.4%</td>
<td>28.6%</td>
<td>18.2%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

CAPITAL PROBLEMS

The reported problems were similar to the problems identified in the interviews. The two largest problems were rising raw material costs and affordability, followed by issues related to timing and project selection. Table 6.8 summarizes reported problems:

Table 6.8
Capital problems faced by survey respondents

<table>
<thead>
<tr>
<th>Capital Problems</th>
<th>All</th>
<th>Full Service</th>
<th>In-Betweeners</th>
<th>Delegators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Selection</td>
<td>46.4%</td>
<td>64.3%</td>
<td>27.3%</td>
<td>33.3%</td>
</tr>
<tr>
<td>Project Tracking</td>
<td>32.1%</td>
<td>35.7%</td>
<td>27.3%</td>
<td>33.3%</td>
</tr>
<tr>
<td>Material Costs</td>
<td>71.4%</td>
<td>78.6%</td>
<td>63.6%</td>
<td>66.7%</td>
</tr>
<tr>
<td>Timing</td>
<td>53.6%</td>
<td>57.1%</td>
<td>54.5%</td>
<td>33.3%</td>
</tr>
<tr>
<td>Affordability</td>
<td>71.4%</td>
<td>71.4%</td>
<td>72.7%</td>
<td>66.7%</td>
</tr>
<tr>
<td>Project Closeout</td>
<td>39.3%</td>
<td>50.0%</td>
<td>36.4%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Other</td>
<td>3.6%</td>
<td>0.0%</td>
<td>9.1%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

ANALYSIS

While the response rate is disappointing, the responses of capital program managers who took the survey was positive. Many reported that the process of taking the survey proved useful to them and that they might make some changes as a result. Although the sample is too small to reach conclusions with any statistical validity, the following are points suggested by the survey response:

- The need for improved capital program management and effectiveness is recognized however, awareness of how to proceed and tools for proceeding is limited.
- Better performers make greater use of benchmarks and metrics.
- Investor owned utilities seem to be better at design, planning and contractor selection
- Better performers tend to utilize project completion lessons learned as part of continuous improvement.
CHAPTER 7
CAPITAL EFFICIENCY INFORMATION SOURCES

This chapter identifies some of the sources of information available to utilities seeking to become capital efficient. These sources include:

- Sources of Best Practice information
- Sources of inflation factors
- Data that will permit the utility to gauge the level of supply and demand in their local area

BEST PRACTICE INFORMATION

There are a number of sources of Best Practices. This section will focus on three of the sources that appear to be the most relevant to water utilities:

- The California Multi-Agency (CMA) CIP Benchmarking Study (2002)
- The Construction Industry Institute (CII) (2006), and
- The Lean Construction Institute (LCI)

Each group of practices is somewhat different in focus so water utilities are encouraged to analyze each source as to its applicability for their utility or within their program. For example, a utility could utilize CMA at the program level, CII at the project level and use LCI principles only for large plant projects. The following is a brief overview of each:

- The California Multi-Agency (CMA) CIP Benchmarking Study is a study undertaken by seven of the largest municipalities in California. The best practices identified in their reports are consensus best practices, basically the result of informed expert opinion. The projects studied were programs and projects carried out by municipal agencies (about 85% of water utilities are municipal utilities) and the best practices are applicable to both the program and project level.

- The Construction Industry Institute (CII) is a membership organization, located at The University of Texas at Austin, composed almost entirely of private sector members. CII uses a validation process to accept a practice as a Best Practice. Of importance to this project is their statistical validation process that provides a sound basis for their estimates of cost and schedule savings associated with each Best Practice. CII currently has 14 validated Best Practices. CII best practices are primarily project oriented.

- The Lean Construction Institute seeks to bring the Toyota “lean production” process to construction.

The following discussion describes each program in more detail, including the size of the project database. Also included is a cross-walk between the CMA consensus Best Practices and the CII validated Best Practices.
California Multi-Agency CIP Benchmarking Study

Seven of the largest municipalities in California have been working together to identify how to make capital projects more efficient. Six reports have been issued. The 2002 California Multi-Agency CIP Benchmarking Study presented design and construction management cost data on 239 completed projects with a total construction value of $490 million. In Update 2003 the list increased to 453 projects with a total construction value of $830 million. Update 2004 includes project delivery costs on 595 projects with a construction value of nearly $900 million. Update 2005 includes project delivery costs on 642 projects with a construction value of nearly $933 million. Update 2007 includes project delivery costs on 698 projects. For those interested, details and reports are available at the following Web address http://eng.lacity.org/techdocs/cabm/.

The CMA CIP Benchmarking study divides the Capital Process into the following six categories:

- Planning
- Design
- Quality Assurance/Quality Control
- Construction Management
- Project Management
- Consultant Selection and Use

The report lists 32 Best Practices. These are presented in Appendix A. As noted earlier, these are consensus best practices and have not been subject to a formalized validation process or procedure.

Construction Industry Institute

The Construction Industry Institute (CII) is a membership organization based at The University of Texas, Austin. Their Web site address is at http://www.construction-institute.org/scriptcontent/Index.cfm. CII uses a validation process to accept a practice as a Best Practice. Of importance to this project is their statistical validation process that provides a sound basis for their estimates of cost and schedule savings associated with each Best Practice. CII currently has 14 validated Best Practices. These, as well as their definitions, are presented in Appendix B. Some of the steps involved in the validation process are described below:

- The database of projects used to perform the analysis is provided by member organizations. Each organization submitting data is required to have someone go through CII benchmark training.
- Multiple, specific questions are used to identify the intensity of practices used.
- Data is reviewed by the benchmark-trained individual prior to being submitted to CII.
- The data is reviewed again at CII to identify inconsistencies in data, missing data, etc.
- Outliers are then identified. The criteria for outliers is 1.5 x interquartile range (the range for the middle 50% of values).
• Since most organizations use multiple practices, projects representing groups of practices are separated into four quartiles ranging from low to high intensity of use. These are then tested for statistically significant differences.
• Linear regression is used to estimate the impact of individual practices.

**Lean Construction Institute**

The Lean Construction Institute (LCI) was founded in August, 1997 and is now a non-profit corporation. LCI does research to develop knowledge regarding project based production management in the design, engineering, and construction of capital facilities.

LCI aims to extend to the construction industry the Lean production revolution started in manufacturing. This approach maximizes value delivered to the customer while minimizing waste. LCI understands that designing and building is different from manufacturing, but principles drawn from Lean Production Management can be applied through techniques tailored for application over the life of a project. Taken together these principles and techniques form the basis for the *Lean Project Delivery System*™. LCI’s Lean Principles are applied at five areas:

• **Customer Focus**
  - Meet customer requirements
  - Define value from the viewpoint of the customer
  - Use flexible resources and adaptive planning
  - Cross train crew members to provide production (project site) flexibility
  - Use target costing and value engineering

• **Culture/People**
  - Provide training at every level
  - Encourage employee empowerment
  - Ensure management commitment
  - Work with subcontractors and suppliers

• **Workplace Organization and Standardization**
  - Encourage workplace organization and use 5S (sort, stabilize, shine, standardize, sustain)
  - Implement error proofing devices
  - Provide visual management devices
  - Create defined work processes
  - Create logistics, material movement, and storage plans

• **Waste Elimination**
  - Minimize double handling and worker and equipment movement
  - Balance crews; synchronize flows
  - Remove material constraints with kits and reduce input variation
  - Reduce difficult setup/changeover
  - Reduce scrap
  - Use total productive maintenance
  - Institute just in time delivery
  - Use production planning and detailed crew instructions, predictable task items
  - Implement Last Planner, reliable production scheduling, short interval schedules
- Practice the last responsible moment, pull scheduling
- Use small batch sizes, minimize work in process inventory
- Use decoupling linkages. Understand buffer size and location
- Reduce the parts count, use standardized parts
- Use preassembly and prefabrication
- Use preproduction engineering and constructability analysis

**Continuous Improvement and Built In Quality**
- Prepare for organizational learning and root cause analysis
- Develop and use metrics to measure performance, use stretch targets
- Create a standard response to defects
- Encourage employees to develop a sense of responsibility for quality

More information about LCI can be found at http://www.leanconstruction.org/.

**COST INFLATION AND COST ESTIMATION**

Experience has shown that increased expenditure levels (such as the period that the industry has been in since the turn of the century) leads to increases in construction cost inflation, as shown in **Figure 7.1** below. As a result, it becomes crucial that utilities understand the sources of cost estimation and construction inflation data and select the one(s) that is most appropriate for them.

![Figure 7.1 Construction cost index value over time](source)

*Source: Engineering News Record*

**Figure 7.1 Construction cost index value over time**
There are three primary sources of cost indexes:


The following discussion contains materials extracted from the three Web sites noted above.

**Handy - Whitman Indices**

The Handy-Whitman Indices show the level of costs for different types of utility construction. Separate sets of indexes are published for the electric, gas and water industries. Each set of indexes are maintained for general items of construction, such as reinforced concrete, and specific items of material or equipment, such as pipe or turbo-generators. All indexes begin in 1912. These publications are used by regulatory bodies, operating bodies, operating utilities, service companies, valuation engineers, and equipment industries. Hardy-Whitman Index numbers are widely used to trend earlier valuations and original cost at prices prevailing at a certain date. They are the only published indexes specifically tailored to the utility industry. The gas and electrical indexes have been published semiannually since 1924, and the water indexes since 1957. They contain indexes for (1) Electric - 27 Plant Federal Energy Regulatory Commission (FERC) accounts, 10 other plant items; (2) Gas -15 Plant FERC accounts, 4 other plant items; (3) Water - 11 Plant National Association of Regulatory Utility Commissioners (NARUC) accounts, 3 other plant items. The plant account indexes conform to the uniform systems established by FERC and NARUC as applicable. Handy – Whitman compiles construction cost indices for various categories of plant capital for the electric, gas, and water utility industries.

**R.S. Means**

R.S. Means cost data is widely used by appraisers. Means offers cost data on more than 50 building types in 930 locations throughout the United States and Canada, allowing users to quickly calculate an estimated cost localized to pre-selected areas. The calculations include add-on costs itemizing low, medium and high estimates for A/E fees and contractor’s overhead and profit. R.S. Means offers data that covers a wide variety of variables including:

- City cost indexes
- Productivity rate
- Crew composition
- Contractor’s overhead and profit rate
Engineering News Record

The Engineering News Record (ENR) publishes both a Construction Cost Index (CCI) and Building Cost Index (BCI) that are widely used in the construction industry. The ENR website contains an explanation of the indexes' methodology and a complete history of the 20-city national average for the CCI and BCI. Both indexes have a materials and labor component. In the second issue of each month ENR publishes the CCI, BCI, materials index, skilled labor index and common labor index for 20 cities and the national average. The first issue also contains an index review of all five national indexes for the latest 14-month period. The CCI, BCI and Materials Cost Index are updated monthly by ENR's price reporters who call a single source for each product in 20 U.S. cities. The price represents the amount paid by a contractor for a specified large order. The national average prices and prices for individual cities can be found in each issue of ENR on the Construction Economics page. ENR's Quarterly Cost Reports analyze these price trends in detail. Monthly prices appear on the following weekly rotating cycle:

- **Week one** has prices for 21 products covering asphalt, cement, aggregates, concrete, brick, concrete block and mason's lime.
- **Week two** has prices for 20 pipe products covering reinforced concrete pipe, corrugated steel pipe, vitrified clay pipe, PE underdrain, PVC sewer and water pipe, ductile iron pipe and copper water tubing.
- **Week three** has prices for 18 products covering lumber, plywood, plyform, particle board, gypsum wallboard and insulation.
- **Week four** has prices for 16 products covering structural steel, reinforcing bar, steel plate, metal lath, aluminum sheet, stainless steel sheet and plate and H-piles.
- **Week five** Occasionally ENR publishes five issues in a month. When that happens, check the news section for Construction Economics information, under finance & Business.

Selecting an Appropriate Index

Each utility should investigate the various sources of information and select for itself the one that appears to be most appropriate. As a rule, regulated utilities may prefer Handy Whitman for its breakdown into NARUC accounts, appraisers frequently utilize R.S.Means for its wide range of building types and locations. ENR’s CCI is the index used by the US EPA Needs survey and is a convenient and inexpensive source. The CCI is the index used in the models accompanying this report.

GAUGING SUPPLY AND DEMAND IN YOUR AREA

In addition to being able to estimate and inflate costs properly, the capital efficient utility needs to be able to accurately gauge local conditions. The ideal situation would be one in which work is put out to bid only when the market is looking for work, resulting in multiple bids. Figure 7.2, on the following page, shows the price penalty for having a low number of bidders.
The following is a summary of some methods for gauging supply and demand:

- Track your own experience — number of bidders by type of project, where based. This backward looking approach will identify market competitiveness and identify nearby areas of strong and weak markets.
- Check the agendas of regional public works agencies to estimate when competing work will be put out to bid. This can be done through direct contact, by reviewing publicly available Board minutes, tracking the issuance of RFQs, etc.
- The Bureau of Labor Statistics publishes construction employment by state, employment by metro area and construction pay statewide for various construction occupations (note: there is a 9-month lag in this date). A rise in construction wages relative to all wages is an indicator of a tightening market. Also, look for the degree of correlation between employment and construction activity.
- The Associated General Contractors of America (AGC) regularly do regional surveys. Depending on the region your utility is in this can provide more useful and more current information.
- AGC provides a weekly summary of relevant economic information called Data DIGest (available as an e-mail by request to simonsonk@agc.org).
CHAPTER 8
CAPITAL PROGRAM BENCHMARKS AND METRICS

Benchmarking and the use of metrics to track progress is widely considered a best practice by industry associations, by the utilities surveyed and from feedback received during the course of this research project. Considering the importance attached to benchmarking, it was a surprise to identify that there was a generally low level of use of benchmarks and metrics in our survey, with the apparently better performers making greater use of benchmarks and metrics. Some utilities we interviewed cited a lack of knowledge regarding sources of such information. In this section, we identify the extent to which benchmarks and metrics were reported by the utilities in the survey, briefly review the benchmarks related to capital in the QualServe benchmarking (AWWA 2007), and then make some recommendations related to benchmarking and metrics. This discussion suggests the different levels at which to utilize benchmarks and metrics and identifies sources of benchmarks.

USE OF BENCHMARKS

The survey revealed a generally low level of use of benchmarks and targets. Table 8.1 summarizes the use of benchmarks and targets by survey respondents:

<table>
<thead>
<tr>
<th>Benchmark or Metric Targets</th>
<th>Percentage Using</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change Order %</td>
<td>57.1%</td>
</tr>
<tr>
<td>Claims %</td>
<td>21.4%</td>
</tr>
<tr>
<td>Design Cost %</td>
<td>60.7%</td>
</tr>
<tr>
<td>CM Costs</td>
<td>53.6%</td>
</tr>
<tr>
<td>Others</td>
<td>17.9%</td>
</tr>
</tbody>
</table>

As applied above, a change order is a change in the contractor’s scope, cost and/or schedule – usually all three – due to unexpected changes encountered in the field, owner requested changes or other changes. The change order costs as a percentage of initially contracted amounts is a widely used measure. A construction claim is a request for additional money initiated by a contractor under litigious circumstances. See the Los Angeles case study in Chapter 13 for a discussion of these two factors.

The high and low target values (or values experienced) for the cost components are summarized below:

- Change Orders: 0% to 30% of contract costs
- Claims %: 0% to 10% of contract costs
- Design Cost (as % of total) – 5% to 20%%
- CM Cost (as % of total) – 2% to 15%
QUALSERVE CAPITAL BENCHMARKS

The joint American Water Works Association (AWWA) and Water Environment Federation (WEF) QualServe Benchmarking program utilizes the following benchmarks that have a relationship to capital (reported by QualServe area) (AWWA 2007):

- **Business Operations**
  - *Debt ratio* – this ratio (total liabilities divided by total assets) is a measure of indebtedness and only indirectly impinges on capital efficiency.
  - *System renewal and replacement rate* – this ratio (actual expenditures on renewal and replacement plus reserves divided by total present worth of renewal and replacement needs for each asset class) is a measure of spending as percent of needs

- **Water Operations** – includes three indirect measures of capital efficiency:
  - Drinking water compliance rate (% days)
  - Distribution system water loss (%)
  - Water distribution system integrity – (leaks plus breaks divided by miles of distribution piping)

- **Organizational Development** – one of the best practices identified is Optimized Asset Management

While helpful criteria and information that should be known and tracked by any well-managed utility, these QualServe developed benchmarks demonstrate the difficulty in establishing usable metrics that are consistently repeatable and comparable for capital efficiency and effectiveness.

BENCHMARKS AND METRIC LEVELS

Benchmarks and metrics vary depending at which level they are being applied. In this chapter, we provide benchmarks and metrics at three levels:

1. The utility or program level. These are broad metrics that apply to the aggregate capital projects of a utility.
2. The project level. Some benchmarks vary with the size and complexity of the project.
3. At the job site level. These benchmarks are primarily productivity measures.

It is understood that, to an extent, each utility is uniquely affected by its local markets and unique regulations, age of infrastructure etc. In addition, a metric is a value taken at one point in time; it is important to know if the metric is improving or getting worse. It is equally important to recognize that benchmarks should be used in combination with related benchmarks and best practice evaluations to identify an internally consistent set of conclusions that support a consensus/comprehensive understanding before reaching actionable conclusions.

The following discussion presents benchmark definitions, target values and survey medians for selected values.
UTILITY OR PROGRAM LEVEL BENCHMARKS

The key utility level benchmarks are:

- Asset to revenue level or capital intensity
- Actual to budget for the capital improvement program as a whole.
- Actual to planned on the CIP schedule

Capital Intensity

Capital intensity is the ratio of net asset value to operating revenues is a useful indicator of capital efficiency. As previously detailed in Chapter 2, national averages for this value are presented in Table 8.2:

Table 8.2

<table>
<thead>
<tr>
<th>Utility Type</th>
<th>Capital Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipal Water -</td>
<td>$7.03</td>
</tr>
<tr>
<td>Municipal Wastewater</td>
<td>$7.85</td>
</tr>
<tr>
<td>Investor owned water</td>
<td>$3.85</td>
</tr>
<tr>
<td>Average for 28 utility survey*</td>
<td>$5.57</td>
</tr>
</tbody>
</table>

*This was a mix of municipal, investor owned, foreign and both water only and combined utilities

As with any benchmark, this measure needs to be used with caution and in conjunction with a best practice analysis. Capital intensity is subject to a number of explanatory factors (items outside of the intermediate term control of management) such as:

- Unique regulations (this will generally affect wastewater utilities more than water utilities)
- Supply-demand conditions among the local contracting pool driving prices up
- Influence applied through owner (i.e., elected officials) resulting in overbuilding
- Inability to increase rates to an appropriate level
- High net asset values due to contributions in aid of construction and/or assets acquired through non-operating revenues such as system development charges

As a result, comparison of capital intensity from utility to utility is very difficult and potentially not a strong measure of capital effectiveness. The formation of a peer group for comparison, if properly selected, can reduce some of the effects of explanatory factors. These comparisons and factors should also be documented. In the case of fast growth utilities with assets either donated (by developers) or acquired from non-operating revenues, a high capital intensity value should be a warning to maintain rates at a level appropriate to the assets under the stewardship of the utility. Assets, even ones not purchased from operating revenues, eventually must be repaired, replaced or rehabilitated. A high-capital intensity relative to peers may indicate:
• A method of identifying candidate projects that does not appropriately recognize criticality or does not utilize rigorous condition level as a basis for inclusion
• A method of project selection that does not examine as well as it should non or light construction alternatives
• Contracts which allocate too much risk to contractors, resulting in additional contingency amounts in contractors bids (or the requirement by sureties that substantial additional contingency be added to bids)
• A bid development and timing process that results in too few bidders
• A failure to perform constructability analysis or value engineering
• Failure to employ risk management
• Poorly managed project development

The Project Readiness Index in the capital efficiency toolkit attached to this report can help identify some of these conditions, as can later chapters on risk and project selection and prioritization. For all utilities, the usage of this index over time does demonstrate if rate revenues are keeping pace with asset investments. If the increase in current revenues falls behind expenditures over time, the stage is being set for significant rate increases in the future.

Actual to Budget and Actual to Planned

These were the most widely used metrics in our survey sample with nearly 3 out of 4 reporting use of this metric. In a capital program that is not “gamed” or subject to strong outside influences, a target value in the 90%+ would represent a best practice benchmark indicating a well managed program. This is especially true for full service utilities such as Los Angeles (see the case study in Chapter 13) that develop resource loading of engineering activities based on the proposed CIP. As with any benchmarks, the underlying practices need to be understood to interpret values that are well below or above 100%. This metric is one that should also be tracked over time.

Ratio of Contract Value to In-House Dollars (For Comparable Projects) Over Time

This can be a useful measure for full service utilities that have a large enough number of projects developed in-house to track the movement in this metric over time for similar projects. In utilities where this has been used, this value rose following the implementation of best practices.

Cost Components (Change Order, Claims, Design, CM, PM % of Total)

Some utilities utilize target values for these components at the program level. This may be useful if there is a large enough number and diversity of jobs, however, these values will vary with size and complexity. The next section discussing project benchmarks will present some curves reflecting the impact of these variables.
Number of Bidders per Solicitation and Ratio of Bid Price to Engineer’s Estimate (sometimes called Bid Premium)

Tracking these values provides insight into the bid process, the fairness of contracts, timing of solicitations and whether or not the utility is a “client of choice.” Analysis of bid tabs can help identify a number of problems:

- A small number of bidders will often result in bid prices in excess of engineers’ estimate
- High bid prices may indicate poorly developed projects
- Some utilities pay attention to where the bidders are from – are local bidders declining in number? Are they being replaced by out of state far away bidders?

Project Level Benchmarks

At the individual project level, most utilities track actual to estimate on both price and schedule. To varying levels, cost components are tracked. Change order percentage and claims percentage are tracked because they result in increases to delivered price of the project. The curves that follow in Figure 8.1 and Figure 8.2 show how these values vary with project size. It should be noted that there appears to be some regional variations in acceptable target values; some parts of the country may consider the values shown to be generous.

![Figure 8.1 Design percentage vs. total construction cost – pressure pipe systems](image)

Source: 2007 California Multi-Agency CIP Benchmarking Study Update
It is common practice in the private sector to measure productivity at the job site level. We found no evidence of a comparable effort among the utilities we spoke to. CII has a benchmarking program focused on engineering and construction productivity:

**Engineering Productivity** = Actual work-hours (per design component)/Issued for construction (IFC) quantity

**Construction Productivity** = Actual work hours/quantity installed

More information regarding Productivity Benchmarking can be found at the CII Website (https://www.construction-institute.org/scriptcontent/bmm.cfm?section=bmm).
CHAPTER 9
PROJECT SELECTION AND PRIORITIZATION

This chapter addresses a number of issues and presents techniques relative to project selection and prioritization. After affordability, project timing (50%) and project selection (39%) were the next ranked needs. To provide a context for the discussions of this chapter, it is important to recall the larger process for which project selection and prioritization are the key results or desired outcomes. This larger process is summarized below:

- Identify and define the need
- Develop alternatives
- Determine Methodology and Develop criteria
- Validate data
- Test alternatives
- Prioritize and select

CHANGING CAPITAL PARADIGMS

Our research leads to the conclusion that utilities are and will continue to confront changing paradigms when it comes to capital project selection and prioritization. A continuation of the trends identified earlier in this document and what has been identified from interviews with leading edge utilities, point to the items listed in Table 9.1:

<table>
<thead>
<tr>
<th>Item #</th>
<th>Old Paradigm</th>
<th>New Paradigm</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Fix it before it breaks</td>
<td>Run to failure</td>
</tr>
<tr>
<td>B</td>
<td>Capital is cheaper than O&amp;M</td>
<td>It can be cheaper to fix some things quickly than to replace them</td>
</tr>
<tr>
<td>C</td>
<td>Make sure we have enough capacity; redundancy is safer and smarter and a good capital investment</td>
<td>Small can be beautiful (keep capacity utilization high); redundancy by itself is not a justification for capital expenditures</td>
</tr>
<tr>
<td>D</td>
<td>Take your time, be methodical</td>
<td>Time is money; faster and leaner will provide better result</td>
</tr>
</tbody>
</table>

It is important to note that none of the old or new paradigms is absolute. The following discussion highlights some of the factors behind each paradigm and provides lessons being learned when the old and new paradigm are compared and evaluated for implications and insights.
Item # A

Fix it before it breaks – a common mantra of the O&M optimization of the past decade, this paradigm reflects the fact that (as a rule of thumb) replacements (such as a distribution line segment, for example) cost twice as much in a reactive mode than in a planned mode.

Run to failure – this is one of the tenets of the Australian/New Zealand approach to asset management which recognizes that some system components could be run to failure and quickly repaired (i.e., by stocking replacement parts instead of rehabbing) and that some parts of the system could be allowed to run to failure with minimal customer disruption and cost increases. The early U.S. adaptors of asset management’s claims to cost savings are derived either from deliberate run to failure approaches or determining that some portions of their CIP were not needed.

Lesson – an investment in development of project alternatives is likely to pay off. When alternatives are properly developed, the do-nothing alternative should be explored, along with non-construction and lighter construction alternatives. Additional strategies that should be looked at include the incremental cost of replacing components quickly versus the cost of preemptive rehabilitation.

Item # B

Capital is cheaper than O&M – during recent efforts to lower O&M costs, significant investments in capital (including technology) were justified on the basis for reduced need for O&M staffing with newer and more automated facilities.

It’s cheaper to be able to fix quickly than to replace in advance of need – for the past four years, inflation in materials of construction has been double the rate of labor cost inflation (many items – concrete, rebar, structural steel, copper and stainless steel - have more than doubled in cost from 2003 to 2006). A number of Australian utilities have found it less costly, at a minor cost to customer satisfaction, to be able to repair main breaks quickly than to preemptively replace segments of the distribution system. In doing so, these utilities have obviously considered and included in their evaluation of implications of such potential service outages and concluded the approach is explainable and supportable to utility customers and officials. Implicitly, these utilities are utilizing a more “holistic” assessment technique similar to the Seattle Triple Bottom Line process discussed in the Case Study section of this report.

Lesson – capital decision rules of thumb need to be rethought. Update the cost of O&M alternatives when performing economic analysis. Investigate possibilities in different strategies. Improvements are possible in the approach to corrective maintenance.

Item # C

Make sure you have enough – a result of decades of growth, municipal utilities are generally characterized as building in excess capacity and running at low capacity utilization (unanimously echoed by municipal utility managers interviewed as part of this study) whether by choice or as a result of political pressures. A look at the many pressures of managing in the public sector makes this an understandable strategy – the public cost of being short of capacity or
having inadequate redundancy to deal with even remotely possible situations overwhelms the benefits of sound, cost effective capacity management.

**Small is beautiful** – this approach recognizes the rising cost of excess capacity, affordability concerns, the decline in per capita consumption, the willingness to conserve and technical solutions that allow running at higher capacity utilization. All these items, either singularly or collectively, can permit designing with higher capacity utilization as a major goal. Less prominently mentioned as a reason for high capacity utilization (but no less important) is the increased comprehensiveness of maintenance programs combined with the fact that many water utility components last longer and are less costly to maintain if run closer to design capacity.

**Lesson** – excess capacity, while providing a high level of comfort to utility management and capital designers, may no longer be affordable or justifiable. Designers should look at design approaches that allow for relatively inexpensive incremental capacity addition (such as membranes) and factor in the many cost reductions associated with running at higher capacity utilization. Capacity requirement projections should take into account the basis for declining per capita consumption (more efficient indoor water using fixtures) as well as alternatives for dealing with peak demands so as to run at higher capacity utilization levels for average water production (daily and monthly).

**Item # D**

**Take your time, be methodical** – a product of many pressures and considerations (public sector interactions and reviews and PUC interactions), some approaches to developing CIPs can be very lengthy. This observation is particularly true when the CIP process includes public official requests to “turn over another card.” and potentially add non-optimal alternatives that involve utility staff time and resources to consider. Besides adding time to the process, these situations delay finalization of CIP programs, delay project initiation, and delivery, and artificially reduce near term capital expenditures. As a result, our research and interviews support that notion that many utilities develop CIP cost and time estimates that are high and with significant risk dollars (undeclared) for covering the costs associated with delays. In the same vein, construction schedules have slack built into them to avoid delay claims and to deliver “on time” project performance.

**Time is money – faster and leaner is better** – with construction cost inflation rising in the double digits every year, delay is expensive. Construction costs for most utilities are rising at more than double the utility’s cost of money. Simulation tools and strategies, such as expert panels, can result in faster decision-making. Lean construction can lower cost and result in an improved, more productive and safer project. Utilization of alternative delivery methodologies (CM @ risk, Design - Build) demonstrates the ability to reduce timelines and transfer risks to ultimately achieve lower costs.

**Lesson** – realize that time is money and focused project and CIP planning combined with management approaches designed to be quicker can produce better, as well as less costly results.
STAGES IN THE PRIORITIZATION AND PLANNING PROCESS

Identify and Define the Need

In a perfect world, capital needs would be derived from strategic plans that addressed such issues as regulatory compliance, meeting growth related needs, customer satisfaction, sustainability and financial considerations. Replacement needs would be determined based on condition assessments and analyses of the data residing in asset management programs to perform replacement or rehabilitation when the condition of the asset (and the analysis of historic data) determined that this was the optimum time to replace or rehab. Achievement of this “perfect world” scenario, requires a toolkit of techniques and approaches.

Framing of the capital needs is the first step in avoiding the “any road will get you there, if you do not know where you are going” pathway. The checklist presented below, developed by a CII member (provided in a private communication), can help utilities identify how well the need has been framed. Utilization of these levels allows characterization of individual projects into these five levels with the noted implications for need justification and completeness.

Stakeholder Involvement

- **Level 1** – project is well framed, problem is clearly defined, boundaries established with key stakeholders representing all involved parties. There is a high level of buy in to the project objectives and all is completely documented.
- **Level 2** – project is framed by the project team. Key stakeholders representing most of the value chain buy into the framework.
- **Level 3** – Project is framed by project team and reviewed with some of the key stakeholders – but it is mixed.
- **Level 4** – project is framed and dictated by a person in management or Board or developed by the project team with some stakeholder involvement
- **Level 5** – no stakeholder buy in or involvement

Development of Alternatives

The process of developing alternatives inevitably involves some “rules of thumb” about trends for future water demand, labor availability and costs, and asset replacement policies. Without invoking some of these “rules of thumb” as selection and prioritization shortcuts, the activities and analysis necessary to support the process of selection and prioritization expands significantly and becomes, in the extreme, unacceptably lengthy and costly.

Some of these rules of thumb commonly utilized include the following:

- Per capita water consumption is rising (partially as a result of increasing wealth) so building in additional capacity will be necessary to accommodate future demand from existing users
- Land is cheap, so avoid compact designs that may increase O&M later or make maintenance difficult.
• Labor costs are rising so spend more money on plant and technology to minimize staffing needs

However, some of these “rules of thumb” need to be reviewed and updated to take into account the following facts and impacts:

• Indoor per capita water use has been steadily declining because of the introduction of more efficient water using fixtures in the late 1970s. The U.S. Geological Survey (USGS) estimated that per capita indoor water use declined 25% from 1975 to 2000 (25% roughly corresponds to the difference between late ‘70s and early’90s fixtures for a typical mix of uses). Additional water fixture efficiency increases were introduced in the early 2000s for white goods (clothes washers and dish washers) as part of the energy and “green” certification programs. As a result, most urban centers have been seeing declining indoor per capita usage. Other drivers for reduced per capita consumption include loss of major commercial/industrial customers, and substitution of less water intensive outdoor landscaping. Loss of center city population and resulting reductions in people per dwelling units account for additional overall volume losses for utilities.

• Between 2003 and 2007 cost inflation for materials has been twice the inflation rate for labor costs. Unless China and India both hit major recessions, this trend should continue. Decision rules that historically assumed that bricks and mortar were cheaper than labor need to reflect this trend. Complicating this assessment is the fact that the availability of skilled operators and staff is becoming increasingly difficult to attract and to retain by the utility.

• The cost of land has increased and additional land availability may be extremely limited. In addition, spacious plant designs also have an inherent tendency to use more materials of construction for a given capacity level and require additional “travel time” for plant operators and maintenance staff as they perform their duties and rounds. These factors, combined with the increased availability of small footprint technologies provide two reasons to rethink the historic avoidance of small footprint designs (this is especially true for wastewater treatment plants).

Our research has identified, and this report has emphasized, that, in the development of a comprehensive suite of alternatives for need accomplishment, increased importance must be attached to non-construction and light construction alternatives. Table 9.2 provides a checklist of such alternatives, potential situations under which they are worth considering and potential CIP related impacts beginning on the following page.
<table>
<thead>
<tr>
<th>Action</th>
<th>Worth Consideration If…</th>
<th>Impacts</th>
</tr>
</thead>
</table>
| Review design criteria and parameters for needed treatment capacity so as to reflect the trend of reduced per capita consumption | • Design parameters have not been reviewed or changed recently  
• Per capita consumption estimate is high  
• Capacity utilization is low or gradually getting lower | • Supply  
• Plant  
• Pump station sizing  
• Storage  
• T&D |
| Implement demand management: 1) structural (toilet rebates, etc.) and 2) behavioral (pricing, public information programs, irrigation limits etc.) | • Age of system (older systems are more likely to yield savings)  
• Water supply is limited  
• Daily demand has extreme usage peaks (time of day issue)  
• High cost water supply needs | • Supply  
• Plant  
• Pump station sizing  
• Storage  
• T&D |
| Leak detection and control (detect, prioritize, correct)               | • Old system  
• High per capita consumption (calculated from plant output)  
• High non-revenue water (water pumped less water read from meters) | • Supply  
• Plant  
• Pump station sizing  
• Storage  
• T&D |
| Meter maintenance (helps in leak detection and revenue collection)     | • High per capita consumption combined with low non-revenue water  
• Large customers have been reducing demand and meters have not been right-sized  
• Average age of residential and small commercial meters is rising  
• Usage is trending down | • Plant  
• Pump station sizing  
• Storage  
• T&D |

(continued)
<table>
<thead>
<tr>
<th>Action</th>
<th>Worth Consideration If…</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost optimize process of meeting peak demand – variable frequency drives (VFD), add inexpensive storage, aquifer storage and retrieval (ASR), negotiate agreements with nearby systems with available capacity, real time pricing</td>
<td>• High peak to average ratio (max hour to max day, max day to average day)</td>
<td>• Supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Plant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pump station sizing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Storage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(continued)</td>
</tr>
<tr>
<td>Update/refine O&amp;M vs. capital cost tradeoff for distribution system (see detailed discussion below)</td>
<td>• Have not updated rules of thumb in developing CIP for distribution system</td>
<td>• Distribution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pump station sizing &amp; operational strategies</td>
</tr>
<tr>
<td>Improve break repair performance (improve valve maintenance, improve leak repair strategy and methods, use just in time [JIT] approaches)</td>
<td>• Old system</td>
<td>• Distribution</td>
</tr>
<tr>
<td></td>
<td>• Excessive break rates</td>
<td>(continued)</td>
</tr>
<tr>
<td></td>
<td>• High percentage of field crew work is reactive</td>
<td></td>
</tr>
<tr>
<td>Pressure management</td>
<td>• Distribution system has segments operating at high pressure</td>
<td>(continued)</td>
</tr>
<tr>
<td></td>
<td>• Excessive break rates and/or leakage rate in high pressure areas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Distribution system capital costs are high</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Distribution</td>
<td></td>
</tr>
<tr>
<td>Valves have not been exercised in a while</td>
<td>• Valves have not been exercised in a while</td>
<td>(continued)</td>
</tr>
<tr>
<td></td>
<td>• Valve problems magnify time to repair leaks and main breaks</td>
<td></td>
</tr>
<tr>
<td>Valve criticality study – Identify critical valves and ensure they are maintained.</td>
<td>(continued)</td>
<td></td>
</tr>
<tr>
<td>Modular capacity addition (e.g., membranes)</td>
<td>• Capacity additions as originally planned are large, resulting in initial low capacity utilization and relatively high O&amp;M costs</td>
<td>(continued)</td>
</tr>
</tbody>
</table>
Table 9.2 (Continued)

<table>
<thead>
<tr>
<th>Action</th>
<th>Worth Consideration If...</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rerate plant/optimize process</td>
<td>• Process optimization has not been done previously</td>
<td>• Plant</td>
</tr>
<tr>
<td></td>
<td>• Historic capacity rating relied upon operator skill only - without SCADA system augmentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ten State Standards are acknowledged as conservative basis for design &amp; rating</td>
<td></td>
</tr>
<tr>
<td>High throughput plant design (also smaller footprint)</td>
<td>• Land costs are high</td>
<td>• Plant</td>
</tr>
<tr>
<td></td>
<td>• Material costs in region are high</td>
<td></td>
</tr>
</tbody>
</table>

The Do-Nothing Alternative

Every capital project selection/prioritization decision should start be defining the “do-nothing” alternative. Readers interested in a detailed discussion of developing this alternative can find the approach and process in the Seattle Public Utilities (SPU) documents that SPU will provide on request. Two “Do-Nothing” scenarios will be discussed here – distribution system leaks and breaks and the “run to failure” option.

Distribution System O&M vs. Capital Tradeoff

The decision to replace distribution system segments is the result of two decisions:

- **Criteria or metrics for breaks per mile:** If a distribution system segment is experiencing an increasing rate of breaks per mile, the decision is between tolerating a rising break per mile rate and its associated financial costs and customer dissatisfaction or making a capital expenditure that will reduce the break rate to near zero. In other words, the tradeoff is between capital costs today vs. x years of rising O&M costs (and breaks) with a delay in capital expenditures. A well-done analysis might involve a net present value (NPV) calculation that forecasts rising costs in the do-nothing alternative and compares a stream of those costs against a capital expenditure today. The analysis should include both the financial costs and the implicit costs of impacts on customer service and system reliability. A more sophisticated analysis might also account for the fact that an emergency line replacement sometime in the future (as might be the result of a major break) will cost much more than a planned line replacement. This second analysis might estimate a probability of such a failure occurring over time and add the expected value (probability of major failure X the cost of repairing that failure under emergency conditions) to the NPV calculation (this of course increases the probability that a line replacement will become part of the CIP).
However, some utilities that have studied this calculation and have analyzed non-construction alternatives finding a number of actions that could potentially defer capital expenditures:

- **Improve response to main breaks** – a number of steps can be taken to improve break repair performance, including valve maintenance (in some utilities a criticality study may have to precede this approach and provide justification), improved break repair equipment, improved strategies for sending out crews, outfitting of trucks etc. In addition, other utilities have successfully prioritized the importance of uninterrupted water supply delivery for sections or areas of their overall service area and have thereby established segments of the system where higher levels of line break performance may be tolerated without significant impacts on customer satisfaction. In any case, these actions and analysis all have the result of reducing the cost of the “do-nothing” alternative and thereby allowing the conscious and supportable strategy of deferring specific line replacement expenditures to a future date. For many utilities, the financial cost of improving break repair performance is small compared to the capital cost being contemplated. If the significance of the outage is not high and the repair time is short and with the ability to use alternative distribution system pathways in the interim, then significant capital costs may be systematically managed and effectively deferred without significant impacts on levels of service and customer satisfaction.

- **Reduce break frequency** – some systems can extend distribution system life by managing pressure in their distribution system and/or expanding the usage of storage facilities as an alternative to higher distribution system pressures for meeting fire protection criteria. These actions have the potential effect of reducing the do-nothing cost stream.

**Run to Failure**

- **Replacement philosophy and metrics:** Many CIP decisions utilize a “fix it before it breaks” philosophy that is the basis for elaborate maintenance management (MMS) systems. In many cases, this is a sound approach because (as noted above) replacement under emergency conditions costs more than a planned replacement. However, many components do not meet the requirement to replace only under pre-planned conditions. For example:

  - Some components do not need to be replaced immediately upon failure. Workarounds and usage of alternative distribution system pathways and interconnects are often possible so as to allow for the replacement to occur under close to pre-planned conditions and costs
  - Same distribution components can be stocked and easily replaced if the component inventory is readily available and accessible. Equipment and component suppliers will often maintain such inventories on a regional or national basis with rapid response time commitments and guarantees. As a
result, the replacement financial costs experienced under failure conditions can be close to the cost of replacement under planned conditions.

Complementing and augmenting the approaches discussed for deferring capital expenditures and run to failure approaches are the systematic analysis and criticality classifications inherent in asset management systems currently being implemented by utilities. Many utilities with asset management systems report CIP reductions as a result of deferrals or run to failure decisions.

In order for these approaches and techniques to be properly assessed and implemented, utilities must understand and include in their assessments the implications and costs (financial, social and regulatory) that accrue from unanticipated failures, line breaks, and loss of service. Where the collective consequences are assessed as “acceptable”, the analysis process has identified a candidate for consideration.

Seattle Public Utilities’ Triple Bottom Line Handbook (briefly described in the case study in Chapter 13) includes the following key questions to ask in identifying alternatives (Seattle Public Utilities 2005:19):

- What is the basic underlying service objective or required basis for this project?
- What, if anything, is the available “do-nothing” alternative for this project?
- Does the project objective have reasonable and feasible alternatives of the following types?
  - More capital or O&M intensive?
  - More centralized or decentralized?
  - Collaborative with other groups?
  - More or less natural system oriented?
  - Demand management independent?
- What are the system infrastructure impacts (improvements?) of the project alternatives? Specifically, what are the:
  - Units of service of main project purpose?
  - Expected amount of service impact?
  - Expected variability in service impact?
  - Duration of project service impacts?
  - Geographic area affected?
  - Probable impacts on other (utility) services?

DETERMINE METHODOLOGY AND DEVELOP CRITERIA

Economic Methodologies

Typically, most utility projects are evaluated primarily based on economics. The following briefly reviews some of the key concepts involved in economic evaluations, including the SPU Triple Bottom Line Handbook (Seattle Public Utilities 2005), various Water Research Foundation reports and economic textbooks.
**Time Value of Money and Discounting**

Most projects and programs take a number of years to implement and are designed to provide benefits for an extended period of time. There may be both initial and ongoing expenditures and benefits will generally extend over the project life. Because schedules of benefits and costs rarely match up, discounting (converting benefits and costs in multiple years to a single value) is used to facilitate analysis. Discounting a future stream of costs and benefits can be easily done with widely available spreadsheet software (the model attached to this report has this capability).

The challenge to analysts lies in selecting an appropriate discount rate. Project costs and benefits generally grow over time as a result of the effects of inflation – if O&M costs are growing at the rate of 3% per year, a project with a maintenance cost of $1,000 today will cost $1,030 next year. However, construction projects may have a higher inflation rate (as has been the case recently) so a multi-year project inflating at the rate of 6%, requiring level cash flows, would increase in cost from, say, $10,000 this year to $10,600 next year. Inflation rates rise and fall over time. However, the real discount rate that reflects the utility’s time-value of money tends to be more consistent over time. A default rate commonly used as a starting point for municipal utilities is the weighted average interest rate of outstanding debt. For investor owned utilities, the default rate (as a starting point) is the value of money reflected in their rate of return.

**Choice of Discount Rate**

For projects involving long time periods for both costs and/or benefits the impact of inflation and discount rate on the present values of alternatives can be significant. It is important to consider the impact of a wide range of potential discount rates as part of the overall evaluation of options. As an example, Seattle’s TBL Handbook (Seattle Public Utilities 2005) recommends the following standard ranges:

- **Upper Bound** - 7.0%
- **Baseline Rate** - 5.0%
- **Lower Bound** - 3.0%

**Present Value**

Applying discounting to a future stream of costs (or benefits) results in a single value, simplifying comparison among alternatives. The present value is the amount of money that would have to be deposited today to produce the future stream of cash needs developed by discounting that future stream of payments at the discount rate. For example, if a utility has a multiple number of projects producing equivalent results, discounting the future stream of costs to a present value makes the selection relatively easy. Comparing the present value of alternatives can be used to select projects if:

- Benefits are at least as great as the costs, and
- Are similar among the options considered
Net Present Value

When there is a variation in the mix of benefits and costs and a further variation over time, net present value (NPV) may be a more appropriate selection methodology. In this method, the future stream of costs and benefits is projected, each is discounted to a present value, and a ratio of benefits to cost is calculated. Projects with a calculated NPV of greater than one are considered to provide a positive NPV; projects with a calculated NPV of less than one provide a negative NPV (i.e., costs exceed benefits).

Benefit Cost Ratio

The NPVs for projects compared above may have widely differing costs. The benefit cost ratio compares the discounted present values of benefits to the discounted present value of costs and the analysis can be extended to consider rate of return.

Levelized Cost per Unit

NPV determines if a project is better than the “do-nothing” alternative. However, when there are multiple options which address differing categories of service to a different degree, the problem is more complex. This frequently happens with comprehensive plans where there are a variety of different technical approaches, each with its own costs and partially meeting service needs. For this situation, SPU converts their life cycle costs into costs per equivalent unit. This permits a direct comparison and ranking potentially resulting in a mix of various approaches. SPU calls this Levelized Cost per Unit which is useful in comparing among costs with different service capacities or alternatives with different project lives.

Summary

Table 9.3 is a summary of Economic Performance Measures is taken from Seattle Public Utilities’ Triple Bottom Line Guidebook:
Table 9.3  
Summary of economic performance measures used by Seattle Public Utilities

<table>
<thead>
<tr>
<th>Measure</th>
<th>Definition</th>
<th>Appropriate Conditions for Project or Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present Value of Costs</td>
<td>• Discounted present value of project costs</td>
<td>• Benefits assumed to exceed costs of project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Project required to meet utility criteria</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Benefits similar among project options</td>
</tr>
<tr>
<td>Net present value (NPV)</td>
<td>• Discounted present value of benefits minus discounted present value of costs</td>
<td>• Project is elective or discretionary, or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Both benefit stream and cost streams of options vary over time, and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Multiple options with positive NPVs have similar compositions and levels of costs</td>
</tr>
<tr>
<td>Benefit Cost Ratio</td>
<td>• Discounted present value of benefits divided by discounted present value of costs</td>
<td>• Project is elective or discretionary, or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Both benefit and cost streams of alternative options vary over time, and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Some options with NPVs have dissimilar compositions and level of costs</td>
</tr>
<tr>
<td>Per Unit Levelized Cost (LC)</td>
<td>• Constant inflation adjusted per unit value producing present value equal to the present value of projects actual life cycle cost stream.</td>
<td>• Alternative’s lives differ, requiring varying replacement schedules</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Per unit costs of existing service or supply are known</td>
</tr>
</tbody>
</table>

**Developing Benefits**

The above discussion on economic methodology assumed that it would be possible to calculate the benefits associated with a project. Benefits generally consist of either:

- Improvement in meeting a strategic objective (such as customer satisfaction), or
- Avoiding increased costs resulting from not performing the project.

In developing benefits associated with improving a strategic objective, the utility will need to be able to identify criteria and have benchmarks or metrics that allow the utility to identify how well a project will be able to meet those criteria. This study will not address how to identify criteria or the extent to which a candidate project meets the criteria – those are addressed
in other Foundation studies. The next section will identify methods for applying and ranking criteria within the project selection and prioritization process.

Estimating avoided increased costs can be more difficult. For example, estimating the likelihood of a distribution line segment failure at some point in the future is challenging (this is part of the process of justifying replacement of a line segment). Implementing a capital project to meet a regulatory requirement may produce a quantifiable benefit of avoided fines, but the cost to the utility’s reputation is more difficult to calculate. Many utilities take the simplifying route of placing regulatory and growth projects into the “must do” category and applying selection and prioritizing methodologies to remaining projects.

IDENTIFYING AND VALUING CRITERIA

In the complex world in which utilities operate, project selection may involved multiple criteria. One way of selecting among alternatives is through the calculation of an expected value using a payoff matrix. To provide an example, let’s say we are looking at two projects (Project A and Project B) and we have three criteria (in this example, economic, customer and sustainability). Each project has a different likelihood of meeting each criteria. If we know what those likelihoods are, all we have to do is place a relative value on each criteria and produce the following payoff matrix in Table 9.4 using a scale of 1 to 10 (10 is best):

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Importance to Utility</th>
<th>Project A score</th>
<th>Weighted Score for A</th>
<th>Project B score</th>
<th>Weighted Score for B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>8</td>
<td>5</td>
<td>40</td>
<td>7</td>
<td>56</td>
</tr>
<tr>
<td>Customer Satisfaction</td>
<td>9</td>
<td>7</td>
<td>63</td>
<td>5</td>
<td>45</td>
</tr>
<tr>
<td>Sustainability</td>
<td>7</td>
<td>9</td>
<td>63</td>
<td>8</td>
<td>56</td>
</tr>
<tr>
<td>Totals:</td>
<td></td>
<td></td>
<td>166</td>
<td>157</td>
<td></td>
</tr>
</tbody>
</table>

In this case, had we done the proper weighting, project A would have been selected because it had the highest overall score (166 to 157), although in the real world, a cost disparity as large as that shown might be hard to overcome.

What happens if you have many criteria? Some utilities facing difficult choices have identified as many as 20 relevant criteria, including such factors as constructability, ease of permitting etc. In a case such as this, attaching appropriate relevant weights can be difficult. This difficulty can be solved by taking advantage of the fact that people usually have an easy time comparing between two choices. Developing relative weights for multiple criteria involves an expanded table as shown on the following page in Figure 9.1:
### Criteria for Comparison

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weight</th>
<th>Raw Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Responsiveness to all customers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Ability to contain or reduce costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Debt and capital finance implications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Permits and regulatory compliance implications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Impact of funding sources and financing strategies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Management of risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. Managerial/labor relationship implications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. Technological impact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. Regionalization issues</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Criteria Scoring Matrix

<table>
<thead>
<tr>
<th>How Important?</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 - Major Preference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - Medium Preference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 - Minor Preference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 - Slight, No Preference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Compare each criterion against each other criterion and identify which is more important. Enter the letter of the more important criterion followed by a number indicating strength of preference. If criteria are equally preferred, enter both letters and no number.

---

**Figure 9.1 Pair-wise comparison template**

The accompanying capital efficiency toolkit includes an Excel template for pair wise comparisons.

**Introducing Probabilities**

As noted in the earlier discussion on the calculation of benefits, some of the calculations performed in prioritization involve probabilities. Actually, most of the elements involved in comparing projects involve probabilities. If these various probabilities can be successfully estimated along with the nature of the probability distribution (i.e., is it a one sided or a normal distribution?) we can perform a much more sophisticated analysis utilizing inexpensive commercially available software, such as Crystal Ball™. This software uses operations research techniques, such as linear programming, to be able to answer such questions as:
• Which group of projects will give us the lowest overall risk?
• Which group of projects will produce a consistent condition level?
• Which group of projects is most likely to result in the lowest total cost?

The Construction Industry Institute is beginning to develop such approaches. However, any utility interested in pursuing such an approach must expect that they will need training in developing good estimates. As noted in our earlier discussion, people develop mental strategies in order to facilitate evaluations and these strategies are prone to bias. For example:

• **Availability bias** – people tend to overestimate the significance of rare but striking factors
• **Immediacy of effect** – results that directly follow causes receive greater attention (and weighting) than more remote cause effect relationships
• **Loss aversion** – the damage from a loss is weighted more highly than an equal benefit.

**Validate Data**

The validation of the data that will be used as inputs to make multi-million dollar decisions is essential. The following is a checklist that provides helpful guidance:

• **Data bias and value of information** –
  – A method such as peer review was used to test for and eliminate bias in the data
  – The value of gathering additional information has been formally evaluated together with stakeholders and management.
  – The team, internally, looked at pro and con data to eliminate bias from their estimates and assessments.
  – The value of gathering additional information was discussed and qualitatively evaluated with stakeholder involvement.

• **Information risks and uncertainties** –
  – Critical risks and uncertainties were clearly identified and assessed using good techniques with expert input to develop the ranges.
  – Experts were involved from outside the project team.
  – Formal risk analysis was done.
CHAPTER 10
ALTERNATIVE PROJECT DELIVERY

An overwhelming percentage of the contractual arrangements utilized by the utilities in our survey were of the design-bid-build variety. This method involves three distinct roles in the project delivery: utility owner, designer, constructor. Typically under this approach, construction contracts are competitively bid, lump sum amounts based on complete and prescriptive contract drawings. Contractor selection is based on the lowest priced responsible bid or total contract price. The traditional approach provides the opportunity for construction planning to be based on completed drawings and documents using a complete set of specifications and quality standards. With all construction and equipment related elements of the project competitively bid, this traditional method relies upon the competitive marketplace to deliver the lowest capital project costs.

A number of factors and consideration have led to the current interest in Alternative Delivery Methods for capital projects. Among these factors and considerations are:

- Increased project complexity
- Need for accelerated project delivery schedules
- The benefits of construction inputs during the design process
- Reduction of the potential for conflicts over project specifications
- Improvement in the specification of legal responsibility amongst the parties for project performance and cost impacts

The factors and characteristics of the Traditional Delivery Method that encourage the consideration of alternatives to the traditional model are summarized below in Table 10.1:

<table>
<thead>
<tr>
<th>Traditional Features</th>
<th>Potential Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Segmentation of Design, Construction, and Operations</td>
<td>1) Excessive Design &amp; Construction Costs</td>
</tr>
<tr>
<td>2) Low bid selection of contractors</td>
<td>2) Heightened risk of performance failures</td>
</tr>
<tr>
<td>3) Utility assumes ultimate responsibility</td>
<td>3) Ambiguity of design vs. construction vs. operations</td>
</tr>
<tr>
<td>4) New facilities are technologically complex</td>
<td>4) Difficult O&amp;M for the utility once facility is accepted</td>
</tr>
<tr>
<td>5) Inherently long lead times</td>
<td>5) Achievement of schedule</td>
</tr>
</tbody>
</table>

Alternative Delivery Methods are quite varied and different. As a result, the key factors and characteristics for each Alternative Delivery Method are significantly different. Key factors of differentiation include:

- Workscope
- Risk Assignment
A recent survey conducted by FMI/CMAA on construction delivery methods reports, “When asked which method of project delivery delivers the best value, both CM-at-risk (35%) and Design / Build (29%) rated higher than Design –Bid – Build (23%)” (FMI/CMAA 2005).

THE SPECTRUM OF ALTERNATIVE PROJECT DELIVERY METHODOLOGIES

Legal availability of these Project Delivery Alternatives varies state by state depending upon the legislative statutes of each state. Hence, not all alternatives are available for usage by all utilities. Overall, the following alternatives provide a representative characterization of the alternatives being utilized and potentially available (subject to state and local laws and ordinances):

- Construction Management at Risk (CM@Risk)
- Design / Build (DB)
- Design / Build / Operate (DBO)

CM@Risk

In CM@Risk two contracts are utilized by the owner. One contract is for the design engineer and the design workscope. The second contract is for the construction firm who is selected early in the design phase and provides inputs throughout the project design. In some instances, the CM@Risk designation has been utilized to mean the CM holds all the trades contracts and takes the performance risk for construction. More desirable, and also used, is the CM@Risk approach whereby the CM@Risk entity holds all the trades contracts and also provides a guaranteed price for the construction. Where a guaranteed price is included, considerations as to the timing for establishment of the guaranteed price, the amount of design information to be available, and determination of any owner sharing of cost over-runs are elements that require explicit recognition and resolution (CMAA 2002).

Design-Build (DB)

In this approach, the utility owner contracts with a single entity for the design and construction of the facilities. Typically, the DB firm then develops a 30-50% design and submits a guaranteed construction price and schedule for completion of the design and construction of facilities. No operating cost guarantee is provided and life cycle costs are not a risk assumed by the contractor. However, because of the single contract and single entity responsibility, the contract requirements also include the demonstration of passing a mutually developed and agreed
upon set of performance tests with financial responsibility for any cost overruns or modifications to achieve the specified performance the responsibility of the DB firm (CII 2001). The prime drivers for consideration of this deliver alternative include:

1) early involvement of the project constructor in project design and equipment specification
2) risk shifting to the contracted firm and the ability to initiate equipment procurement and construction activities sooner
3) accelerated project delivery
4) single point of responsibility for the utility owner
5) cost and schedule considerations
6) establishment of performance testing specifications with a single point of responsibility and accountability.

Design- Build- Operate (DBO)

This approach involves transference of operational staffing and operations to the Design-Build entity so that the overall workscope, under a single contract, is for the design, construction, and operation of the facilities. As such, significant additional risks may be transferred to the contractor firm (i.e. guaranteed operating costs, on-going regulatory compliance, facility maintenance, equipment replacement costs as examples). The utility retains overall policy and rate setting responsibility but is no longer the day to day operator of the facility. Regulatory permits remain with the utility with indemnifications for non-compliance provided by the contractor. Significant cost savings (capital and life-cycle) are reported by utilities who have utilized this DBO approach. Like the design-build procurement alternative, significant risk shifting to the DBO firm and provision of guarantees (capital costs, schedule, regulatory compliance, operating costs) are obtained. Financial assurances (insurance, bonds, and letters of credit) support the guarantees (DBIA 2006).

Key Factors of Differentiation

As summarized above, these alternatives, when compared to the traditional design-bid-build alternative and amongst themselves, demonstrate significant differences, potential benefits and implications for the user. Key factors of differentiation include the following:

1) Number of contract entities
2) Risk assignment
3) Guarantees provided
4) Performance obligations and demonstration responsibility
5) Involvement of contractor during design phase
6) Ability to initiate construction in parallel with design finalization
7) Involvement of utility owner in design, construction, and startup
8) Achievement of cost savings and accelerated project schedules and startup
Table 10.2, on the following page, provides a framework with which a utility can perform its own site specific assessment and evaluation for the usage of these alternatives. As readily demonstrated by the factors listed in the table, the selection of the most appropriate alternative involves many site specific and utility specific considerations.

For example, a capital project utilizing new technologies may be best suited for the DBO format so that cost, schedule and performance guarantees may be obtained; whereas, expansion of an existing facility involving additions of the same treatment processes may best be served by a CM@Risk or a DB approach. Specific utility capabilities (staffing and experiences) should also be considered as part of the assessment and selection of the “best fit” alternative.

On the other hand, capital projects involving no operational component (bridges and pipelines are examples) would not likely utilize a DBO format and would focus on CM @ Risk or DB alternatives.

Successful usage of Alternative Project Delivery methods involves a significant upfront commitment of resources and time by a utility to understand the Project Delivery alternatives and the approaches, techniques, and skills necessary for the effective and successful usage of the Alternative. New work scope and contract documents will also be necessary for the successful usage of these Alternative Project Delivery methods. In all these examples, the need for an early and comprehensive legal review as to the ability to use the alternative procurement approach(es) must be a top priority.

By way of example, some states do not allow DBO procurements and in other states the usage of the DB approach is restricted. Additional issues exist, state by state, as to the ability to utilize SRF funding with an Alternative Procurement methodology. Washington State and California provide current examples where the usage of SRF funds for a DB procurement methodology is extremely difficult to accomplish.

Key Components and Differentiators for Project Delivery Alternatives

Provided below is a brief summary of the key components and differentiators for the project delivery alternatives. The importance and / or significance of these components for each utility and each project will be a site specific, case-by-case assessment. Listed below is a summary of the factors that should be considered in assessing risk and guarantee transfer for each of the project delivery alternatives:

Risk and Guarantee Transfer - Key Factors for Assessment

- Regulatory Compliance
- Regulatory Fines & Coverages
- Cost Guarantees
- Schedule
- Proper Facility Management
- Capital Program Workscope and Accountability
- Labor Relations and Staffing
- Insurance Coverages, Bonds and letters of credit (LOC)
Table 10.2
Comparison of Project Delivery Alternatives

<table>
<thead>
<tr>
<th>Work scope Included:</th>
<th>Traditional</th>
<th>CM@Risk</th>
<th>DB</th>
<th>DBO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility O&amp;M</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Regulatory Compliance</td>
<td>No</td>
<td>No</td>
<td>Perf. Test Only</td>
<td>Yes</td>
</tr>
<tr>
<td>Staffing &amp; Labor Relations</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Laboratory Operations</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Possible</td>
</tr>
<tr>
<td>Fixed O&amp;M Price With Escalator</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Operating Permits and NPDES Permit</td>
<td>Separate</td>
<td>Separate</td>
<td>Prep</td>
<td>Prep</td>
</tr>
<tr>
<td>Repair &amp; Replacement</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Capital Program: 3 parties, separate contracts</td>
<td>separate contracts</td>
<td>one contract</td>
<td>one contract</td>
<td></td>
</tr>
<tr>
<td>– Permitting generally construction related</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>– Design design contract separate contract integrated pkg. integrated</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Construction competitively bid 100% design docs early involvement of constructor, $ guarantee possible early involvement, guarantees @ 30-50% Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Cost &amp; Schedule yes at construction bid, change order risk yes with guarantees, reduced change order risk yes, guarantees, single entity Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Interface Issues significant potentially significant per test passage Few</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Performance no single entity accountability no single entity accountability yes through performance test passage guaranteed long-term</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Project Management segmented, 3 entities some integration, construction only single entity, but no operations component single entity, all 3 elements</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ALLIANCE CONTRACTING

An alternative that has not been used in the United States, but is receiving increasing attention in Australia is Alliance Contracting. The Australian water and wastewater industry has experience in most forms of infrastructure delivery described above (i.e., design-bid build, design-build, design-build-operate etc.). This experience has helped Australian utilities tailor the delivery models for capital improvements and has resulted in a concept called alliance contracting. In alliance contracting, the owner and non-owner participants (NOPs) form an integrated team that shares equal risk in delivering the project from “concept to completion (Henneveld 2006).”

This approach aligns the ultimate goals of the owner and private participants (e.g., the design build team) in a common contractual framework. Under this framework, the participants share project risks and incentives, with the intent of delivering extraordinary value in contrast to pre-established project objectives. Frameworks need to be established at an early stage of project development and involve significant trust, collaboration, and innovation to achieve outstanding results. Alliance contracting helps alliance partners proactively manage risk, reduce cost, reduce schedule and improve project results. Strong candidate projects for alliance contracting include:

- Projects in the concept development stage with significant requirements in terms of community outreach, technology, process and methodology to achieve defined project objectives.
- Highly complex projects with regard to design, construction, technology, development, and number of interfaces with other parties and which cannot be satisfactorily or sufficiently scoped and specified at the commencement of the project.
- Projects where the owner has a strong desire to incorporate delivery innovation through design, constructibility, and operability into the earliest possible stages of the definition, design and development of the project.
- Projects using a developing technology or one where there is a challenging schedule.
- Projects that require a reduced capital cost to enable service to be delivered at an economical cost through technical, engineering and constructability innovation.
- Projects that have a stakeholder or external project interests that have the potential to influence and impact project objectives, but if addressed early in a co-operative team approach can lead to innovative outcomes.
- Projects where the experience and expertise needed to deliver a project is both in the public and private sector’s organization.

The key to successful alliance contracting is to ensure that all participants receive appropriate incentives and penalties for key result areas (KRAs). The following principles are usually part of the commercial framework between alliance partners:

- Development of a Target Cost Estimate
- The only way to achieve higher profit is through higher performance.
• Potential losses for NOPs are capped at:
  - the fee for combined Target Cost Estimate (TCE), Project Performance and non-cost design and construction KRAs painshare, and
  - the fee plus 10% for combined TCE, project performance, non-cost design and construction KRAs and the non-cost process performance KRAs painshare
• The alliance participants have meaningful incentives to pursue “breakthroughs”
• The owner is committed to the NOPs having the opportunity to earn 100% of the available Performance Adjustments
• The philosophy of pain share: gain share for all participants
• Each of the NOPs reach the maximum painshare position at the same amount of cost overrun.

An approach with some similarities to Alliance Contracting is the CII version of partnering. Unlike the common approach to partnering current used by utilities today, partnering involves a form of partnership between the owner (utility) and the contractor in which the contractor provides a favorable price in exchange for schedule flexibility (one example). This might apply to a long-term distribution replacement program that has some schedule flexibility, allowing the contractor to perform work during the contractor’s slack periods.

CONCLUSIONS

While many utilities respond positively as to the value received from Alternative Delivery methods, few utilities (less than 5% of our survey respondents) have actual experience with Alternative Delivery methods.

Evaluations of results delivered demonstrate significant benefits. For example, the D/B project delivery methodology demonstrated cost savings and schedule time reductions (as reported by the Design-Build Institute of America); DBO projects deliver an average of 26% life cycle cost savings as compared to the target costs established for Traditional Project delivery (Eisenhardt 2002) and provide completed projects that meet regulatory requirements. Both methods transfer significant additional risk elements to the vendor and obtain additional guarantees for costs, project quality, and performance. CM@Risk provides for early involvement of the constructor, as do DB and DBO formats, and demonstrated benefits accrue regarding project design, constructability, costs and schedule. However, the utility must still manage the Designer/Constructor interface in a CM@Risk format and unlike DB and DBO may face significant questions and issues in justifying the “negotiated” construction price for the project.

With increasing demand for increased capital expenditures (replacement of aging infrastructure, new regulatory requirements, growth of customer base, energy efficiency being just four examples) and the increasing costs for the accomplishment of each project, the stage is set for increased consideration and usage of Alternative Delivery methods. If double digit construction cost inflation continues, the schedule reduction associated with these methods alone will result in significant cost decreases. Utilities considering these alternatives should keep in mind the lessons learned by others. The key lessons learned are the following:
• Assemble a team of resources experienced with Alternative Delivery
• Allow adequate time to understand the alternatives and the implications and appropriateness for the particular project
• Understand and document your objectives for using an Alternative Delivery method and clearly understand what you want demonstrated as accomplishments
• Anticipate the need to adopt new approaches and techniques, consistent with the Alternative Delivery responsibilities for each party
• Explicitly recognize the inherent differences in work scope, guarantees, responsibility assignments, and contract documents that are required for a successful Project Delivery alternative
• Remember that your first project is a learning experience for your organization; insure that experiences are documented, discussed, and evaluated so that the feedback is available to the project and to others in the utility for future usage.
CHAPTER 11

RISK

Developing and conducting a Capital Improvement Program requires the evaluation and management of risk. In this chapter, we will address the following aspects of risk:

- Allocation and sharing of risk through the contract terms, and
- Identifying and managing risk

CONTRACT RELATED RISK

Our panel of utility managers identified the sharing and allocation of risk in the contract between the utility and contractor as the single biggest source of increased cost. The panel estimated that the cost increase attributable to the typical governmental risk-averse contract was about 25%. While it is always difficult to estimate cost differences between a path taken and one not taken, the following appears to lend credence to this estimate:

- Municipal utilities who met with their contractors as part of a cost reduction effort received similar (25%) estimates of the cost increase attributable to the risk averse contracts being used
- An investigation following a solicitation that received no bids (potential bidders could not get bonding from their sureties) found that sureties required contractors to add a 30% contingency when bidding to that government because of the allocation of risk in their standard contract (it should be noted that this was shortly after a series of natural disasters, including Katrina, cut into the surety’s profits)
- A/Es that we met with who compared some utility’s contracts with the EJCDC proposed contract estimated cost increases in the range of 15-25%

Contract Clauses

A typical contract will contain close to 100 clauses. A 1986 CII study identified about one-third of those that had a statistically significant association with project performance. A review of those clauses with contractor members of the Joint AWWA-AGC Committee revealed that things had not changed a great deal in the intervening years. The nine most problematic clauses (from all respondents in this study) were:

- Work scope definition
- Supporting included documents
- Design changes
- Construction changes
- Definition of cost (unit price)
- Price (escalation factors for materials and equipment)
- Cost reporting and control
- Schedule reporting and control
• Design rework

Based on our discussions, additional clauses of concern for the utility are:

• Performance test
• Mechanical completion
• Start up
• Beneficial occupancy
• Delays: Time extension
• Schedule intervention
• Progress payments
• Liquidated damages
• Subsurface investigation
• Construction rework

To eliminate a multiplicity of different versions of “standard” contract documents, a number of construction industry associations have undertaken an effort to provide a standard set of contract documents. One of the groups involved in this effort, the Engineers Joint Contracts Document Committee (EJCDC) has developed a standard set of contract documents preferred by many contractors and some, but far from all, utilities. The attached CD provides a link to the EJCDC web site (ASCE 1999).

Contract Risk Allocation Panel

As part of our study, a Contracts Panel was formed consisting of four utility personnel, one of whom was an in house counsel. One of the utilities on the panel had just adopted the EJCDC General Conditions after years of using General Conditions developed by the owner County. In contrast, another one of the panel members preferred to develop their own contracting forms and general conditions. They appear to bid out larger jobs than most water utilities and have a smaller pool of qualified contractors. That same utility periodically updates their General Conditions and sends out highlighted copies of proposed revisions to a group of contractors they work with regularly for review and comment prior to incorporation. While this is a positive in terms of involving contractors in the process, some panelists felt that this might give that pool of contractors an edge.

Our panelists discussed the contract terms that, for them, had the greatest impact on capital efficiency:

• Full disclosure of geotechnical information
• Allowing contractors to rely on geotechnical information to the same extent that designers do (i.e., eliminating the requirement for bidders to perform subsurface investigations)
• Insurance requirements
• Raw material cost increases
• Work scope definition
Problematic Contract Clauses and Mitigation Options

Risk-averse contracts place all of the risk and accountability with the contractor in such areas as:

- Unforeseen site conditions
- Escalation of costs in materials or equipment
- Coordination with other contractors
- Unlimited damages clauses
- No compensation for owner caused delays
- Owner generated bond forms

The following examines these areas and discusses ways to better allocate risk:

- **Unforeseen Site Conditions** – this is a problem for contractors because they are required to bear all of the risk related to site conditions in standard contract language. The burden of proof lies with the contractor, requiring a pre-bid investigation, filing of claims and procurement of insurance for hazardous waste or materials. Mitigating actions include full disclosure of geotechnical information, use of the change order process, owner supplied waste removal, and adherence to a process for change.

- **Fixed Price Contracting** – in a rising cost environment fixed prices increase costs because contractors need to forecast what the cost of rapidly escalating items will be when they are needed. Some mitigating actions utilized by our panelists included applying indexes to the cost of these items (although this could cause funding problems for smaller utilities). Other potential actions include owner-supplied equipment (also not a panacea, one of our panelists reported problems pre-purchasing mechanical equipment) and early buy out clauses.

- **Coordination with Other Contractors** – a problem for contractors in projects where there are multiple contractors is that many contracts place all of the responsibility for costs related to delays caused by other contractors entirely on the affected contractor. Mitigation actions include identifying multiple contractors, requiring coordination actions and owner involvement.

- **Owner Generated Bond Forms** – cost is affected through terminations for default and indemnification. Overly broad indemnification makes the contractor responsible for the risk, alleviating the owner’s risk. An inadequate termination process allows insufficient time for curing default and sometimes requires parties to act before knowing what to do. Mitigating actions include the use of standard forms, such as EJCDC, and contractor/surety feedback on owner documents. Other mitigating actions include:
  - Owner provided insurance or OCIP (note: this is discussed in Chapter 15)
  - Project specific vs. blanket coverage
  - Varying coverage amounts
  - Adjusting retention to percent of contract; providing early release
  - Warranty provisions
  - Disclaimers
  - Partnering
IDENTIFYING AND MANAGING RISK

Risk is the product of probability (the likelihood that an adverse event will happen) and consequences (the cost of that event). Managing risk on projects involve, first, developing consequence and probability risk matrices. A starting set of matrices are included in the capital efficiency model file in the Risk Reduction tab. The values included in the matrices are default values; some utilities may need to adjust the numbers. This information should then be used to develop a Risk Reduction Report to be prepared and reported upon by the Project or Construction Managers (also included in the CD under the Risk Reduction tab).
CHAPTER 12
POST DEVELOPMENT AND PROJECT COMPLETION REVIEWS

The better performers in our utility survey all performed project completion reviews or “lessons learned.” For those utilities, this exercise was budgeted as part of the project and was a mandatory requirement as part of the utility’s continuous improvement commitment. The Project Readiness Index (PRI) in the attached model provides a format for performing a structured “lessons learned” review. An overview of how to perform such a review will be presented in this chapter along with some important considerations that should be taken to insure that the exercise is successful.

LESSONS LEARNED FINDINGS

In a recent CII study about lessons learned, 94% of all companies (nearly all privately) surveyed collected lessons learned in some form (CII 2007). Fifty-eight percent of those surveyed collected them electronically (the PRI in the attached model will facilitate electronic lessons learned collection). Among the utilities and construction managers we surveyed, only a few reported a formal lessons learned approach and, for those, formats varied. CII expects to validate lessons learned as a best practice during the second half of 2008.

LEGAL CONSIDERATIONS

One of the problems identified in our survey was the highly litigious nature of construction today. Unfortunately, lessons learned are susceptible to legal actions. It is important for any utility undertaking a lessons learned exercise to mitigate problems by doing the following:

- Be sensitive to potential legal concerns
- Involve someone knowledgeable in legal issues, such as in-house attorney or other knowledgeable individual
- Convert lessons learned into hypothetical scenarios

Legal concerns should not deter the utility from conducting a lessons learned effort, but participants should be aware that any documents produced are discoverable. Thoughtful structuring and conduct of the “lessons learned” assessment is necessary but can be accomplished, as demonstrated by both the CII study and utilities who participated in our survey.

LESSONS LEARNED FRAMEWORK

This study developed an approach to performing a lessons learned review by incorporating it into the Project Readiness Index (also incorporated in the model). By utilizing the Project Readiness Index framework utilities will be able to identify steps that were taken in the project development phase when performing the lessons learned review. In this way, it will be possible to adjust the steps and scoring of the Index.
Utilities should feel free to develop an approach to Lessons Learned with which they are comfortable. Typically, a lessons learned session begins by reviewing the project history and what could have been improved, corrective actions taken and what went well. Contrasting areas that went well against those that could have been improved can be instructive.

The next step should be to use the PRI model. The PRI tool breaks down the Project Development activities into three tracks – Business, Engineering and Project – with 107 elements in total. The next steps are the following:

- Review each element
- For elements which were the cause of or linked to an area that could have been improved. click on the adjacent questionnaire box
- This will tell you how well you estimated this element to have been developed and includes a text box for you to enter lessons learned comments
- Complete this for all elements that had some bearing on the project
- The model includes a lessons learned tab, but currently requires that you cut and paste any lessons learned into the appropriate area in the lessons learned tab
- When completed the lessons learned tab should give you a good overview of the lessons learned in the project

Following this review, it may be appropriate to take one or more of the following actions:

- Revise the weighting for certain elements. It is possible that one or more elements were not weighted strongly enough. Weightings can be adjusted in Columns F through K in the worksheets for the three tracks.
- Revise the questionnaire in one or more elements. Possibly the questionnaire failed to take into account actions that proved to be essential to project success
- Consider revising the target score
- All of the above steps can be taken for elements involved in what went well. It may be possible that certain elements no longer are as important as they used to be.
CHAPTER 13
CONDUCTING YOUR OWN CAPITAL EFFICIENCY IMPROVEMENT PROGRAM

The information presented here is designed to provide you with the information and tools needed to conduct a capital efficiency improvement program. In this chapter, we present case studies of the approaches taken by three utilities that highlight the multiple paths that can be taken to achieve improvement. Although each utility was motivated by spiraling capital costs, they also saw additional factors that shaped the approach they took. Because of the extraordinary diversity of utilities and the differences in their circumstances, utilities will want to fashion their own improvement program drawing on the lessons from these case studies and the best practices presented earlier. In this chapter, we present case studies of the improvement programs undertaken by the Los Angeles Bureau of Engineering (BOE), Seattle Public Utilities (SPU) and the New York City Department of Environmental Protection (DEP). Although each received assistance from consultants who are identified in the case studies, the improvements were implemented by the utilities themselves. Following the case studies, a scenario planning approach towards conducting an improvement session is presented. This approach, and the example scenarios, was utilized with great success at the 2007 and 2008 AWWA Annual Conference and Exposition (ACE).

INTRODUCTION TO THE CASE STUDIES

Although each utility saw similar problems (high levels of resource intensity and rising future capital costs) the paths each took was slightly different:

- **Seattle Public Utilities (SPU):** One of SPU’s strategic objectives is to insure that it manages existing assets prudently and selects new assets consistent with a stated policy of comprehensive consideration of financial, environment and social impacts of proposed projects and programs. SPU developed and refined an Asset Management process that utilizes formal written and oral presentations to SPU’s Asset Management Committee (AMC). The AMC requires a consistent analytical approach that incorporates the desired financial, environmental and social impacts into a systematic and comprehensive assessment of capital project and program alternatives. This approach is known as Triple Bottom Line (TBL) and has been extensively documented by SPU in its TBL manuals.

- **Los Angeles Bureau of Engineering (BOE):** The City has a long history of Consent Decree work with mixed results. They embarked on a series of efforts to improve project delivery with a focus on measuring success. BOE was one of the leaders in the California Multi-Agency Benchmarking Program and conducted its own extensive Best Practices study. Concurrent with that effort (around 2000) they noted that many of their senior personnel were close to retirement and that the coming loss of tacit knowledge could be damaging within a culture that allowed each Program Manager to run things his or her own way. They implemented a series of efforts to introduce uniformity to project delivery – a Project Delivery Manual, Uniform Project
Reporting System, Master Specifications, Master General Conditions and General Requirements.

- **New York City Department of Environmental Protection (DEP):** Faced with sharp increases of their 10-year capital budget to $19.5 billion, DEP performed a Capital Program Management study that incorporated benchmarking, life cycle project management incorporating codified business processes and guidelines for consistent project delivery and a workforce development program. Their program also included efforts to become a “client of choice” for contractors in a very busy marketplace.

While the steps taken by these utilities may appear to be different, there are some unifying themes. All improvement programs include:

- Benchmarking
- Asset management
- Uniform methods and procedures
- Succession planning

**SEATTLE PUBLIC UTILITIES: TRIPLE BOTTOM LINE FOR THE ECONOMIC APPRAISAL OF CAPITAL PROJECTS**

**About Seattle Public Utilities**

Seattle Public Utilities (SPU) is a department of the Seattle city government reporting to the City’s Mayor with the City Council providing the role equivalent of a Board of Directors. SPU supplies water to 1.3 million people and businesses in the region. Nearly all of this water is from the 90,000-acre Cedar River Watershed and the 13,300-acre South Fork Tolt River Watershed – both in eastern King County. The Cedar River water treatment facility (180 MGD capacity) opened in early 2003 and utilizes ozone and ultraviolet treatment technologies. The Tolt River water treatment facility (120 MGD) opened in 2000 and utilizes filtration and ozone technologies. The water utility’s capital assets support long distance transport of raw water supplies, management of very large watershed areas, and management of significant underground pipe replacement because of the age of older portions of the water distribution system. Current replacement cost value of SPU assets is estimated at approximately $4.0 billion with capital project CIP of $420 million established for the next five (5) years.

**Background**

SPU provides essential services that are resource intensive and rely on a substantial portfolio of SPU assets. The utility annually considers numerous policy decisions and major investment choices. One of SPU’s strategic objectives is to insure that it manages its existing assets prudently and selects new assets consistent with stated policy of thoughtful consideration of financial, environment, and social impacts. SPU also gives thoughtful consideration toward ensuring service equity and understanding differential social impacts across the diverse communities and various neighborhoods it serves. Consistent with these strategic objectives, and to that end, SPU developed and refined an Asset Management process that utilizes analysis of life cycle triple bottom line costs and benefits, and formal written and oral presentations to the
Utility’s executive level Asset Management Committee (AMC). Effective utilization of the AMC necessitates the need for consistency of analytic approach and inclusion of the financial, environmental, and social impacts. These requirements created managerial challenges for the achievement of these objectives. Uniform evaluation and consistent application of comprehensive evaluation criteria were two of these challenges.

In response to these challenges and requirements initiated and established by the utility’s strategic plans and directions, the Triple Bottom Line (TBL) approach was established to more rigorously formalize the inclusion of the environmental and social impacts in the analysis for SPU’s capital projects and programs. SPU has a long established usage of formalized financial analysis tools in its capital project planning and analysis, including: cost analysis, present value analysis, and operating budget analysis. The TBL builds on these financial tools to create more refined analytic tools to examine capital projects and programs for their environmental and social impact components.

**Triple Bottom Line (TBL) Analysis**

The established purpose of TBL analysis is to consistently provide assessments of proposed capital projects or programs in a manner that produces a consistent quantification of the financial, environmental, and social impacts (the “triple” components of the analysis) and, to the extent practical, values each component. The TBL process also retains all non-quantified and non-valued impacts as part of its structured analysis and summary description of CIP project or program alternatives.

**Components of the TBL Analysis**

- **Objectives.** Objectives are defined so that, consistent with SPU’s core objectives, appropriate sets of alternatives can be identified for evaluation.
- **Alternatives.** The TBL process encourages a field or array of alternatives be considered and evaluated.
- **Economic Costs and Benefits.** Generally, market based prices and costs are utilized. Where market place prices do not exist or provide an incomplete measure, the TBL process strives to value non-market costs and benefits of social and environmental impacts.
- **Externalities.** Impacts of a decision or activity that are borne by 3rd parties (e.g., dust, noise and traffic impacts of construction).
- **Intangibles.** This category includes perceptual values that some people may ascribe to certain programs or activities. They reflect social benefits (or costs) and should be captured in the analysis, even if not quantified.
- **Distributional Equity.** Represents a fairly common type of social impact where the benefits occur sooner or later than the costs of the project in which case there are intergenerational equity transfers, or occur differentially across the community. The TBL process recognizes the importance of including these impacts in the TBL assessment.
- **Valuation.** The TBL assessment utilizes several standard techniques to capture the costs and benefits of project alternatives that do not have market prices.
• **Evaluation Period.** Allows project alternatives to be assessed over their envisioned useful lives. Variations amongst useful lives are adjusted by either extending the review period, establishing residual values for a cut off date, or converting impacts to a standard set of assessment units.

• **Inflation.** TBL recognizes that different rates of inflation for either specific cost or benefit components may occur and allows the usage of these differing inflation rates.

• **Residual Value.** Provides for the economic value or costs due at the end of the project’s life. Examples include salvage value, surviving benefits, disposal costs, environmental restoration costs.

• **Discounting.** Utilized by the TBL to provide a “present worth” of project costs and benefits so as to reflect the time value of money. The calculated net present values allow a quantitative ranking of the project alternatives. The TBL can include varying discount rates to provide sensitivity analysis on project rankings for the discount rate selected.

• **Economic Evaluation Measures.** Standardized for the TBL so that an appropriate summary measure can be defined and consistently applied across the TBL evaluation.

• **Risk and Uncertainty.** TBL assessments provide for explicit identification of risks, the strategies available to manage the risks, and the “risk cost” arising from the product of likelihood and consequences.

• **Sensitivity Analysis.** TBL recognizes that all project assessments rely upon projections and scenarios for the future with some projections and / or scenarios less certain than other. The TBL analysis strives to quantify the effects of these uncertainties on the assessment.

• **Follow-up Evaluation.** SPU tracks the outcomes of assumptions and conditions utilized in the TBL assessment so as to track the consistency of its planning assumptions and to maintain a record of commitments that have been made. As such, a formalized process for tracking project performance is included within the TBL process.

Usage of TBL to Select Asset Replacement Strategy for SPU’s Plastic Water Line Service

This example, provided by SPU, illustrates the TBL process and the techniques utilized to capture the financial, social, and environmental costs and benefits of the various timelines over which such lines could be replaced prior to failure or replaced upon failure. SPU’s stated objective is to minimize the life-cycle costs (financial, social and environmental) of renewing plastic service lines as assessed by the TBL analysis.

Consistent with the established TBL methodology, a variety of asset renewal strategies (i.e. approaches to line replacement) were identified for a change in strategy from the run to failure approach utilized by SPU. These alternatives were then grouped into two options for a change of strategy: 1) Production Mode strategies where blocks of replacements can be accomplished, where pavement restoration is inexpensive and crews can mobilize and complete renewals in a true production mode; 2) High Consequence strategies for renewals where the consequences of failure were expected to be high (social costs such as a critical customer service, e.g. food processing, hotels, hospitals, medical facilities, etc.) or where the costs for reactive replacement would be high or damages would be high.
As the first step in the TBL analysis, the financial costs for line replacements under the alternatives were determined with the key assumptions of financial costs noted for each alternative. Summarized below in Table 13.1 are the financial costs for three (3) types of line replacements under reactive and proactive strategies. These costs exclude any social costs that result from line failures.

### Table 13.1
Type of Line Replacement Risk

<table>
<thead>
<tr>
<th>Input</th>
<th>Large High Risk Cost Lines</th>
<th>Small Low Risk Cost Lines</th>
<th>Small High Risk Cost Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>All existing services fail by</td>
<td>2045</td>
<td>2045</td>
<td>2045</td>
</tr>
<tr>
<td>Utility cost of reactive replacement</td>
<td>$ 9,367</td>
<td>$ 1,954</td>
<td>$ 3,453</td>
</tr>
<tr>
<td>Utility cost of proactive replacement</td>
<td>$ 6,260</td>
<td>$ 1,285</td>
<td>$ 1,285</td>
</tr>
<tr>
<td>Proactive replacements per year</td>
<td>50</td>
<td>1,000</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Summarized below in Table 13.2 are the Net Present Values (NPV’s) for the three (3) pro-active alternatives as compared to the baseline of the NPV costs for the reactive strategy. No social risk costs are included for line failures.

### Table 13.2
Cost of Line Replacement Alternatives

<table>
<thead>
<tr>
<th>Program Category</th>
<th>Program NPV</th>
<th>Per Service NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large, High Risk Cost Category</td>
<td>- $ 215,000</td>
<td>- $ 295</td>
</tr>
<tr>
<td>Small, Low Risk Cost Category</td>
<td>- $ 497,000</td>
<td>- $ 29</td>
</tr>
<tr>
<td>Small, High Risk Cost Category</td>
<td>$ 3,172,000</td>
<td>$ 575</td>
</tr>
</tbody>
</table>

These results show that proactive replacement of the 6,000 small, high-risk cost service lines makes very good financial sense with a positive NPV of $ 3,172,000 or $ 575 per line as compared to the financial NPV costs for reactive replacement. The analysis also shows that financial costs alone do not justify the usage of the proactive strategy as compared to the reactive strategy for the additional two categories. Indirect social costs, based upon the above table, must be at least equal to $ 295 per service for the “Large, High Risk Cost Category” and equal to $ 29 per service for the “Small Low Risk Cost Category” for proactive replacement to have a positive NVP under the analysis.

The TBL analysis then focuses on a systematic understanding and quantification of the social costs associated with the two scenarios (i.e. Large, High Risk and Small, Low Risk categories). The objective: analyze the social costs to see if the quantified social costs result in a positive NPV and justify a revised replacement strategy for these capital project / program activities. Specifically, the following social risk costs were identified and evaluated:

1. Potential for water main shut down that will affect large numbers of, and/or high shutdown cost customers (e.g., hospitals)
2. Potential damage to private property such as breakage adjacent to basements, steep slopes or streets lacking curbs and gutters
3. Potential for line breakage to impact sensitive creeks or surface water bodies
4. Potential for high traffic impacts due to lack of repair scheduling during breakage emergency

Table 13.3 summarize the cost quantification for these risk categories using probability-weighted costs based on the likelihood of occurrence times the cost consequence of the occurrence:

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Probability</th>
<th>Consequence</th>
<th>Risk Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watermain Service Interruption</td>
<td>10%</td>
<td>+ 1 hr x 10 cust x $ 5/hr/cust</td>
<td>$ 5</td>
</tr>
<tr>
<td>Property / Street Damage</td>
<td>1%</td>
<td>$ 1,000</td>
<td>$ 10</td>
</tr>
<tr>
<td>Surface Water Discharge</td>
<td>0.1%</td>
<td>$ 1,000</td>
<td>$ 1</td>
</tr>
<tr>
<td>Construction Traffic Delay</td>
<td>10%</td>
<td>+ 1 hr x 40 cars/hr x $ 5 / car</td>
<td>$ 20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>$ 36</strong></td>
</tr>
</tbody>
</table>

As displayed in the NPV financial analysis, this category needs social risk costs in excess of $ 29 per unit to create a positive NPV for the proactive replacement program. Based upon the TBL analysis, the identified social risk costs were assessed as reasonably likely to exceed this amount in Table 13.4.

Table 13.4
Large, High Risk Cost Service Category

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Probability</th>
<th>Consequence</th>
<th>Risk Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watermain Service Interruption</td>
<td>10%</td>
<td>+ 1 hr x 10 cust x $ 100/hr/cust</td>
<td>$ 100</td>
</tr>
<tr>
<td>Property / Street Damage</td>
<td>1%</td>
<td>$ 2,000</td>
<td>$ 20</td>
</tr>
<tr>
<td>Surface Water Discharge</td>
<td>0.1%</td>
<td>$ 1,000</td>
<td>$ 1</td>
</tr>
<tr>
<td>Construction Traffic Delay</td>
<td>10%</td>
<td>= 1 hr x 400 cars/hr x $ 5 / car</td>
<td>$ 200</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>$ 321</strong></td>
</tr>
</tbody>
</table>

Similarly, this table indicates a reasonably likelihood for the social risk costs to exceed the threshold of $ 295 / unit. Based upon this TBL analysis, the pursuit of the pro-active replacement alternative would be justified under the TBL process and analysis.

**Conclusions**

As discussed and illustrated by this case study, SPU has developed a rigorous and formalized methodology for systematically including financial, environmental, and social costs and benefits into the evaluation and selection of capital projects and programs. Built upon the direction and approaches specified in SPU’s strategic planning, the TBL methodology provides consistent and uniform project and program evaluations that integrate all three (3) components (financial, environmental, and social) of costs and benefits. Continued evolution of the TBL measures used for the assessments will occur and continue to improve and refine SPU’s TBL process. However, even at the current time, utilization of the TBL process and methodology provides transparency of analysis for all three (3) components (financial, environmental, social)
that SPU wants explicitly considered and assessed in its capital evaluations and project / program selections. Electronic copies of SPU’s “Quick Start Guide” and “Triple Bottom Line Guidebook” may be obtained by contacting Elizabeth S. Kelly, P.E., SPU Director of Strategic Asset Management, at liz.kelly@seattle.gov.

LOS ANGELES BUREAU OF ENGINEERING: REDUCING CAPITAL COSTS THROUGH IMPROVED PROJECT DELIVERY TECHNIQUES

About the Los Angeles Bureau of Engineering

Within the City of Los Angeles, the Bureau of Engineering (BOE) has much of the capital program responsibility for the Bureau of Sanitation (BuSan), which includes the City’s wastewater utility. BuSan provides wastewater services to more than 4 million people through both retail and wholesale arrangements. It has four wastewater treatment plants, the largest of which is the Hyperion Treatment Plant. BOE is capable of performing the entire capital process from design to project delivery. Due to a variety of mandates and natural events (earthquakes), capital expenditures for the past 20 years have been running at $100-250 million dollars per year. Due to a recent settlement agreement and a facilities plan that calls for a variety of tunneling projects future capital expenditures will continue at a $150-250 million annual expenditure rate until about 2020.

Background

BOE has gone through a number of substantial capital efforts in the past few decades that have helped to identify some of their needs for improved project delivery. In 1980, the City entered into a consent decree with the U.S. EPA and the State to implement the sludge management plan according to an aggressive schedule. Design of the recommended facilities began in 1980 and, by 1983, the capital program was spending at a rate over $100 million/year (2005 dollars). “Sludge out” became the largest capital program undertaken by the Department of Public Works (DPW). Sludge was successfully removed from the ocean by 1987, replaced by energy recovery and land application.

The “sludge out” facilities were still being constructed when the City entered another consent decree to provide full secondary treatment at Hyperion. “Hyperion Full Secondary” became the new “largest capital program” and continued expenditures at the rate of $100 to $250 million/year through the 1990’s (2005 dollars). A new, pure oxygen activated sludge process was commissioned in 1998.

In February 1998, the City experienced torrential rains from an El Nino weather pattern. Sewage spills occurred throughout a wide area of the City. Civic pride and responsibility, perhaps aided by a Cease and Desist Order (CDO) from U.S. EPA and the State, finally broke the logjam. Large tunneling projects followed that resulted in the two largest single contracts ever awarded by the Department of Public Works ($162 million and $240 million).

In 2004, the City entered into a 10-year settlement agreement with local environmental groups, the U. S. EPA and the State to resolve issues over continued sewage spills caused by a combination of capacity restrictions, roots, and fats, oils and grease problems. A facilities plan is also in preparation that will call for additional tunneling projects to replace more upstream
portions of the North Outfall Sewer. These actions virtually assure that the capital program will continue its $150 to $250 million annual expenditure rate (2005 dollars) until about 2020.

In summary, the wastewater capital program has experienced two decades of large annual expenditures and looks forward to another decade or more of such expenditures. Delivering successful projects and controlling their costs is very important to the City’s program.

Lessons Learned

A review of the major projects resulted in a number of key lessons learned. The consent decree for “sludge out” imposed what turned out to be an unachievable time schedule on the facilities needed to achieve the objective. The first milestone was the delivery of design documents. BOE and DPW management wanted to demonstrate compliance with this milestone and many contracts were rushed forward with incomplete plans and specifications. To compound the problem, several key processes used innovative and alternative (I&A) technologies that had never been used before on wastewater sludge. Hindsight would say that a longer design time, not a shorter one, should have been mandated for these facilities. These factors combined to cause excessive change order costs on several of the seventeen contracts in the “sludge out” program. One contract exceeded 60% change orders and another almost 100%. Even worse, one of the I&A processes was declared a failure after many years and dollars of expenditure.

The wastewater program learned many valuable lessons from the “sludge out” experience. One was that it’s not the award amount that counts; it’s the final cost of construction including change orders. The direction from the “sludge out” experience was clear. Find ways to control change order costs during construction.

The consent decree for “full secondary” contained a more achievable schedule and, indeed, it was met with several months to spare. Unfortunately, four of the largest construction contracts ended in litigation, some of which are still ongoing, generating multi-million dollar legal fees and potential settlements.

The program again learned valuable lessons from the “full secondary” experience. The final cost of construction is not just the award amount plus change orders. Litigation costs can seriously influence the cost of total project delivery. The direction from the “full secondary” experience was clear. Find ways to eliminate or mitigate construction claims and litigation.

Approach

BOE’s analysis was that there are no magic bullets or “procedural antibiotics” that magically will cure a sick or ailing program. Instead, multiple efforts on many fronts are usually required. Fortunately, the wastewater program was not “on death’s door.” While it encountered a number of difficult projects, it did deliver its projects, most with great success. Efforts began around 1990 to improve the program and address the problems identified in the lessons learned exercises. This case study will review the following initiatives:

- Benchmarking and Best Practices
- Improving Project Delivery and Project Management
- Sustainable Progress
Benchmarking and Best Practices

Benchmarking is a process of comparing your organization to other outside organizations, hopefully those with a world-class reputation. The goal is to compare your procedures and results with best-of-class organizations, implement improvements, and eventually achieve best-of-class standards yourself. The wastewater capital program began its first benchmarking study in 1995 with nine outside peer agencies. The focus was on delivery costs for design and construction management (CM) services. Other studies followed and today the Bureau leads an effort with seven California agencies, called the California Multi-Agency Benchmarking Study. Goals for project delivery have been established in a number of categories as a result of these studies. The consensus Best Practices resulting from this effort form the basis for the survey described earlier in Chapter 6.

In 1999, the City engaged a contractor to perform a forward-looking, best practices study of its wastewater program. As that time, capital costs represented about one-third of the wastewater program budget. Working with the Bureau, the project team identified a number of opportunities for improved project delivery; of the 22 major recommendations for Bureau of Sanitation five involved the capital program. Almost all of the recommendations have been implemented and the result of that implementation will be presented in the next section.

Improving Project Delivery

The following paragraphs describe some of the management initiatives undertaken to improve project delivery.

Change Corporate Culture

Managing change is not easy for any organization. Self-examination showed that many programs within the Bureau accepted “over budget and late” as a way of life. In some cases, the project’s budget and schedule were not even known to those charged with implementing it. Seemingly, there were no consequences to “over budget and late.” This was not a corporate culture that would serve to improve project delivery. Beginning in the mid-1990’s the Bureau undertook a series of training exercises to develop a corporate culture of continuous improvement. The Deming theory of management was introduced along with other concepts. Every new hire is introduced to the idea of continuous improvement from their first day on the job. Management is very conscious of its role to “walk the talk” when it comes to continuous improvement and consistently reinforces this concept. Almost all promotional interviews include a question like “describe a process that you have improved in your current position.” The message spreads quickly. The last five years have seen a remarkable change in corporate culture. Many of the improvements described in subsequent paragraphs are the result of the continuous improvement ethic instilled in the BOE corporate culture.

Emphasize Design Quality and Design Clarity

Achieving design quality is the foundation for keeping costs under control during construction. Design quality must be stressed during all stages of project design, including concept development, pre-design, detailed design, and bid and award. Effective construction
management (CM) begins during design because the costs of CM, including change orders and claims, are largely determined by the quality of design. There is no better or more effective way to control total project costs than producing well-documented, well-designed plans and specifications. **Design quality is Job #1** in the Bureau of Engineering.

Plans and specifications must not only be of high quality, they must also be clear, understandable, and constructible. The contractor should know exactly what he/she is bidding. Areas of interpretation should be kept to a minimum because the contractor’s interpretation may differ from that of the project engineer or the inspector. Avoid ambiguity and be specific. **Design clarity is Job #2.**

A cadre of **quality control and quality assurance** measures was implemented to achieve design quality and clarity. These include (1) early documentation of project scope by concept and pre-design reports, (2) a series of in-house reviews during design, (3) constructability, operability and maintainability reviews by qualified construction and operations personnel, (4) 3-D computer-aided design and drafting (CADD) imaging, and (5) the use of oversight committees to control “scope creep” during design.

In a design-bid-build world, the **engineer should be the designer and the contractor should be the builder.** The less the contractor has to design, the better off you are.

The capital program has established a benchmark of averaging 5% change orders or less averaged over its projects. This benchmark has been achieved for all projects since 1998.

**Partnersing During Construction**

The wastewater program is committed to the concept of partnering during construction. Partnering cannot solve every construction problem and it cannot necessarily make a bad design into a good project. However, adversarial relationships during construction inevitably lead you on a path toward litigation and its associated costs. Partnering is a cooperative business plan, developed between members of the project team, which guides the administration of the contract in a fair and equitable manner. Partnering is simply a commitment to professional, fair, and ethical treatment toward all members of the project team, including the contractor. It is an attitude that if one member of the project team has a problem (say the contractor), the project has a problem, and that makes it everyone’s problem. All member of the project team are committed to work toward a solution of the problem. When issues arise, and they always will on any construction project, negotiations must begin immediately and continue until the issue is resolved. There must be a clear path of issues resolution within the organization if an issue cannot be resolved at the staff level. Inaction on an issue is not an option. Unresolved issues will fester and eventually infect the owner/contractor relationship. **Claims are the inevitable result of unresolved issues.**

Since the era of the “full secondary” litigation, the wastewater program has delivered hundreds of projects with virtually no construction lawsuits.

**Reputation as an Owner**

There is a secondary benefit of partnering whose dollar value probably exceeds that of just avoiding litigation. It is the owner’s reputation among the contracting community. During meetings with contractors, contractors report that they bid lower prices when they know that the BOE CM team will partner with them during construction. One large, national contractor stated...
that a local major agency, known as a difficult and adversarial Owner, received bids 25 to 50% higher because of their poor reputation within the contracting community. Los Angeles has taken many steps to be an owner identified as fair, ethical, honest, and capable of making decisions in a timely manner and sticking to them.

Improving Project Management

The BOE’s Best Practices study noted at the beginning of this chapter made five major recommendations, most directed at improving project management:

- Implement Uniform Construction and Change Management Procedures
- Reduce Project Implementation Period and Design Costs
- Modify Work Program Resource Requirement Processes
- Implement Uniform Project Management and Reporting Procedures
- Alternative Project Delivery

As noted earlier, these recommendations were made in 2000. In mid 2003, an analysis was performed of BOE’s progress on these recommendations:

- Implement Uniform Construction and Change Management Procedures – In addition to the uniform procedures manuals and uniform project reporting, BOE now has master general specification requirements. The resulting improvements show up in the numbers – claims are running well under 1%, indicative of sound pre-design work, well-drawn specifications and well controlled change management procedures. Moreover, total project delivery costs (pre-design, design, construction management, inspection and closeout) are running at 32% of total project costs, an improvement from the 52%+ of three years ago. In other words, one dollar of project delivery delivers more than 50% more project that it did before.

- Reduce Project Implementation Period and Design Costs – one byproduct of a high actual to budget percentage is that if you plan to expend a certain level of effort within a given time frame, it gets expended during that time frame, and projects do not drag out with their associated cost increases. Since receiving the Best Practices recommendations, every project is on a master schedule and has a “cradle to grave” project manager (for PMs 1, 2 and 3) with improved accountability and reduced slippage. People focus on the schedule and stick to it. Ninety-five percent of construction management is now done in-house, further reducing implementation periods. A newly implemented multi-function mapping system used on the Secondary Sewer Replacement Program reduces the design time from 6-8 months to 2 months. The cost reduction associated with reduced project implementation is detailed in a later section.

- Modify Work Program Resource Requirement (WPRR) Process – the primary objective of this recommendation was to raise the actual to budget performance from the low 60% level to at least the low 90% level through more realistic planning and a relentless focus on raising this performance measure. The nature of the WPRR process is that optimistic CIP schedules raise the BOE personnel cost to BuSan. At the time of the interview, the actual to budget performance had been raised to near
99%, essentially meaning that BuSan does not have to pay for more Design and Construction Management personnel than they need. At current actual to budget levels, the BOE capital labor efficiency has been increased more than 50% in the two years since the Best Practices study was completed (calculations are presented in a following section).

- **Implement Uniform Project Management and Reporting Procedures** – A uniform procedures manual is now in place and is on the BOE Web site. A uniform project reporting system is in place and every program and every master schedule is in a single database. Every quarter each program manager meets with the City Engineer to review progress and identify and resolve problems. One important objective of uniform reporting is to ensure that small projects (typical of some collection system projects) do not get lost in the system. The result is reduced project delivery times, with smaller projects (such as collection system projects) benefiting the most.

**The Result of Implementing Capital Best Practices**

The added efficiency in the capital process can be shown through the following calculation. The collection system capital projects for the years 1999-2000 and 2002-2003 were compared in Financial Management Department reports. In 1999-2000, the ratio of pre-design, design, construction management, inspection and closeout costs to total project cost was 52%. By 2002-2003, this ratio had dropped to 38%. In 2004, the percentage was down to 32% indicative of a trend of continuing improvement. In other words, one dollar of in-house cost today is delivering more than 50% more completed capital projects than it did 3 years ago.

**Sustainable Progress**

One of the areas of concern identified in the Best Practices study was the substantial loss of senior personnel to retirement in the near future, often called the “succession problem.” The loss of key personnel is difficult in itself, but a secondary problem is the loss of corporate knowledge. BOE is attempting to deal with this problem in a number of ways.

Following years of hiring freezes, BOE is again recruiting from college campuses. The goal is to hire “the best and the brightest.” A new “hiring for attitude” concept has replaced an older focus on technical qualifications alone. The belief is that attitudes toward school, work and other people are more important that one’s technical knowledge after only four years of engineering college. The effectiveness of recent hires supports that approach.

Training is being emphasized for all engineers in the Bureau. Programs are being developed to teach sewer and treatment plant design concepts to all new hires. Supervisors meet semi-annually with executive management and one question is always the training that is provided to staff.

Multiple approaches are being used to codify the Bureau’s knowledge and experiences into something more lasting than individual memory. Master specifications and the Project Delivery Manual are two examples. To the extent possible, “lessons learned” from projects result in changes to the master specs, notices to specifier, or the Project Delivery Manual.
NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION

About the New York City Department of Environmental Protection (DEP)

The New York City DEP provides water and wastewater services to the 8,000,000 residents of New York City and approximately an additional one million people through wholesale arrangements in upstate New York.

Background

The New York City Department of Environmental Protection (DEP) is currently experiencing challenges in cost control, resourcing, meeting schedule milestones, and prioritization for its expanding capital improvements program. The projects that comprise this program include new and upgraded water supply and distribution facilities (reservoirs, dams, tunnels, etc.), upgrades to its 14 major wastewater treatment plants and collection facilities, combined sewer overflow facilities, and numerous dams, bridges, roads and smaller wastewater treatment plants in the upstate watershed.

Within NYC DEP the majority of the capital program is implemented by DEP’s Bureau of Design and Construction (BEDC) which manages the planning, design, and construction management of the projects for eventual turnover to its client operating Bureaus.

Faced with sharp increases of their 10-year capital budget to $19.5 billion, and with $8.5 billion currently under contract for planning, design or construction, DEP performed a Capital Program Management needs evaluation to determine best practices, streamline processes, review organizational structure, benchmark the agency against other successful utilities, and identify new tools to improve the delivery of the capital program. The findings of the evaluation are now being implemented and include a revised organization structure that provides life-cycle project management (cradle-to-grave project ownership), codified business processes and guidelines for consistent project delivery, a Project Management Information System (PMIS) for transparent performance tracking, and a Workforce Development program that supports the new initiatives and enables continuous improvement.

In addition, DEP performed a Construction Cost Evaluation on two of its largest capital projects to determine the root cause of why several recent bids far exceeded engineering estimates and what mitigation measures could be taken to predict and prevent this trend from continuing. Market analyses were conducted relative to regional market conditions, materials, labor and other construction industry resources to determine the potential impact on the DEP’s ten-year Capital Program.

Organizational Evaluation and Findings

Data Collection and Evaluation – Interviews and Workshops

The objective of the organizational evaluation was to provide the DEP Bureau of Engineering Design and Construction (BEDC) with an understanding of the current state of organizational strengths, weaknesses, business processes, and ability to deliver on capital program goals. Staff interviews, steering committee meetings, workshops, business process evaluations, organizational analyses, a programmatic evaluation of a cross-section of DEP...
capital projects, and a special study on construction cost escalation were conducted to provide DEP with a detailed picture of the current state of its organization.

The primary means to understanding how the organization functions – its strengths and weaknesses and where opportunities for improvement exist – was through one-on-one or small group interviews with a representative sample of employees from across functional groups. Following extensive interviewing, a series of workshops were conducted to examine strategic objectives in detail, collaborate in facilitated breakout groups, and articulate the vision for the future. A summary of the workshop is provided in Table 13.5.

<table>
<thead>
<tr>
<th>Workshop Agenda</th>
<th>Output</th>
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</thead>
<tbody>
<tr>
<td>#1. Project Overview and Output from Staff Interviews</td>
<td>Selected Benchmarking Cities for Site Visits. Developed Business Process Shortlist for Evaluation. Selected Project Prioritization Filters</td>
</tr>
<tr>
<td>#2. Goals and Objectives and Project Prioritization</td>
<td>Refine Capital Goals and Objectives. Select Discussion Topics for Benchmarking Site Visits</td>
</tr>
<tr>
<td>#3. Organizational Design</td>
<td>Feedback from Organizational Assessment Interviews. Identification of Roadblocks to Successful Implementation</td>
</tr>
<tr>
<td>#4. Critical Success Factors and Key Performance Indicators</td>
<td>Developed Draft Critical Success Factors and Key Performance Indicators</td>
</tr>
</tbody>
</table>

**Strategy Development**

Using a six-step process, the study team built a strategic plan for the Capital Program over several months through a series of workshops with DEP leadership. The plan was aligned with the DEP’s Department-Wide Strategic Plan and includes a Mission Statement, Goals, and Objectives.

Following is a summary of the Plan:

1. **Mission Statement.** “The Capital Program delivers water and wastewater infrastructure to provide high quality drinking water and protection of NYC’s harbors, estuaries, and watersheds through effective program management and optimal use of available resources. This is accomplished by our skilled team of professionals who are dedicated to establishing strong stakeholder relationships and maintaining a sustainable environment.”

2. **Goals:** Financial Accountability and Transparency – To be considered successful
financially, how should we appear to our stakeholders (public ratepayers, Mayor’s Office and Elected Officials and Regulators)?

3. Motivated and Skilled Workforce – To succeed, to what extent should we change and grow our staff?

4. World Class Program Management and Delivery – To satisfy our stakeholders and customers, in what business processes must we excel?

Manage Stakeholder Expectations – To succeed, how should we appear to our stakeholders (Regulatory Agencies, the Public, Mayor’s Offices and Public Officials)?

- **Objectives** for each goal, the purpose of which was to define each goal more clearly.

- **Critical Success Factors** (CSFs) to make the strategic plan actionable. CSFs are actions that, if accomplished, define success for that objective.

- **Key Performance Indicators** (KPIs) to measure and quantify the CSFs, so that an organization can measure its progress in accomplishing its strategic plan. Good KPIs are **Specific**, **Measurable**, **Attainable**, **Realistic** and **Timely**.

- **Implementation Plan** to identify the tactics, schedules and resources required for successful implementation of each element of the Capital Program Management initiative.

The work was done in sequential order because each step built upon the results of the previous. **Figure 13.1**, on the following page, presents the elements of the Strategy Map from the DEP Key Objectives down to the Capital Program Objective level.
**DEP Key Objectives**

- Close the regulatory gap, enabling the DEP to plan and invest more strategically
- Support public health, economic vitality and quality of life of NYC
- Build consensus for 50 yr target for systems and develop financial models which can support its achievement

**MISSION:** The Capital Program delivers water and wastewater infrastructure to provide high quality drinking water and protection of NYC's harbors, estuaries, and watersheds, through effective program management and optimal use of available resources. This is accomplished by our skilled team of professionals who are dedicated to establishing strong stakeholder relationships and maintaining a sustainable environment.

**Figure 13.1 - Capital Program Strategy Map**

**Organization Model Assessment and Selection**

Effective organizational models reflect and contribute to an organization’s strategic direction. The evaluation team compared the existing organization capabilities and the future needs (as determined by the Capital Program Strategic Framework) and emerged with six key organizational design needs:

- Enable Life-Cycle Program Management
- Gain Efficiency Through Project Portfolio Ownership
- Create Strong Relations with Operating Bureaus
• Build Effective Relationships with Support Bureaus
• Establish Program Management Support
• Build Organizational Capability

The DEP leadership considered several organization structures and selected the Life-Cycle Program Management Model. While the Life-Cycle Program Management Model required the most change of the existing organization, it emerged as the best fit to capitalize on existing organizational strengths and overcome existing organizational weaknesses. The key features of this organization include project ownership from cradle to grave, alignment with the Operating Bureaus, and a matrixed support team focused on cost and schedule control, engineering standards, permitting, workforce development and quality control.

The ability to recruit engineers to DEP came up as a critical need in the interviews and workshops. Undervalued starting salaries were suggested as a major hurdle in the recruitment process. In response, DEP requested a salary survey on current market salaries for positions similar to those in DEP’s organization structure. The final analysis was based on information gathered from four salary information sources available in the public domain. The survey results indicate that DEP’s starting salaries for entry-level engineers are at least 30% below the regional average. As a result, adjustments have been made by re-classifying entry-level employees. This allowed for upper adjustments in starting salaries resulting in some recent recruiting successes.

Organizational success also requires supporting Workforce Development programs to ensure its viability and acceptance. The supporting programs recommended to support the new organization include: 1) Recruitment and Retention, 2) Education and Training, 3) Career Development Framework, 4) Performance Review, and 5) Communication.

Business Process Analysis

To improve effectiveness and efficiency within DEP’s capital program, four key business processes were mapped, reviewed, and analyzed. The four key business processes identified for action were:

• Budgeting
• cost estimating
• change orders, and
• workforce development.

Once these business processes were identified, the study team mapped the existing processes and developed corresponding matrices that provided responsibilities and actions for each of the process steps. The output of the working groups provided recommended tools and supporting needs for each of the processes analyzed are presented in Table 13.6.
### Table 13.6
Business Process Improvement Needs

<table>
<thead>
<tr>
<th>Budgeting and Financial Management</th>
<th>Expedited Change Order Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 20-year financial model tool to understand rates and capital program dynamics • Cost estimating</td>
<td></td>
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<tr>
<td>guidelines that help establish realistic budgetary estimates • Scheduling guidelines based on</td>
<td></td>
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<tr>
<td>historic realities • 10% encumbrance for change orders • Completion of an Integrated Asset and</td>
<td></td>
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<tr>
<td>Risk Management System for objective, transparent prioritization • Project Management Information</td>
<td></td>
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<tr>
<td>System to provide access to budget and schedule information and decisions • Budget prioritization</td>
<td></td>
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<tr>
<td>group consisting of representation from the Commissioner’s Office, BEDC, Operations and Budget</td>
<td></td>
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<tr>
<td>• 10% encumbrance for change orders in each project to eliminate need for offsets • Potential</td>
<td></td>
</tr>
<tr>
<td>Change Order register to help forecast potential changes • Contract provisions to speed up</td>
<td></td>
</tr>
<tr>
<td>contractor submittals on change orders • Construction management guidelines • Cost estimating</td>
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<tr>
<td>guidelines that support change order costing • Constructability and Operational reviews early in</td>
<td></td>
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<tr>
<td>the project delivery to reduce the need for change orders • Skilled negotiation capability</td>
<td></td>
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<td>through training</td>
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<table>
<thead>
<tr>
<th>Life-Cycle Cost Estimating</th>
<th>Workforce Development</th>
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</thead>
<tbody>
<tr>
<td>• Reliable life-cycle cost estimates that are consistent and certain • Life-cycle cost estimating</td>
<td></td>
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<tr>
<td>guidelines and manual •</td>
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<tr>
<td>Cost estimating databases</td>
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<td>that feed estimates •</td>
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<td>Cost escalation and</td>
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<td>contingencies regularly</td>
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<td>assessed and adjusted •</td>
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<td>Visible cost changes at</td>
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<td>specified phases of the</td>
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<td>project (i.e. 30%, 60%,</td>
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<tr>
<td>90%, 100% of design) that</td>
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<tr>
<td>account for project</td>
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<td>progress and scope</td>
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<tr>
<td>changes over time •</td>
<td></td>
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<tr>
<td>Dedicated controls/estimating group supporting project managers</td>
<td>• Adjusted salaries commensurate with market conditions to assist in recruiting • Staff rotational</td>
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<tr>
<td></td>
<td>programs to enhance diversity in experience • Multiple career tracks to allow for advancement of</td>
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<tr>
<td></td>
<td>good employees outside of management track • Training Academy offering enhanced curriculum of</td>
</tr>
<tr>
<td></td>
<td>courses with relevance to capital program delivery and aligned with employee career tracks • Defined</td>
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<tr>
<td></td>
<td>job performance expectations, roles and responsibilities communicated effectively through an</td>
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<tr>
<td></td>
<td>enhanced performance review process • Establish specific guidance for managers regarding marginal</td>
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<tr>
<td></td>
<td>and non-performers • Employee recognition program to improve morale and encourage better</td>
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<td></td>
<td>performance</td>
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</table>

World-class program management also requires standardization in delivery, the ability for project teams to quickly access project data and decisions, and the capability to continuously track and communicate program and project progress, status and issues. To that end, standards and guidelines for project management, construction management, cost estimating, and cost and schedule controls were recommended for development to provide consistency and efficiency in delivery.

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**Benchmarking**

A benchmarking evaluation was performed to identify potential comparable water/wastewater utilities against which DEP could be compared. Eleven organizations were selected for initial screening. A Benchmarking Report was prepared that summarized the key aspects of each organization such as size, personnel, organization structure, types of projects, program drivers, critical success factors, performance indicators, and business processes. Using this summary, a Steering Committee selected two organizations (Kansas City Capital Improvement Management Office and Clean Water Atlanta Department of Watershed Protection) who would host two-day visits by selected DEP personnel. The purpose of these visits was for DEP to observe and understand successful programmatic organizations, business processes and systems, along with the performance metrics that drive these programs. In addition to the two site visits, DEP hosted a forum of representatives from other water/wastewater capital programs (City of Los Angeles Department of Public Works, Metropolitan Water District of Southern California; and Southern Water and United Utilities of the United Kingdom) at a roundtable workshop in New York City.

**Construction Cost Evaluation**

In March of 2006, coincident with the initiation of the Capital Program Management Evaluation, DEP opened bids for a Newtown Creek Water Pollution Control Plant (WPCP) contract to construct a new central residuals building. Concerns arose relative to DEP’s CIP budget, as well as the cost estimating process, when an engineer’s estimate for this project identified an anticipated bid price of approximately $270,396,000 and the aggregate apparent low bid submitted totaled $457,785,000, approximately 69% more than anticipated.

The significant difference between anticipated and actual bid results created a number of concerns and questions in the mind of DEP:

- Was this a single cost estimating anomaly or is there a greater market trend to be concerned about?
- If a new market trend is occurring, what is its nature?
- If new market trends are taking place, how will they affect upcoming projects such as the $1 Billion Croton Water Treatment Plant contract, and what can be done in the short term to mitigate those effects?
- How will the overall Capital Improvement Program be affected and what can be done by DEP to mitigate these effects?

A study was commissioned and included the following three elements:

- Perform an assessment and analysis of market conditions relative to materials, labor and related construction industry resources, and evaluate their potential impact upon DEP’s Ten-Year Capital Improvement Program (CIP). This analysis included a review of cost indexes, literature, reports, and interviews with contractors and trade associations.
- Conduct a comparative assessment of the construction cost estimates and recent bids received to date. Analyze the cost drivers associated with the major differences
between the engineers’ estimates and bids received, and the related project schedule and compliance requirements.

- As a result of the exercise above, provide recommendations relative to business processes and organization structure to facilitate the successful execution of DEP’s CIP.

**Summary Results**

The analysis partitioned the major cost drivers into four elements. While all of these elements appear to have some contribution, analysis indicates that the majority of the difference is associated with elements other than direct costs. Taken together, these four elements create a dynamic situation that can drive the cost model into a situation where essentially a “perfect storm” of cost increase is created. An estimate of the contribution of each element to the increased bid price is listed below:

- **Direct Costs - 5 % to 10%**
  - Risk and cost associated with the removal of the contaminated soil.
  - Increase in reinforcing steel prices since the engineer’s estimate was prepared.
  - Possible under estimation of concrete formwork costs.
- **General Contractor Indirect/Overhead Costs - 10% to 30%**
  - The amount included in the engineer’s estimate for the general contractor’s onsite general expenses may not adequately represent real costs due to the anticipated duration of the project.
- **Market Factors - 10 % to 40 %**
  - A robust economy has produced a “seller’s market” in the construction industry.
  - Reduced competition due to fewer bidders.
  - Escalation that has occurred since the engineer’s estimate was prepared (estimate prepared more than one year before the bid in a time of considerable market volatility).
  - Projected escalation higher than what would have normally been anticipated at the time the engineer’s estimate was prepared.
- **Intangibles and Risk - Up to 50 %**
  - Challenging contract terms and conditions.
  - Perceived challenges in doing business with the DEP.
  - Long project duration adds risk and uncertainty.
  - Shrinking bonding capacity.

Marketplace factors were found to contribute a considerable impact. Over $25 Billion worth of projects were to be bid in 2006 alone in the New York area. Conservatively, $30 to $40 Billion will be spent on major construction projects over the next 5 years. As a result, local Contractors will have many choices in relation to the opportunities they will pursue and those choices will be predicated upon their own individual business decisions. For some, these decisions will be based upon avoidance of risk and, in many cases, the safeguarding of long-established family businesses. For others with substantial financial capacity, risk-laden projects may be more feasible to consider, but only at a commensurate level of reward.
As a result of the expanding Chinese economy, the reconstruction of the hurricane-stricken Gulf Coast and the robust United States economy, the cost of materials has also risen significantly. However, local labor has only risen marginally, with the normal annual increase in labor rising from 3% to 4%. This stability is attributed to the fact that trades-people are well-rooted in the New York area and are not moving south to meet labor demands there. However, those same local marketplace forces are not facilitating the movement of new contractors or trades-people into the New York area to meet expected increased local demand.

**Contractor’s experience with DEP** plays a significant role in DEP’s ability to attract multiple bidders on their projects. Meetings with multiple area contractors and trade groups indicated the following views:

- DEP shifts significant project risk to the contractors. The unpredictability of these risks causes contractors to add cost to their bids to cover these risks.
- Many types of costs are non-recoverable through DEP contract conditions (i.e. No damages for delay). Therefore, more cost is added to the bid.
- DEP payment provisions do not match contractor cash flow requirements (i.e. Change orders fully processed after the work is done). Contractors must finance these costs and they are added to the bid.

For the reasons stated above, local contractors view DEP as an undesirable owner to work for. This affected the number of bidders and this trend may continue on other DEP contracts.

There is increasing recognition in the industry that construction contracts represent partnerships that are entered into by different parties for individual objectives, but who share some common goals. Interviews with other owners indicate that they believe that contractors need to make a fair return on investment to stay in business, as they are necessary partners in those owners’ Capital Improvement Program (CIP) goals. They understand that contractors either, need to protect themselves from risk or look elsewhere for opportunities. If the perceived risk is too high, the risk margins added to the bid by the remaining bidders may be equally high. They understand that owners will be competing for the services of competent contractors and that there must be some visible perceived value to attract these contractors. That investigation resulted in the following recommendations that targeted various elements of the issue that can drive bid prices higher than engineer’s estimates.

- Limit project duration to less than 4 years to minimize uncertainties associated with bonding and market changes.
- Perform independent cost estimates for each project and reconcile any major category differences between the two to produce the most realistic estimate possible. Also, update the estimates prior to bidding such that the rationalized estimate is no more than 3 months old.
- Include materials escalation clauses in the contract documents to minimize uncertainties associated with the current construction environment.
- To minimize added cost associated with contractor’s risk mitigation, review and revise contract document payment clauses associated with:
  - Materials stored “on hand”
  - Material and equipment “in place”
  - “Time and materials” payment allowances
– Payment for delay

To minimize added costs associated with contractor’s risk mitigation for delays, develop and institutionalize procedures, practices, and process flowcharts with target durations for the following:

- Change Order processing
- Request for Information processing
- Submittal review
- Contaminated soils testing

**Longer Term Recommendations** will take more time and effort to conceptualize, develop, implement, and become part of the culture. Given the size and duration of DEP’s capital program, such an undertaking can produce significant capital savings well beyond the cost of investment. Longer-term recommendations are as follows:

- Conduct a series of facilitated workshops to determine factors causing contractors to inflate contingencies in response to the risk of uncertainties. Reassess contract risk profiles, targeting both contract conditions and contract administration procedures. Benchmark contract conditions and contract administration procedures against other agencies.
- After considering the input received, make a determination on which recommendations will be accepted. Prepare a timeframe for implementation of the recommendations. Reconvene the workshops to report progress and solicit input and advice. Two elements associated with implementation are described below:
  - Develop a dedicated taskforce to explore and implement recommended revisions to the contract documents. Incorporate the utilization of “expert” contract document resources to take advantage of industry expertise, as well as City legal authorities to facilitate review and adoption.
  - To standardize and institutionalize project delivery procedures by DEP project management teams and their consultants, prepare a “Project Delivery Manual” with a formalized Project Delivery Manual training course for DEP project management teams and their consultants.

**Implementation Plan – Capital Program Management Support Team and Life Cycle Project Management**

The evaluation study concluded with the development of an implementation plan that includes the schedule and resources required for successful implementation of each element of the Capital Program Management initiative. Like high performing capital programs around the world, DEP must develop consistency in delivery and project ownership from beginning to end. The primary outcome of the evaluation was a recommendation to create the DEP-Way for project delivery and organize the bureau responsible for capital delivery into a Life Cycle Project Management Delivery Model.
**Life Cycle Project Management**

Life-Cycle Project Management means that a life-cycle project management team has responsibility for their project from cradle-to-grave; or in other words one team sees a project from planning (the “cradle”) - through design, construction and start-up - to project close-out (the “grave”). One project management team can provide continuity of approach and decision-making to maintain project cost and schedule in line with critical targets.

Life-Cycle Project Management ensures that one team has the project vision, knowing why DEP is building this project, and what DEP is hoping to accomplish. It also ensures that in addition to giving the team life-cycle project responsibility and consequently holding them accountable for on time and on budget performance, the team is provided with the necessary support to do his/her job in the form of systems, tools, and processes.

This vital support function has been provided within the organization structure with the formation of the Program Management Support Division. This group’s goal is to assist with the creation of the DEP-Way for capital program management, through: 1) Continuous Workforce Development; 2) Consistent Project Delivery; 3) Transparent Program Performance and 4) Robust Governance and Communication.

Capturing, maintaining, and advancing a project vision (i.e. - asking *Why we are building this? and what do we need to accomplish?*) on each project is paramount to capital program success and efficiency. For the delivery team, it requires gaining meaningful input of the people who will be using the finished product, the Operating Bureaus.

**Engineering Standards - Consistent Project Delivery**

The Engineering Standards Group is focused on the delivery of tasks aimed at improving the quality, consistency and efficiency of Capital Project Delivery. The primary areas of focus of the Engineering Standards Group are:

- Driving consistency and efficiency in project delivery through development of web-based Project Management and Construction Management Delivery Systems.
- Developing a series of guidance manuals to provide in-depth instruction and technical knowledge focused on key areas of project delivery (i.e. Cost Estimating, Scope Management, Project Controls, and Risk Management).
- Reducing the cost and improving the quality of constructed projects by modifying and updating of the department’s contract and technical specifications.

**Project Delivery System.** A Project Delivery System will be developed with the goal of achieving sustained improvement, consistency and quality in the successful delivery of the DEP’s massive capital program. This consistency will be realized in the generation and codification of a series of practices, or Standard Operating Procedures, that are mapped to the phases of the project life-cycle: Initiation, Planning, Design, Construction and Closeout.

The vision of the Project Delivery System is a web or intranet-enabled interface that allows project managers easy access to the standard operating procedures and practices. Tools will be developed, such as workflow diagrams, policies and procedures, guidance manuals, checklists, and templates. This easy to access, one-stop source of information, will improve quality and efficiency by ensuring that the latest versions are being utilized by each and every
Construction Management Manual. The Engineering Standards Group will also develop a Construction Management (CM) Manual for the BEDC Construction Group. This includes the development of SOPs and associated tools for all activities involved in the procurement and management of contractors for construction of DEP capital projects. To develop this manual, a CM Task Force has been created and consists of DEP and consultant construction staff familiar with DEP procedures for construction management. The task force focuses on identifying required procedures and helping to translate existing documents and information into a standardized set of procedures, work flow diagrams, and associated tools and forms. In the long term, a web-based system for storage and distribution of the CM Manual documents will be created as a way to facilitate easy access and updating for all CM projects.

Cost Estimating Guidelines Manual. Inaccurate cost estimating has been identified as a significant impediment to effectively managing and delivering projects. A review of historical project data revealed that many of the early project estimates were substantially lower than estimates developed during the detailed design phases and that engineer’s estimates were often well below the awarded bid price. The discrepancies were largely attributed to poor project definition, scope-creep during planning and design, and substandard estimating. To help mitigate these problems, a Cost Estimating Guidance Manual will be developed to standardize the methodology and presentation of cost information throughout the project life cycle.

The manual will provide comprehensive instruction on how all aspects of cost estimating and will cover the following general topics:

- Cost estimating methodology and reporting format in each phase of the life cycle.
- Content requirements of each life cycle phase aligned with the cost estimate class as established by the American Association of Cost Estimating (AACE).
- Cost estimating work breakdown structure for each phase of the project and for the various types of projects that BEDC conducts.
  - Integration of cost estimates with the City’s budgeting process.
  - Integration of cost information with project controls data needs.

Review and Update Standard Specifications. One of the tasks under the Engineering Standards is to provide support in updating the Department’s general specifications. Currently, BEDC maintains a library of approximately 250 general specifications that are required for use in the contract documents for capital projects. The general specifications were last updated nearly seven years ago and only a few have undergone any major updating since then. As a result, many of the specifications contain outdated information, as industry standards and practices have evolved. Additionally, BEDC recognizes that some of the specifications contain excessive requirements that may not provide significant value. Although updating all of the general specifications is a major undertaking, significant cost savings should be realized if such areas as over-specification were eliminated.

Contractor Outreach. In the construction cost evaluation report, a problem that was identified was the difficulty in attracting contractors to bid DEP construction projects, thus driving the bid prices higher than the engineer’s estimates. In an attempt to increase the participation of contractors, the Capital Program Management Team will be starting a contractor outreach program. The objective of the program is to interview not only contractors that
currently bid DEP Projects, but also those that do not but bid similar work for different agencies.

Centralized Permitting Function. Permitting is a highly specialized and critical function in successful project delivery. The newly-formed BEDC Program Management Permit Group will support project teams in ensuring that all permitting requirements are properly identified, secured, and managed throughout the project life-cycle.

Transparent Program Performance

World-class program management also requires the capability to continuously track and communicate progress and status across the portfolios of capital projects that make up the DEP’s $19.5 billion 10-year capital program. To that end, standards and guidelines for cost and schedule controls will be developed to provide transparency in delivery. This transparency will be actualized in the further development and expansion of a system-wide Project Management Information System with the following long-term vision:

- Standardize BEDC’s business policies, practices and procedures to facilitate transparent and consistent program and project status reporting and measurement of Bureau performance using accepted performance indicators
- Capitalize on the BEDC’s existing investments in various databases and systems
- Develop a framework to allow several of the Bureau’s legacy data systems and other supporting systems throughout the department to be integrated into the resulting management system
- Conduct timely tracking and documentation for program and project budgets, costs, schedules, and key issues for BEDC’s capital improvements
- Execute an integrated capital planning and budgeting process to contribute to the Department’s annual capital planning cycle
- Perform analysis of BEDC programs and projects to assess program progress and evaluate performance against budget, cost and schedule milestones, and key performance indicators established by bureau managers

This vision will be realized by expanding the range and functionality of the existing Project Management Information System (PMIS), currently being used on the Advanced Wastewater Treatment and Combined Sewer Overflow programs, to all projects managed by BEDC, and eventually those capital projects managed by the operating bureaus. The PMIS is a web-based system that provides a mechanism to consistently maintain and communicate data, issues, and measures of performance (cost and schedule) for individual projects, collections of projects and programs.

Development of the PMIS will include the development of a master schedule, utilizing Primavera software, and capture the entire portfolio of 150-plus projects that make up the BEDC capital project portfolio. Business processes to be incorporated into the PMIS, such as budgeting and issues management, will also be analyzed for the required functional requirements to be incorporated into the system architecture.

The PMIS system will essentially create a one stop cost and schedule data capture and reporting enterprise that can be utilized by project managers for day-to-day project management as well as high level “dashboard” reporting of portfolio and program status for DEP executive staff.
**Continuous Workforce Development**

Workforce Development is the process of identifying and developing the skills and competencies BEDC personnel need to deliver projects effectively. The workforce Development focuses on five main elements: Talent Recruitment, New Hire Orientation, Education and Training, Performance Review and Career Development. Each element contributes to BEDC’s capacity for continuous improvement in both individual and organizational capabilities.

**Workforce Development Tasks**

**Talent Recruitment.** The goal of Talent Recruitment is to improve processes for bringing on quality employment candidates at all levels who contribute positively to delivering BEDC’s projects. Tasks would focus on recruiting young engineers at college fairs, drafting useful job descriptions, and communicating the benefits of a career at DEP. In addition, providing guidance and training for those individuals directly involved in the recruiting process on screening resumes, conducting interviews, and communicating with perspective employees are all being undertaken with the goal of increasing the yield of job acceptances. Success of talent recruiting ultimately is measured in the long-term by how many well-performing new employees are brought into the agency.

**New Hire Orientation.** Research shows that new employees to any organization decide early in their employment tenure (approximately 90 days or less) if they believe they will remain with the organization for the long-term. Job satisfaction and motivation are greatly influenced by how well and how quickly new employees at all levels are integrated into their teams. New hire orientation is the first opportunity to integrate new staff quickly, ultimately leading to shorter time durations for new hires to become positive contributors to project delivery. Improving the integration of new staff increases the efficiency of delivering complex capital projects. New hire orientation activities include development of a BEDC seminar that introduces new hires to the mission of BEDC and to the various groups that make up DEP as a whole. This begins to answer the question for new hires of “Where do I fit in?”

**Education and Training.** The goal of the Education and Training Academy is to create a curriculum of learning opportunities that is aligned with job function and career level. For Education and Training, the Program Management Support Team helps define the learning needs based on the strategic direction of the organization, then develops learning curriculum components specifically geared towards each organizational tier. Because BEDC employees have a range of learning sources, including city-employee training seminars, partnerships with local colleges, and industry conferences, a key role of the Education and Training Academy is to help the organization identify the most appropriate learning events for various experience levels and job classifications. For 2007, the Academy curriculum is scheduled to include Project Management, Construction Management and Leadership Development courses, with additional offerings planned for 2008. Additional specific-skill-based training events are provided as new BEDC processes, procedures, and tools are developed. Continuing Education Units (CEUs) are provided for those who attend academy courses.

**Performance Review.** Closely tied to Career Development (see below), performance reviews are used to evaluate how well personnel within an organization meet goals and expectations set by supervisors. Currently, BEDC uses the City’s standard annual performance review process to review the year’s accomplishments and set new goals. In addition, mapping
job classifications and tying specific roles and responsibilities to performance criteria will help teams further advance their abilities to deliver projects effectively. Providing guidance and coaching to supervisors and employees on giving and receiving effective feedback helps crystallize what is expected of personnel to encourage effective project delivery.

**Career Development.** A Career Development program helps employees understand what specific skills, competencies, and behaviors are required for each job level. Desired career paths for BEDC personnel are being identified and more clearly defined with specific requirements for what skills, training, and behaviors are expected to be considered for advancement. Career development provides a framework for BEDC employees to understand for themselves what they can do individually to progress along a successful career path.

**Conclusion**

Over the next 10 years, DEP will implement a $19.5 billion Capital Improvement Program for its massive water and wastewater infrastructure. To successfully complete this aggressive program on time and budget, the DEP looked outside its organization to identify the best practices of other successful capital delivery organizations and to compare those practices to their own. The findings generated a series of recommended changes and embellishments centered on a revised organization structure that provides life-cycle project management (cradle-to-grave project ownership) and recommend significant increases to staffing within that organization structure. Supporting features include codified business processes and guidelines for consistent project delivery, a Project Management Information System for transparent performance tracking, and a Workforce Development Program that supports the new initiatives and enables continuous improvement.

**IMPROVING YOUR UTILITY’S CAPITAL PROGRAM USING SCENARIO PLANNING**

The information in this report including the above case studies can be used to improve your utility’s program. The study authors recognize that many utilities lack the size and complexity of Seattle, Los Angeles, or New York. However, we strongly believe that the key components and elements illustrated and adopted by these utilities can and should be considered, at appropriate scale and complexity, by all utilities seeking to improve capital program efficiency and effectiveness. To that end, the following methodology was successfully used in workshops at the 2007 and 2008 AWWA Annual Convention and Exposition.

- Review your utility’s situation and identify the key dimensions affecting the size and scope of your utility’s Capital Improvement Program. These paired dimensions could be high-growth: economic slowdown paired with high regulation: laissez faire.
- Develop scenarios that reflect the situations at the extremes of those dimensions. Appendix D contains the scenarios utilized in the 2007 ACE.
- Form teams and assign them to individual scenarios. Following their review of their scenario, ask them to answer the following questions:
  - Given these facts (plus additional assumptions that you can add) what can you, as a capital projects manager, do to make this affordable? Identify, in priority order:
  - Which best practices might be the best for you to adopt to meet your objective?
- Which parts of your program should you focus on – project selection, project development, project execution?
- Which other members of your utility management team would you enlist to help you meet this goal?

- Ask each team to present back to the larger group. Look for common strategies as well as mutually exclusive strategies.
- Ask that teams go back and review their scenario and identify what a utility that would have successfully resolved their scenarios would look like in terms of:
  - Organization structure
  - Staffing levels by function
  - Training
  - Outsourcing strategy
CHAPTER 14
SUCCESSION PLANNING

More than half of the utilities surveyed reported shortages in their engineering staff and difficulty in filling vacant positions. Multiple previous Water Research Foundation studies have previously identified trends which should be troubling for utilities – the forecasted demand for engineers is rising while graduation rates have been in decline for much of this decade. Discussions with utilities have identified that new engineers are more likely to accept job offers from large urban centers, making things even more difficult for the medium and small utilities that appear to be less attractive to new graduates.

What strategies should utilities pursue given this situation? The following are some approaches that are being reported:

• **Let engineers focus on work that requires their skills and knowledge** – some utilities that have performed Knowledge Capture workshops (as described in Olstein et. al. 2005) have identified that engineers working on capital programs frequently perform duties, such as purchasing and related functions. That could easily be filled by easier to hire personnel with skills needed for those duties. Utilities should flow chart their capital process, using benchmarks and other information, to bring efficiency to the process and identify how much of the work could be performed by personnel more widely available in the labor pool.

• **Implement Uniform Project Management Procedures** – many utilities still employ the “project manager is king” strategy. Besides being inefficient, this approach increases the amount of tacit knowledge involved in the process and puts the utility at increased risk of the loss of crucial tacit knowledge as their engineers retire. If your utility utilizes this strategy and has a high average age in the engineering department, you should review the Los Angeles case study in Chapter 13. Additional useful approaches include adopting a PRI approach and making a lessons learned session part of every project plan.

• **Take Steps to Become an Employer of Choice** – water utilities should be able to appeal to the high environmental consciousness of the Millennial Generation. A recent study by the Water Research Foundation addresses generational differences in perceptions and employment incentives (Manning et. al. 2008). A related step that should be taken is to become more gender friendly. While females are still a minority of engineering graduates, their percentage is growing. Some water utility attributes that should be improved to attract female recruits have been addressed in the Foundation’s studies noted above.

• **Broaden Your Net** – some utilities have had success in expanding their search to outside the United States and Canada. Post 9/11 changes to foreign visa rules make this more challenging so the utility adopting this approach needs to allow sufficient time.

• **Selectively Outsource Portions of Your Program** – A/E firms may have better access to engineers and be in a position to offer better salaries than municipal utilities. Many utilities already outsource portions of their capital programs through specific
contracts, such as master plans, etc. Tampa Bay Water has an approach that incorporates a multi-level involvement of their contractor with various levels of their utility enhancing the contractor’s ability to support the utility.

- **Enhance Pay Levels and Training** – it goes without saying that forecasted shortages will require utilities to raise their pay levels for these positions to more competitive levels. Pay comparability studies should carefully focus on private sector trends for these key positions. Training should also be enhanced. It is also true that many new engineers do not arrive at a utility trained in engineering construction. We did not find any extraordinary efforts at training among the utility executives we interviewed. Involvement with private sector groups, such as the Construction Industry Institute and the Lean Construction Institute, should also be helpful, as the private sector appears to have experienced pressures to improve efficiency earlier than the utility sector.

A number of universities are offering construction specific training, some of which is designed for municipal utilities. The American Council of Engineering Companies (ACEC) recently joined with Northwestern University, Evanston, Illinois, to create a new graduate degree, the Master of A/E/C Business Management (Engineering News Record, 2005). The course offerings are summarized below in **Table 14.1**:

| **Table 14.1**  
ACEC/Northwestern University course offerings |
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<tbody>
<tr>
<td><strong>Fall Quarter</strong></td>
</tr>
<tr>
<td>Financial issues for engineers</td>
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<tr>
<td>Strategic management for Engineers</td>
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<tr>
<td>A/E/C entrepreneurship</td>
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<tr>
<td>Construction industry technology and the project manager</td>
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<td>Elective</td>
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<td>Elective</td>
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**Typical Electives Are:**
- Construction management
- Project scheduling
- Cost engineering and control
- Public infrastructure management
- Infrastructure systems analysis
- Building construction estimating
- Business development in the Construction industry
- Construction contracts And dispute resolution
- Infrastructure facilities and systems
CHAPTER 15
MISCELLANEOUS CAPITAL EFFICIENCY IMPROVEMENTS

During the course of the research, we came across some capital efficiency improvements that did not fit into the categories covered in the previous chapters. Two are presented here.

OWNER CONTROLLED INSURANCE PROGRAM (OCIP)

Owner-controlled insurance programs (OCIPs) are a type of wrap-up, in which a project owner (the utility) provides various insurance coverages to contractors and subcontractors. It is sometimes referred to as a wrap-up because it allows coverages for multiple insureds to be bundled (or wrapped up) into one consolidated program. OCIPs are typically used on very large construction projects involving many contractors and subcontractors. OCIPs provide an owner with certain cost savings (as a rule savings are only realized for projects with a value of $50 million or greater) and offer some advantages for the contractors and subcontractors working on the project. OCIPs are reputed to reduce an owner’s cost approximately 1-2%, compared to traditional fragmented insurance programs.

According to David Greiner of C-Risk Consultants (Greiner 2000), “Most OCIPs are multi-year programs with a fixed duration. For large construction projects, the most common duration is two to five years. And, the OCIP normally applies to all contractors and subcontractors performing work at the project jobsite. …The insurance coverages most commonly included in an OCIP are workers’ compensation (workers’ comp), employers liability, commercial general liability (CGL), and excess/umbrella liability. In addition (but not always), an OCIP can include builder’s risk, professional liability for design professionals, and environmental liability insurance coverages. In the last few years, design liability and environmental liability insurance have been bundled by some insurance carriers to provide professional and pollution coverage. In addition, some insurers have introduced subcontractor default liability policies into the OCIP mix as an alternative to surety bonds.”

In addition to cost savings, other advantages include:

- The ability to obtain broader insurance coverage with higher dedicated limits for contractors, which should provide better protection to the utility
- Lowered construction costs due to volume discounts on insurance and reduced losses from more effective, comprehensive and uniform safety and loss programs
- Improved risk management services (e.g., claim handling, loss control).
- Substantial reduction in the amount of time required for obtaining certificates of insurance from contractors
- Insurance requirements no longer an obstacle for contractors, particularly smaller contractors such as Women’s or Minority Businesses, bidding work.

However, an OCIP also adds an administrative burden which can become a substantial effort if not anticipated and managed competently. Utilities are advised to seek professional advice before entering into such an arrangement.

We identified a number of utilities and projects to try to independently verify cost savings and pros and cons of OCIPs. The biggest complaint about OCIPs was in the unanticipated
administrative burden (“it put us into the insurance business”). Utilities that were pleased with the program cited:

- Uniformity in insurance related programs (such as drug testing) on the job site
- Making it easier for smaller firms (WBE, MBE, small businesses and disadvantaged firms) to bid and win work

We verified documented cost savings on projects using OCIP. However, the savings we identified were in the ½ to 1% range. As noted above, insurance consultants believe that savings of 1-2% are possible.

COMMERCIAL PAPER FINANCING PROGRAMS

Commercial paper has historically been one of the most cost-effective means for financing the short-term needs of large, creditworthy business enterprises. Commercial paper transactions are exempt from Securities and Exchange Commission (SEC) registration requirements, and commercial paper trades freely in domestic and international capital markets. Commercial paper cannot have a maturity of more than nine months in order to qualify for the SEC exemptions and often has shorter maturities. With the advent of derivatives and new asset-backed structures, commercial paper programs are now available to finance a variety of businesses and assets. Commercial paper is sold through agents or dealers and is not underwritten by investment banks (see the Hunton & Williams web site).

A number of large utilities report using commercial paper as an interim financing vehicle prior to issuing long-term revenue bonds. Commercial paper programs have a number of advantages:

- Low interest rates – commercial paper rates are lower than long-term debt, running as low as less than 1% in 2005 to 2006
- It is relatively inexpensive to obtain
- It is strategically useful because it provides a better estimate of actual funds needed for the subsequent long-term revenue bond.

In consideration of the financial crisis that is currently constraining the credit markets at the time this research study was published, commercial paper is not currently viable. However, once the credit markets are reestablished, it will still be a viable short-term borrowing option for utilities.
CHAPTER 16
USING THE CAPITAL EFFICIENCY TOOLKIT

The attached toolkit has been designed to assist a utility in becoming more capital efficient. Significant instructions are not provided because the model is intended to be intuitive. However, some parts of the toolkit have comments embedded in cells, others have drop down menus etc., so it will be useful to spend some time going through the toolkit to see what the files can do and how you can tailor it to your utility’s needs. Four primary files constitute the capital efficiency toolkit (included in the CD):

- Capital Efficiency Model
- Drinking Water Cost Model
- Wastewater Cost Model
- Project Readiness Index

CAPITAL EFFICIENCY MODEL

The following is a tab-by-tab description of the capital efficiency model:

Introduction to the Model – this tab provides you with an overview of the model contents. It includes a table that identifies each tab, a description of the material in the tab and a list of contents.

The Problem – this tab presents a discussion of the capital problem facing water utilities (A number of utilities have used the graphics incorporated in this tab in their presentations to their Board to explain why rates were increasing above the rates of inflation).

Utility Type – this tab will let you type your utility by completing a single form. Being typed here will take your utility to the appropriate Best Practice audit for your utility type.

Program Best Practice Audit – if you completed the previous tab, this tab will allow you to perform a Best Practice Audit and compare the results for your utility to other utilities of your type. This is the same Best Practice survey utilized in this report.

Best Practice Comparison Chart – this tab displays the results of the Best Practice Audit taken in the previous tab.

Opportunities for Improvement – based on the results of the Best Practice Audit, this tab will identify some report areas for utilities to reference to make improvements.

Performance Measures – this tab will ask you to fill in some information about your utility. Doing so will result in a computation of your utility’s capital performance measures and will compare your results to our survey sample.
**Water CIP Framework** – this tab provides a framework for updating a previously developed water CIP. This framework will prove useful in subsequent tabs. You will also be asked to enter a few key parameters (you will have to select a future inflation rate) to allow you to update any previously developed CIPs.

**Updated Water CIP** – this tab will provide you with an updated CIP based on the information you placed in the previous tab.

**Proposed Water Projects** – this tab allows you to complete the CIP development process if you do not have an existing water CIP by allowing you to add new projects to develop a preliminary water CIP. This worksheet links to the Drinking Water Cost Model for the development of project cost estimates.

**Proposed Water CIP** – this tab escalates proposed water project costs for each year of the cashflow. This tab allows for a six-year water CIP.

**Wastewater CIP Framework** – this tab provides a framework for updating a previously developed wastewater CIP. This framework will prove useful in subsequent tabs. You will also be asked to enter a few key parameters (you will have to select a future inflation rate) to allow you to update any previously developed CIPs.

**Updated Wastewater CIP** – this tab will provide you with an updated CIP based on the information you placed in the previous tab.

**Proposed Wastewater Projects** – this tab allows you to complete the CIP development process if you do not have an existing wastewater CIP by allowing you to add new projects to develop a preliminary wastewater CIP. This worksheet links to the Wastewater Cost Model for the development of project cost estimates.

**Proposed Wastewater CIP** – this tab escalates proposed wastewater project costs for each year of cashflow. This tab allows for a six-year wastewater CIP.

**Non & Light Construction** – this tab includes some non- and light construction alternatives for you to consider as modifications to the (now) developed CIP.

**Prioritization and Selection** – this tab presents some prioritization and selection techniques, including a paired comparison matrix for complex projects.

**Program Best Practice Benefits** – this presents the Construction Industry Institute (CII) Best Practices results validation in graphical form, showing the cost and schedule benefits of different practices. Links are included to the CII web site.

**Risk Reduction** – this tab presents a risk reduction matrix and a project risk management spreadsheet. This is intended to be used as a risk reduction and reporting mechanism for projects.
**Contract Risk Allocation** – this tab presents recommendations on sharing or allocating risk in contracts, as well as example front-end documents. Links are included to the American Society of Civil Engineers’ (ASCE) EJCDC Contract Documents.

**Case Studies** – this tab provides attachments of the case studies included in our report. The Opportunities for Improvement tab may have identified case studies pertinent to your utility’s situation.

**Other Sources** – this tab provides links to organizations working to lower capital costs.

**Water and Wastewater Asset Definitions** – this tab contains a table of definitions for the various capital program items used in the capital efficiency model file.

### DRINKING WATER AND WASTEWATER COST MODELS

Before using these models, users should understand that their purpose is to provide utilities with a rough order of magnitude cost for a collection of projects. They were developed using a single national cost escalation index and you are advised to read the sections of this report which identify ways in which you can gauge your local situation so that you can make appropriate adjustments to the results of this model. *These models are not intended to replace an engineering study or to be used as the basis for a borrowing.*

In order to produce a cost you will need to indicate both capacity and number of items. Clicking on the name of project will take you to a definition of what is included in the project. For a selected project to wind up in your CIP, you will need to click on Add to Basket. When you are finished making your selections go to the basket tab to get your CIP. If desired, you can take the results of this exercise up to the Project (water and/or wastewater) Projects worksheet in the capital efficiency model (you will have to estimate the duration of each project) to ultimately develop a 6 year CIP.

Both models include a tab for historic values for the Engineering News Record (ENR) Construction Cost Indexes (CCI) which is a component of the models. They also incorporate a link to the ENR web site that should allow utilities to obtain current CCI values when the models are used in the future to update project costs.

The water and wastewater models were developed by ASME Innovative Technologies, Inc. (ASME-ITI), a wholly owned not-for-profit subsidiary, of ASME (formerly known as the American Society of Mechanical Engineers) for the U.S. Department of Homeland Security (US DHS) under contract number GS 10-F-035R, order number HSHQDC-060-F-00256. They are included here with permission by US DHS and ASME-ITI.

### PROJECT READINESS INDEX

This is a modified product developed by the authors of this report specifically for water utilities. It is based on CII’s PDRITM. It consists of elements in three tracks – engineering, financial and project. A comment embedded in each element describes what is involved in that particular element. In the cell next to each element is an embedded questionnaire. As utilities answer the questionnaire, they will arrive at a score that indicates how ready a project is to go...
forward. Default scores are included in the file, but users can revise the target scores as they become accustomed to the PRI process.
APPENDIX A
CALIFORNIA MULTI-AGENCY CIP BENCHMARKING STUDY
BEST PRACTICES

Planning
1. Define capital projects well with respect to scope and budget including community and client approval at the end of the planning phase
2. Complete Feasibility Studies on projects prior to defining budget and scope
3. Have a Board/Council project prioritization system
4. Resource-load all CIP projects for design and construction
5. Have a Master Schedule attached to the CIP that identifies start and finish dates for projects
6. Show Projects on a Geographical Information System

Design
7. Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start
8. Define requirements for reliability, maintenance, and operation prior to design initiation
9. Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc.)
10. Train in-house staff to use Green Building Standards
11. Limit Scope Changes to early stages of design
12. Require scope changes during design to be accompanied by Budget and Schedule approvals

Quality Assurance/Quality Control
13. Develop and use a standardized Project Delivery Manual
14. Perform a formal Value Engineering Study for projects larger than $1 million
15. Use a formal Quality Management System
16. Perform and use post-project reviews to identify lessons learned

Construction Management
17. Delegate authority to the City Engineer/Public Works Director or other departments to approve change orders to the contingency amount
18. Classify types of change orders
19. Include a formal Dispute Resolution Procedure in all contract agreements
20. Use a team building process for projects greater than $5 million
21. Involve the Construction Management Team prior to completion of design
22. Delegate authority below Council to make contract awards under $1 million
23. Establish a pre-qualification process for contractors on large, complex projects
24. Make bid documents available online

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Project Management
25. Assign a client representative to every project
26. Provide formal training for Project Managers on a regular basis
27. Adopt and use a Project Control System on all projects
28. Create in-house project management team for small projects
29. Institutionalize Project Manager performance and accountability

Consultant Selection and Use
30. Include a standard consultant contract in the RFQ/RFP with a standard indemnification clause
31. Delegate authority to the Public Works Director/City Engineer to approve consultant contracts under $250,000 when a formal RFP selection process is used
32. Implement and use a consultant rating system that identifies quality of consultant performance
APPENDIX B
CONSTRUCTION INDUSTRY INSTITUTE BEST PRACTICES
AND DEFINITIONS

PRE-PROJECT PLANNING

Pre-project planning is the essential process of developing sufficient strategic information with which owners can address risk and make decisions to commit resources in order to maximize the potential for a successful project. Pre-project planning is also known as front end loading, front end planning, feasibility analysis, conceptual planning, programming/schematic design, and early project planning.

Elements of Pre-Project Planning:

- Pre-project planning is an owner-driven process that must be tied closely to business goals. Pre-project planning is a complex process that must be adapted to the business needs of the organization, tailored to specific projects, and applied consistently to all projects in order to gain full benefits.
- Organizational goals and guidelines for both pre-project planning and the project must be well defined and aligned among project participants. Alignment requires involvement of operations, business, and project management early in the pre-project planning process.
- Pre-project planning is divided into four primary sub-processes:
  1. Organize for pre-project planning.
  2. Select project alternatives.
  3. Develop a project definition package.
  4. Decide whether to proceed with project.
- The pre-project planning effort is typically identified with 1.5 to 8 percent of the project total installed cost (TIC), depending on the type and complexity of the project.
- The 12 key outputs from pre-project planning include:
  1. Business requirements for the project have been addressed.
  2. Critical technologies for the project have been selected.
  3. A site has been selected.
  4. The scope of the work to be accomplished has been well defined.
  5. The cost and schedule for the project have been determined: Seek a realistic forecast of startup duration. Estimate startup costs. Recognize the impact of startup on project economics. Establish startup objectives.
  6. A project team with the proper expertise has been selected to lead the execution effort.

(Reprinted with permission of CII from CII Best Practices Guide [document ID IR166-3].)
7. Project documentation has been prepared to move the project smoothly into execution.
8. Key members of the project team have gained a detailed understanding of the development of the project.
9. The decision maker's needs and concerns have been fully addressed to facilitate the project authorization decision.
10. Intermediate and final recommendations have been presented in a way that allowed the decision maker to evaluate risks.
11. Commitment has been gained from all stakeholders in terms of project scope, cost, schedule and execution plans.
12. Regulatory permits have been fully investigated.

ALIGNMENT

Alignment is the condition where appropriate project participants are working within acceptable tolerances to develop and meet a uniformly defined and understood set of project objectives.

Elements of Alignment

Alignment exists in three dimensions.

- The first dimension, vertical, involves top-to-bottom alignment within an organization. The company executives, business manager, project managers, and functional specialists within each stakeholder organization must be well aligned.
- The second, horizontal, involves the cross-organizational alignment between functional groups within organizations. Different organizations with a stake in the project must also be well aligned. For example, the business, project management, and operations groups as well as other stakeholder groups such as outside contractors must be well aligned with the project objectives and priorities.
- The third dimension, longitudinal, involves alignment of objectives throughout the project life cycle.
- Issues that affect alignment during project planning can be divided into five categories:
  1. Culture: Includes the attitudes, values, behavior, and environment of the owner organization, the contractor(s) and the pre-project planning team.
  2. Execution Processes: The project systems, processes, and procedures that are used to develop and deliver the project.
  3. Information: The data elements, including business objectives that are used to define the scope of the project.
  4. Project Planning Tools: Are tools such as software program, checklists, and aide-memoirs that are typically used to develop and manage projects.

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5. Barriers: The obstacles to creating and maintaining the alignment of the project team.

CONSTRUCTABILITY

Constructability is the effective and timely integration of construction knowledge into the conceptual planning, design, construction, and field operations of a project to achieve the overall project objectives in the best possible time and accuracy at the most cost-effective levels.

Elements of Constructability

Constructability within an organization can be implemented at the organizational and project levels with areas of program overlap.

Organizational Program involves:

- Owner and manager commitment to the concepts of constructability.
- Performing self-assessment and identify barriers.
- Recognizing and assessing constructability benefits.
- Developing implementation policy.
- Understanding and communicating constructability objectives, methods, concepts, and barriers to all levels of the organization team.
- Establishing constructability program.
- Identifying constructability sponsor/champion.
- Establishing functional support organization and procedures.
- Developing main database and lessons-learned system.
- Updating the organizational program using the lessons-learned tool.

Project Program

Understand and communicate constructability objectives, methods, concepts, and barriers to all levels of the project team. Obtain constructability capabilities by:

- Selecting and assembling key owner team members with:
  - Expertise and experience.
  - Communication and team working skills.
  - Openness to new ideas.
- Establishing project objectives considering constructability.
• Selecting organization responsible for constructability.
• Determining the desired level of formality of the constructability program.
• Selecting project contracting strategy, which impacts project constructability.
• Identifying owner's available in-house constructability resources.
• Developing the constructability team.
• Identifying and addressing project barriers.
• Consulting applications matrix and lessons-learned file.
• Developing constructability procedures and integrating into project activities.
• Requiring constructability as part of contractor pre-qualification process.
• Securing contractors, suppliers, and consultants.
• Considering use of incentive clauses tied to constructability performance.
• Implementing constructability.
• Applying constructability concepts and procedures.
• Monitoring and evaluating project program effectiveness.
• Updating organizational program using the lessons-learned tool.
• Considering issues of plant and personnel security that could affect construction execution.

DESIGN EFFECTIVENESS

Design effectiveness is an all-encompassing term to measure the results of the design effort, including input variables and design execution, against the specified expectations of the owner. In addition, the owner's expectations include such criteria as cost, schedule, quality, safety, and other expectations either explicit or implicit in the project objectives.

Elements of Design Effectiveness

• Design effectiveness is a method to evaluate the design and not the designer, as all elements of design are not controlled by the designer.
• Criteria utilized for measurement of design effectiveness can be quantitative, subjective, or a combination of both. Quantitative criteria are preferred whenever possible.
• Many elements contribute to the design product. The following seven evaluation criteria have been determined to be the most significant in the evaluation process (see Table B.1, on the following page, for a sample calculation):
Table B.1
Evaluation Criteria for Design Effectiveness
- Accuracy of Design Documents - Economy of Design
- Usability of Design Documents - Performance Against Schedule
- Cost of Design - Ease of Startup
- Constructability

Not all criteria influence a design to the same degree. A method of assigning weights and performance ratings into a single performance index number can be developed using the Objectives Matrix.

- The Objectives Matrix consists of four main components:
  - Criteria: define the elements to be measured.
  - Weights: determine the relative importance of the criteria to each other and to the overall objective of the measurement.
  - Performance scale: compares the measured value of the criterion to a standard or selected benchmark value.
  - Performance index: once calculated, is used to indicate and track performance.

Determining the Impact of Input Variables to Design Effectiveness

- Project initiation studies (pre-project planning), design contract, and basic engineering decisions have the highest influence on the project.
- The following 10 input variables in Table B.2 have the greatest impact on design effectiveness:

Table B.2
Input Variables with the largest impact on design effectiveness
- Scope Definition - Designer Qualification & Selection
- Owner Profile & Participation - Project Manager Qualifications
- Project Objectives & Priorities - Construction Input
- Pre-Project Planning - Equipment Sources
- Basic Design Data - Type of Contract

MATERIALS MANAGEMENT

Materials management is an integrated process for planning and controlling all necessary efforts to make certain that the quality and quantity of materials and equipment are appropriately specified in a timely manner, are obtained at a reasonable cost, and are available when needed. The materials management system combines and integrates takeoff, vendor evaluation, purchasing, expediting, warehousing, distribution, and disposing of materials functions.

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Elements of Materials Management

- The materials management plan will be part of the project procedure manual and project execution plan.
- The materials management plan will identify and outline the responsibilities for all functions.
- Material takeoff - Clearly communicate engineering and materials requirements to all participants in the project.
- Supplier evaluation - Each project must prepare an Approved Suppliers List to account for its specific requirement.
- Procurement - Strategies for the procurement of both equipment and bulk materials are essential to supporting project objectives.
- Expediting - The primary goal is to ensure that materials are delivered to the site when needed.
- QA/QC - Quality is conformance to established requirements to assure materials meet the specification.
- Warehousing - Plans should provide space for receiving, handling, storage, and distribution of equipment and materials.
- Field control - The objective of materials management is to ensure that materials are available to meet the construction schedule.
- Surplus - The site materials group must have a plan for identifying surplus to purchasing.
- The materials management plan will be computer-based.
- The materials management plan will be integrated with the CAE/CAD, scheduling and cost systems.
- The materials management plan will include the use of bar coding.
- Appropriate craft personnel will have access to the materials management plan.
- Security plans addressing the handling, shipping, and storage of project equipment and materials are in place.

PLANNING FOR STARTUP

Startup is defined as the transitional phase between plant construction completion and commercial operations, including all of the activities that bridge these two phases. Critical steps within the startup phase include systems turnover, check-out of systems, commissioning of systems, introduction of feedstocks, and performance testing.

Elements of Planning for Startup

Mechanical completion is not the project objective; it is successful commercial operation that defines a successful project. Successful commercial operation requires a successful startup. The message is: For a successful project, a successful startup must be planned.

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• Research indicates a reasonably strong correlation between startup success and the extent of planning conducted.
• Effective startup planning requires that the right issues be addressed by the right people at the right times.

CII developed a Startup Planning Model so that startups may be planned in a more thorough, effective, and efficient manner. The Planning for Startup Model is a sequence of 45 planning activities organized according to eight typical project phases. The 45 planning activities are complemented with 26 tools that facilitate the implementation of the particular startup planning activity. Each planning activity is detailed in a one-page activity profile that presents nine fields of descriptive information, as shown in Table B.3:

Table B.3
Fields for planning activity information
A. Phase F. Quality Gate/sequencing Constraints
B. Key Concepts G. Basic Steps
C. Deliverables H. Tools Needed/Provided
D. Motive/Rationale I. Challenges to Successful Implementation
E. Responsibility/Accountability/Consult/Inform

TEAM BUILDING

Team building is a project-focused process that builds and develops shared goals, interdependence trust and commitment, and accountability among team members and that seeks to improve team members’ problem-solving skills.

Elements of Team Building

Alignment, teamwork, and team building appear to be variations of the same concept but are, in fact, three distinct concepts with complementary and different definitions. All three are critical to the success of a project. To effectively utilize the team building concept, a clear understanding of the three concepts and how they complement each other is required.

Alignment concerns whether the team members are all working toward the same, correct goal. Teamwork involves how well the members interact, cooperate, and support one another while working together. Team building is the process used to develop and enhance teamwork. Elements of the team building process include the following:

• Trust.
• A set of shared goals for the project.

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• An interdependent relationship among team members. Team members must possess and demonstrate:
  - Shared commitment to work together.
  - Shared sense of team's accountability.
  - Clearly defined individual accountability.
  - Pride in being a member of the team.
  - Open communication and feedback.
  - Effective conflict management.
  - Increased sense of work satisfaction.

For a project team to operate effectively, it must first be aligned in the areas of culture, execution, information, and tools. The alignment process is addressed in the CII Best Practice 1.2 Alignment, and must be carried out during the development of the project. If this process is conducted properly, the project team will have the groundwork to implement the team building process.

In addition to the alignment process, assessing the effectiveness of communications on the project can also be beneficial. The communication assessment process consists of: developing a communication assessment questionnaire, comparing the results to a reference database, developing an improvement strategy, implementing the improvement strategy, and reassessing the results at regular intervals.

PARTNERING

Partnering may be a long-term commitment between two or more organizations as in an alliance or it may be applied to a shorter period of time such as the duration of a project. The purpose of partnering is to achieve specific business objectives by maximizing the effectiveness of each participant's resources. This requires changing traditional relationships to a shared culture without regard to organizational boundaries. The relationship is based on trust, dedication to common goals, and the understanding of each other's individual expectations and values.

Elements of Partnering

CII research states that nearly all successful partnering relationships have three key attributes in common:

1. Leadership that, through faith in the process, continues to support partnering ideals in the midst of doubt and questioning.
2. A situation where those involved adapt and accept each other's manner of business, with rewards tied to team accomplishments.
3. A belief in the potential for win/win outcomes to grow from collaboration and a willingness to pursue such joint gains.

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These attributes provide a framework for fostering a change in attitude from adversarial to cooperative, self-centered to team-focused, and win/lose to win/win.

Implementation and management of the partnering process is a five-phase process that incorporates executive, management, and craft-level participants.

QUALITY MANAGEMENT

Quality management incorporates all activities conducted to improve the efficiency, contract compliance and cost effectiveness of design, engineering, procurement, QA/QC, construction, and startup elements of construction projects.

Elements of Quality Management

- Quality management is comprised of several separate elements that when combined, enhance the overall quality of the deliverable.
- Total Quality Management (TQM) is the process by which quality management is accomplished.
- Quality management can only be fully effective when senior management is the driving force behind the program.
- Before deciding to institute or improve a quality program within an organization, senior management must be convinced of the benefits of such a program.
- Senior management must personally and persistently lead the building of quality values into the organization's operations.
- A quality program should follow a recognized quality methodology and or a recognized international standard.
- TQM consists of four major phases:
  - Exploration and Commitment
  - Planning and Preparation
  - Implementation
  - Sustaining
- A measurement process is required for evaluating project quality. Elements of the measurement process include:
  - Identification of project variables.
  - Determining why and when these variables should be measured.
  - Providing examples of how to measure these variables.
  - Determining how the results can be utilized in making project decisions.
- Quality Performance Management System (QPMS) is required to categorize and measure quality related costs associated with projects.
- Quality Improvement (QI) activities must reflect organizational goals, address the most results-critical areas for improvement: and coordinated, efficiently executed: and properly supported by higher management.
IMPLEMENTATION OF PRODUCTS

As relates to CII Best Practices, implementation of products is the comprehensive and effective use of proven CII products by member organizations as outlined in the CII implementation Model.

Elements of Implementation of Products

The CII Implementation Model contains a foundation of nine recommendations for an organization to pursue in implementing best practices. The implementation Model is included in this Best Practice Summary and details the following elements:

A Foundation of CII Products, Support, and Benchmarking and Metrics Data

- CII products include implementation resources, research summaries, and educational materials that can be used to assist individuals in process improvements. The products, including CII Best Practices, are discussed in more detail in the next section.
- The CII Benchmarking and Metrics Program provides project performance and process use metrics to assist organizations in understanding improvement opportunities.

Organizational Commitment

- Make a statement that clearly informs employees what the organization expects relative to implementation of CII Products - "Walk the Talk."
- Incorporate implementation of CII Products into Performance Reviews with specific targets - products to be implemented by [date].
- Issue directives to implement specific CII Products into existing processes, procedures, and practices within the company.
- Use the implementation Model as a guide.

Organizational Implementation Champion

Guides and directs participation in CII - maximizes organizational benefits. Essential competencies include:

- Leadership - Identifies greatest organizational need and directs resources to achieve maximum benefits.
- Communication - Communicates benefits, successes, opportunities.
- Knowledge - Enhances awareness of CII Best Practices. Enhances availability of information for application within the organization.
- Measurement - Objective comparison of results with CII Best Practices.

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Self Audit

- CII Implementation Resource 166-2 (CII 2001) describes the organization of the CII Knowledge Structure and how to use it to determine the content and impact of each CII product.
- CII Implementation Resource 166-3 (CII 2006) describes each CII Best Practice and provides a process and set of selected questions for each Best Practice that enable users to determine the extent of applicability of central elements for that practice within the organization.
- Compare performance of the organization within the practice context with performance attained through more complete use of the practice, and the needs or desires of the organization.

Implementation Plan and Goals

- Based on organizational vision, identifies specific goals for the use of CII Best Practices.
- Selects strategies and formulates implementation plans.
- Develops systems to integrate CII Best Practices into organization.

Product Champions/Review Boards

The Product Champion:

- Frequently selected early in the review process to facilitate the understanding of a Best Practice.
- Frequently serves as the overall manager of the implementation process for the selected Best Practice.
- Determines which CII Best Practices are applicable to the organization.
- Recommends specific application of the Best Practices within the organization's business process for capital development projects.

Product(s) Training

- Provides knowledge necessary for successful implementation.
- To be effective, must involve all elements of project team impacted by the Best Practice's being implemented.
- Many CII resources are available to support training.
- Goal is to improve project performance. Needs adequate resources to achieve goal.

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Product(s) Implementation

- Select Best Practices for implementation based on potential for improvement in your organization or project.
- Identify possible barriers and plan enablers to counter barriers.
- Provide leadership, communication, resources, and support.

Measure Results

- Use the same techniques that were used during the self audit.
- Measure both utilization of CII Best Practices and impact of use.
- Participate in surveys conducted by the CII Benchmarking and Metrics Program and the results will give you comparison of your efforts with those of other member organizations.

Celebrate Success

- Communicate implementation benefits: successes, and opportunities.

BENCHMARKING AND METRICS

Benchmarking is the systematic process of measuring an organization's performance against recognized leaders for determining best practices that lead to superior performance when adapted and utilized.

Elements of Benchmarking and Metrics

The CII Benchmarking and Metrics Program measures project performance and CII Best Practices use for both the small and large capital projects as well as the small maintenance project. Once entered into the online system, a project can be immediately compared against industry performance. The essential elements of the Benchmarking and Metrics Program are:

- Process (structured/systematic)
- CII Best Practice oriented
- Part of a continuous improvement process
- Understanding what is important to your organization (critical success factors)
- Measurement, comparison, gap analysis against leaders
- Adapting practices to your organization

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Benchmarking and Metrics is a defined process and method with defined steps and activities:

1. Obtain organization commitment to benchmark as a basis for improvement.
2. Identify person responsible for Benchmarking coordination - Benchmarking Associate.
4. Learn about the CII Benchmarking and Metrics Program.
   - Online data entry.
   - Metrics and terminology.
   - Organization and Industry reports.
5. Identify Project Managers responsible for project benchmarking and improvement.
6. Determine Levels of Use - How much and what do you want to benchmark?
7. Use the Benchmarking & Metrics Implementation Toolkit to train internally
8. Select projects to benchmark.
9. Input project data during project execution:
   - Large project questionnaire.
   - Small project questionnaire.
10. Review and act on interim online CII recommendations.
11. Finalize and submit project questionnaire at close-out.
12. Carry out data validation internally and with CII.
14. Develop and implement improvement plan using CII publications.
15. Repeat steps 5-13 for continuous improvement.

**CHANGE MANAGEMENT**

Change management is the process of incorporating a balanced change culture of recognition, planning, and evaluation of project changes in an organization to effectively manage project changes.

**Elements of Change Management**

- Establishing a good up-front baseline agreement that allows all team members to recognize and measure change is essential in achieving effective change management.
- A classification process is used to determine if the change is a required or an elective change,
- For a required change, immediate focus should be on effective implementation.
- For an elective change, implementation may or may not occur (require financial justification for all changes).
- Generate a measurable outcome that indicates degree of success in achieving some quality objective metric to enable the appropriate management level to implement or reject the changes in a timely manner.

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• Clearly define who is responsible for taking the necessary action based on the metrics supplied. Collections, storage, and accessibility of relevant data throughout the life of the project can be used to make management decisions and measure changes.
• Data collection system must facilitate the timely presentation of analyzed data to the appropriate decision makers.
• Use established benchmarks to monitor project performance.
• Recording or reporting system must be consistently used by all team members to document all changes.
• Recognition/reward system for those who initiate beneficial change.
• Agreements must exist between the project participants at the different levels of the project.

DISPUTES PREVENTION & RESOLUTION

Dispute resolution techniques include the use of a Disputes Review Board as an alternate dispute resolution process to eliminate the necessity to take disputes to litigation. The Dispute Review Board technique provides a process for addressing disputes in their early stages before the dispute affects the progress of the work, creates adversarial positions, and leads to litigation.

Elements of Disputes Prevention & Resolution

• Provisions for a Dispute Review: Board must be in the contract documents
• Provisions for a Dispute Review Board must be in the subcontract contract documents.
• Operation of the Dispute Review Board should be included in the partnering process.
• The Dispute Review Board members need to be selected in the early stages of the project.
• The Dispute Review Board members must be neutral.
• The Dispute Review Board members need to be experienced in the project type. - The owner selects one member. - The contractor selects one member. - The first two members select the team chairman. - The Dispute Review Board, the owner, and the contractor will establish operation procedures.
• The owner and the contractor will establish Dispute Review Board limits of authority.
• The owner and the contractor will establish the method of compensation for the Dispute Review Board members.

ZERO ACCIDENT TECHNIQUES

Zero accident techniques include the site-specific safety programs and implementation, auditing, and incentive efforts to create a project environment and a level of training that embraces the mind set that all accidents are preventable and that zero accidents is an obtainable goal.

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Elements of Zero Accident Techniques

- Zero accidents/safety will be a major topic at all pre-construction and construction meetings.
- A written, site-specific zero accident/safety program will be developed for each project.
- A site safety professional will be assigned full time for safety for each project.
- A zero accident/safety orientation will be conducted for all new personnel including subcontractor personnel.
- A zero accident/safety incentive and award program will be developed for each project.
- Weekly zero accident/safety toolbox meetings will be conducted for each project that all personnel, including subcontractors' personnel, are required to attend.
- Project zero accident/safety inspections will be conducted by site supervisory personnel daily.
- A substance abuse program will be developed that includes random testing and testing for cause.
- Mandatory documentation that is required for each project:
  - Site zero accident/safety procedures manual
  - OSHA logs, Form 200
  - Employee orientation records
  - Agendas for zero accident/safety tool box talks
  - Audit inspection reports
  - Zero accident/safety-training records

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Best Practices Crosswalk

The Construction Industry Institute best practices are statistically validated. Table B.4, which is not part of the CII best practices, shows how the research team correlated the California Multi-Agency CIP Best Practices by practice number to their equivalent CII Best Practices.

Table B.4
California multi-agency CIP/CII best practices crosswalk

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<th>CMA Best Practice</th>
<th>CII Best Practice</th>
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<tr>
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<td>Quality Management</td>
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<td>32</td>
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APPENDIX C
CAPITAL EFFICIENCY BEST PRACTICES SURVEY

Note: The first page of this survey is a cover letter provided to survey respondents.

Why is this survey necessary?

In December 2005, the Water Research Foundation awarded the study “Improving Water Utility Capital Efficiency” to help the water industry identify and implement best practices to lower capital project costs. You can find out more about this and other Foundation studies on their website at http://www.waterresearchfoundation.org/research/TopicsAndProjects/projectCenter.aspx. There are a number of reasons why this study is important to water utilities:

- In 2003, after six flat years, EPA’s (Capital) Needs Estimate increased by 67%
- Since that report, utilities have faced a “perfect storm” driving up capital costs even higher – exploding raw materials prices, a shortage of skilled construction workers, declining Federal support and climbing interest rates. Many utilities have found actual bids coming in at substantially above engineering estimates.

Fortunately, other industries and some water utilities have demonstrated that capital efficiency can be substantially improved. The purpose of this survey is to find out more about utility practices and responsibilities with respect to capital processes so we can do a better job of packaging these solutions. The survey itself is practice-centered and, because utilities vary widely in their in-house responsibilities for capital program execution, you may find that many questions do not apply to your utility. Do not be concerned, just fill in the blanks that apply and let us know which do not apply to your utility.

A glossary of terms is at the back of the survey to help define the meaning of terms used, such as value engineering. If you have any questions, feel free to call or email:

- Jason Jennings – 240.501.0450 or juggernautre@hotmail.com
- Myron Olstein – 703.200.4201 or olsteinma@yahoo.com
Introduction

For purposes of this survey, we have broken down the capital process into the following areas:

- Planning
- Design
- Quality Assurance/Quality Control
- Construction Management
- Project Management
- Consultant Selection and Use
- Performance Measures
- Qualitative Issues

Tell Us About Yourself

Person filling out or responsible for survey data:
Title:
Email address:
Telephone number:

Tell Us About Your Utility

Name:
Address:
Organizational Structure\(^1\):
Utility Governance\(^2\):
Current Net Asset Value\(^3\):
Number of Employees:
Annual Revenues, excluding impact fees:
Annual Revenues from impact fees:
Retail Population Served:
Wholesale Population Served:
Number of Retail Accounts:
Number of Wholesale Accounts:
Outstanding Debt (face value of all debt):
Annual Debt Service (most recent year):
Project CIP – Next Five (5) Years:
Projected CIP – Next Ten (10) Years:
WaterStats ID\(^4\):

Notes:
1. Public (non-enterprise fund), Public (enterprise fund), public (independent authority), investor-owned or other.
2. Board of directors or commissioners, City or county government, or other.
3. From balance sheet.
4. WaterStats is the name assigned for various surveys conducted by AWWA.
## Utility Services Provided
(check all that apply)

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<td>Wastewater Collection (Separated Sewers)</td>
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<tr>
<td>Wastewater Treatment</td>
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<td>Stormwater Treatment</td>
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<td>Reclaimed/Irrigation Water Distribution</td>
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<tr>
<td>Solid Waste Transfer/Disposal</td>
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</table>

## What are your major concerns related to CIP?

1. 
2. 
3. 
4.
Planning Process

'Please rate your utility's use of the practices using the following scale:

1 - Between never and 20% of the time
2 - Between 20 and 40% of the time
3 - Between 40 and 60% of the time
4 - Between 60 and 80% of the time
5 - Between 80% and all of the time
0 - Does not apply to us

<table>
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<th>Rating</th>
<th>Comment</th>
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<td>Capital projects are well defined with respect to scope and budget at the end of the planning phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Feasibility studies are completed on projects prior to defining budget and scope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Projects require an appropriation before any planning or design is started</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>There is a Board-Council project prioritization system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Projects listed in the CIP are resource loaded for design and construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>There is a Master Schedule attached to the CIP that identifies start and finish dates for projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>An annual report is required to Board/Council</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>CIP project implementation planning is based on available Project Management staff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Projects are shown on a GIS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>There is an objective system for qualifying projects on a the CIP before they become part of the CIP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Engineering/Capital Programs is required to sign off on scope, budget and schedule before a project is entered in the CIP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Project Management staff is based on CIP projects to be implemented</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>There is public involvement in the CIP development process</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Indicate who signs off on project to get it into CIP before Board/Council approval</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Design Process

'Please rate your utility's use of the practices using the following scale:

1 - Between never and 20% of the time
2 - Between 20 and 40% of the time
3 - Between 40 and 60% of the time
4 - Between 60 and 80% of the time
5 - Between 80% and all of the time
0 - Does not apply to us

<table>
<thead>
<tr>
<th>#</th>
<th>Practice</th>
<th>Rating</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Designers are given a specific budget prior to design start</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Designers are given a clear, specific scope prior to design start</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Designers are given a milestone schedule by which to deliver documents prior to design start</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Designers are required to provide a work plan or design schedule prior to design start</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Design fees/budgets are based on a) % of construction costs; b) lump sum, or c) cost plus a fee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Design requirements for reliability, maintenance and operation are defined prior to design start</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Designs are done on a 2D CAD system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Designs are done on a 3D CAD system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Site adaptations of successful designs are done whenever possible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Surveyors are in-house</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Please rate your utility's use of the practices using the following scale:

1 - Between never and 20% of the time  
2 - Between 20 and 40% of the time  
3 - Between 40 and 60% of the time  
4 - Between 60 and 80% of the time  
5 - Between 80% and all of the time  
0 - Does not apply to us

<table>
<thead>
<tr>
<th>#</th>
<th>Practice</th>
<th>Rating</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>A standard Project delivery Manual is being used</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Flowcharts and/or checklists are used to standardize project management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Roles and responsibilities of team members are clearly defined in Project Management Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>We use standard forms for RFIs, Change Orders, Field Clarifications, Minutes of meetings etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>A Constructability Review Process is implemented on all projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>A Value Engineering analysis is performed on projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Value Engineering is done independently of the designer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>There is a Constructibility Review or VE coordinator within the utility who is responsible for management and implementation of the process</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Cost savings resulting from Constructibility Review and/or VE are tracked</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>A formal Quality Management System is used</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Post project reviews are performed and used for lessons learned</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Inspection is on site full time for projects under construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Inspectors are utility employees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Laboratory and testing services are in-house</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>Practice</td>
<td>Rating</td>
<td>Comment</td>
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<tr>
<td>-----</td>
<td>--------------------------------------------------------------------------</td>
<td>--------</td>
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</tr>
<tr>
<td>39.</td>
<td>Inspection consultants/contractors are required to carry Errors &amp; Omissions insurance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40.</td>
<td>Inspectors are trained and, where required, certified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41.</td>
<td>The utility's Quality management approach includes ISO certification (Fill in number in comments column)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42.</td>
<td>Inspectors are separately budgeted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43.</td>
<td>Inspection personnel are independent from the Project Management team</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Construction Management Process

'Please rate your utility's use of the practices using the following scale:

1 - Between never and 20% of the time
2 - Between 20 and 40% of the time
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5 - Between 80% and all of the time
0 - Does not apply to us

<table>
<thead>
<tr>
<th>#</th>
<th>Practice</th>
<th>Rating</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>Chief Engineer or CIP manager has authority to approve change orders - indicate maximum amount in comment column</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>Change order policies provide for a separate contingency account for Errors &amp; Omissions and Changed/Unforeseen conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Change order policies provide a separate account for Owner/User required scope revisions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>A formal change order process is in place which defines all forms and methods necessary to finalize change orders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>Project managers have estimators available to perform comparative estimates on change orders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>A change order contingency is set aside at the start of the project</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>What % change order contingency is set aside (place % in comment column)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>The change order contingency varies with new vs. renovation/rehab projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>All changes are required to go through a change justification procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>Project areas susceptible to change are identified and risk is evaluated prior to determining the final budget</td>
<td></td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>Project team members take proactive measures to promptly settle, authorize and execute change orders</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Project Management Process

'Please rate your utility's use of the practices using the following scale:

1 - Between never and 20% of the time
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4 - Between 60 and 80% of the time
5 - Between 80% and all of the time
0 - Does not apply to us

<table>
<thead>
<tr>
<th>#</th>
<th>Practice</th>
<th>Rating</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>Design PM's signature is sufficient for Contract Documents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>Construction decisions (budget, scheduling and justification) are made by the Project Manager</td>
<td></td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>A project manager is assigned to every project</td>
<td></td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>Project Manager has &quot;cradle to grave&quot; involvement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>There is a user representative assigned to every project</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>Routine, timely, accurate &quot;labor expended&quot; reports are available to the Project Manager</td>
<td></td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>PM has authority to recruit/terminate Team members</td>
<td></td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>PM processes Change Orders without upper-level approval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>Formal training is provided to PMs on a regular basis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>Formal training is provided for support staff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>Technical training is provided for engineers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>66</td>
<td>A standard Project Controls system has been adopted and is in use on all projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>67</td>
<td>Computerized and/or Web based PM tools are used</td>
<td></td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>Archiving and retrieval of projects information is facilitated by an in-house database</td>
<td></td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>Project forms and documents are on-line and are filled out and communicated between team members electronically</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Consultant Selection and Use

'Please rate your utility’s use of the practices using the following scale:

1 - Between never and 20% of the time
2 - Between 20 and 40% of the time
3 - Between 40 and 60% of the time
4 - Between 60 and 80% of the time
5 - Between 80% and all of the time
0 - Does not apply to us

<table>
<thead>
<tr>
<th>#</th>
<th>Practice</th>
<th>Rating</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>Consultants are required to comply with indemnification and insurance requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>71</td>
<td>Documents produced by the consultant belong to the utility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>72</td>
<td>A standard consultant contract is included in the RFQ/RFP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>Consultants are required to identify exceptions to the contract form or content at the time of submittal in response to the RFQ/RFP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>The utility engineer or capital programs director has authority to approve consulting contracts with justification - list ceiling amount in comments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>An annual RFQ/RFP solicitation is used to develop an on-call list of pre-approved consultants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>76</td>
<td>There is a consultant rating system that identifies quality of consultant performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>The consultant selection process is qualification based</td>
<td></td>
<td></td>
</tr>
<tr>
<td>78</td>
<td>Consultants can be sole sourced with justification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>79</td>
<td>When are consultants required to provide fee proposal? List in comments section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>Consultant fees are most often based on 1) % of construction cost, 2) Lump sum, 3) Loaded hourly rates - Identify in comments section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>81</td>
<td>Consultant fees are negotiated based on comparison with other proposals or are negotiated blind</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Performance Measures

#### What metrics do you use in tracking and evaluating your capital program?

<table>
<thead>
<tr>
<th>Metric</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual to Budget Ratio$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual vs. Planned (Schedule)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please fill in)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Do you have any metric targets or benchmarks?

If you use any of the following, please provide the targets.

<table>
<thead>
<tr>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change order as % of total construction cost</td>
</tr>
<tr>
<td>Claims as % of total construction cost</td>
</tr>
<tr>
<td>Design cost as % of total construction cost</td>
</tr>
<tr>
<td>CM costs as % of total construction cost</td>
</tr>
<tr>
<td>Other (please fill in)</td>
</tr>
</tbody>
</table>
### Qualitative Issues

Indicate in-house project delivery services availability with an x (select all that apply).

<table>
<thead>
<tr>
<th>Available In-House Project Delivery Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
</tr>
<tr>
<td>Design</td>
</tr>
<tr>
<td>Architectural</td>
</tr>
<tr>
<td>Structural</td>
</tr>
<tr>
<td>Mechanical</td>
</tr>
<tr>
<td>Electrical</td>
</tr>
<tr>
<td>Civil</td>
</tr>
<tr>
<td>Instrumentation &amp; Control</td>
</tr>
<tr>
<td>Materials pre-qualification</td>
</tr>
<tr>
<td>Geotechnical</td>
</tr>
<tr>
<td>Construction Management</td>
</tr>
<tr>
<td>Survey</td>
</tr>
<tr>
<td>Real Estate</td>
</tr>
<tr>
<td>Estimating</td>
</tr>
<tr>
<td>Environmental</td>
</tr>
<tr>
<td>Scheduling</td>
</tr>
<tr>
<td>Inspection</td>
</tr>
<tr>
<td>Compliance(testing &amp; lab)</td>
</tr>
</tbody>
</table>

Indicate by % how frequently alternative project delivery is used.

<table>
<thead>
<tr>
<th>Alternative Project Delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design-bid-build</td>
</tr>
<tr>
<td>CM/GC (CM at risk)</td>
</tr>
<tr>
<td>PM/GC (PM at risk)</td>
</tr>
<tr>
<td>Design-Build</td>
</tr>
<tr>
<td>Other (describe)</td>
</tr>
</tbody>
</table>

We are trying to identify which areas the project should focus on. Please indicate which areas are problems for your utility. Feel free to provide comments.
<table>
<thead>
<tr>
<th>Capital Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project selection</td>
</tr>
<tr>
<td>Project tracking</td>
</tr>
<tr>
<td>Material costs</td>
</tr>
<tr>
<td>Timing</td>
</tr>
<tr>
<td>Affordability</td>
</tr>
<tr>
<td>Project closeout</td>
</tr>
<tr>
<td>Other (describe)</td>
</tr>
<tr>
<td>Comments:</td>
</tr>
</tbody>
</table>
Other Issues

Internal Understanding and Communication
To help us identify the extent to which the capital process is understood and communicated throughout the utility. Please tell us for each of the following statements: a) it is always true, b) sometimes true or c) never true.

1. All utility employees are familiar with our CIP process as a result of our internal communications and training programs.
2. We involve our operations and maintenance (O&M) personnel, as appropriate, in the process to ensure that operability and O&M efficiency is part of our capital program development.
3. CIP development is strictly limited to top management, finance, engineering and planning.
4. Our CIP process is more limited. Please explain:

Cost of Regulation
Have you calculated how much of your (5-year) CIP is the result of regulatory initiatives, i.e. arsenic, DBP, etc.

<table>
<thead>
<tr>
<th>Regulation</th>
<th>%</th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
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<tr>
<td>2.</td>
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<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cost of Delays, etc.
Our interviews with utilities have identified that some contributors to high CIP costs are abandoned projects; slow decision-making by Boards, political delays resulting in higher prices when finally awarded, etc.

Have you encountered any of these delays? ______ Yes ______ No
If yes, what were they?
If yes, what is the cost impact? $ (if known) ______
% (if estimated) ______
Capital Efficiency
What measures do you use to identify success of project execution or capital efficiency? Please identify.

_________________________________________________________

________________________________________________________

________________________________________________________

Variance reporting – How do you report and track variances in cash and/or schedule?

________________________________________________________

________________________________________________________

________________________________________________________

Importance of capital efficiency. – Utility management involves trade offs. What major goals (such as operations efficiency, regulatory compliance, etc.) are more important than capital efficiency?

________________________________________________________

________________________________________________________

________________________________________________________

Have past reengineering efforts at your utility (i.e. staffing reductions, O&M cost reduction) increased your capital costs? If yes, how much (approximately) and for what?

________________________________________________________

________________________________________________________

________________________________________________________

Other Capital Project Related Issues
1. Does your job site have to be union? ______ Yes ______ No
   If yes, what is the source of the requirement? _________________________________

2. Have culture and communications (i.e. non-English speakers) issues or the job site impacted your capital program? ______ Yes ______ No
Glossary

**Construction Management** – A professional management practice consisting of an array of services applied to construction projects and programs through the planning, design, construction and post-construction phases for the purpose of achieving project objectives, including the management of quality, cost, time and scope.

**Construction Management-at-Risk** – A delivery system which entails a commitment by the construction manager (CM) for construction quality, time and cost. The CM provides professional management assistance to the owner prior to construction, and during the construction, the CM holds subcontracts for construction, guaranteeing schedule and maximum cost of construction.

**Design-Build** – A project delivery method in which the agency or owner holds a single contract with a single entity for both the design and construction of a project.

**ISO** – International Standards Organization

**Value Engineering** – The systematic application of recognized techniques by a multi-disciplined team to identify the function of a product or service, establish a worth for that function, generate alternatives through the use of creative thinking, and provide the needed functions to accomplish the original purpose of the project at the lowest life-cycle cost without sacrificing safety, necessary quality, and or environmental attributes of the project
APPENDIX D
ADDITIONAL CASE STUDIES

USING EXPERT PANELS TO REDUCE EXPANSION COSTS AND OPTIMIZE OPERATIONS, JEA; JACKSONVILLE, FLORIDA

About JEA

JEA (formerly Jacksonville Electric Authority) is a regional utility serving the fast growing Northeast Florida metropolitan area, providing water, wastewater, electric, and chilled water services to approximately 900,000 accounts. JEA also owns and operates five regional and 10 local water reclamation facilities, 40 water treatment facilities and more than 1,200 wastewater lift stations in 4 counties.

Background

JEA’s service area in the Jacksonville, Florida metropolitan area is one of the fastest growing regions in the country. As a result, JEA is challenged with significant expansion costs associated with that growth. Additionally, the region also includes the St. Johns River, which has been designated as a heritage river. JEA was also facing major costs to reduce nutrient discharges to the St. Johns River due to the potential for increasingly strict regulations associated with the establishment of Total Mass Daily Loadings (TMDL). In an attempt to address both of these challenges, JEA chose to implement the “BNR Initiative” – a program with the stringent goal of reducing nitrogen discharged into the St. Johns River by 50 percent.

JEA used the traditional process of obtaining a consultant engineer to develop a master plan to determine required changes at four regional wastewater treatment plants to realize biological nutrient removal (BNR) to lower the amount of nitrogen discharged into the St. Johns River. The improvements identified primarily focused on traditional wastewater treatment approaches, such as denitrification filters. It was estimated that JEA would require approximately $125 million dollars in new construction to meet its desired goals of lower nitrogen discharges and expanded capacity.

Concurrently, JEA had voluntarily agreed to abolish a centralized biosolids incineration process and to construct a facility that can produce a useful Class A biosolids product. JEA had the facility constructed for $50 million and to its dismay, the facility was at capacity after only two years in operation, with the need for an additional treatment train. The cost of the second train was estimated at $40 to $45 million in construction costs.

The Solution

The estimated cost of both projects combined with continued system growth and its accompanying rate pressures compelled JEA to seek out other solutions. After conducting some market research, JEA observed that there were experts in the field that were developing and implementing highly groundbreaking and effective processing approaches, but they were affiliated with a number of consulting firms. Additionally, JEA had been communicating with other large utilities in Florida and initiated a conversation with the City of Orlando about the
BNR upgrades they had carried out at their plants. Orlando had acquired the services of multiple engineering consultants to work on a single project with very good results. JEA issued a RFP for its BNR initiative and evaluated the proposals based on the expertise of the staff presented in the proposals. JEA selected five consultants for the BNR project and it now had assembled its first expert panel for its BNR Initiative.

Fortunately, the BNR expert panel had a very successful outcome and it was determined that the same approach would be used to address the biosolids processing project. For that particular project, three consultants were selected for their respective expertise. In addition to that project going well, the expert panel was also able to develop some useful short term solutions that allowed JEA to postpone significant capital expense and to provide its project team with the time to develop long-term solutions.

The use of expert panels proved to be a very successful approach optimizing JEA’s existing treatment facilities in a cost effective manner. As with all successful methodologies, the devil is in the details.

Creating an Expert Panel

What is an expert panel? JEA has defined an “expert panel” as a group of individuals with varying degrees of industry recognition for being an expert on a defined subject matter. Clearly, some projects simply will not justify the expense of assembling an expert panel, but any large or complex project with multiple phases, master plans, or rare design/construction characteristics are probably good candidates for this approach. The goal of the expert panel is to ensure that all ideas to execute the project are evaluated and tested.

To use this type of project approach, a utility must comprehend the level of risk associated and understand that the there is a direct correlation between the level of risk the utility is willing to make versus the degree to optimization or cost savings that a particular endeavor can produce. Part of the process is identifying and listing the risks associated with taking this project approach and what risk can be tolerated. If the utility deems a specific risk acceptable, then that risk is clearly identified up front. The expert must be willing to “push the limits” of design within the defined risks.

Team Selection

JEA issued a Request for Qualifications (RFQ) in conformance with the State of Florida requirements to solicit and obtain the services of an expert panel, as well as other engineering services necessary for the implementation of recommended changes. The RFQ process is specifically designed to favor the expertise of the primary personnel offered for the project by responding firms. The responding firms were required to provide full resumes of their experts that would be available for the project. The RFQ also clearly stated that JEA would be using the experts on a panel to develop Preliminary Design Reports and no other personnel would be funded unless pre-approved. It is very important for firms to understand that the utility is requesting the services of an identified individual to serve on a panel. It also must be clear that the firms chosen for this task will also be used for the design phase of any identified projects at the utility’s discretion.

Once the proposals were submitted to JEA, the credentials of the experts offered were reviewed to determine if their expertise was appropriate for the intended area of practice. Based
on JEA’s experience, a productive panel should contain three to five experts, depending on the size of the project. In reality, the number of members on the expert panel are set based on the potential number of design projects needed out of the process. A preliminary workshop schedule is developed and, based on the schedule, each firm provides an estimated cost to participate on the panel. This cost estimate is used to issue purchase orders.

Utilities must also understand that not every consulting engineering firm is going to warm to the idea of offering up intellectual property without knowing if they will be working on the projects that arise out of the panel. By establishing the potential to provide successful firms with the design projects that arise from the panel’s work, most firms will be more willing to offer their experts for the panel.

Managing Expectations

A critical aspect of employing an expert panel is to have unambiguous outcome expectations. Each firm selected should also know that the utility will fairly award design projects to the firms that openly participated in the expert panel process. The desired deliverables required from the workshop should be clearly defined.

The best method for developing ideas is in open workshops. Well-managed workshops are very effective at defining problems, establishing metrics to be measured, analyzing existing data, investigating solutions and establishing controls to determine the ideas that should be brought to the preliminary design report (PDR) stage. The utility must also be clear that there is no guarantee of work after the preliminary design report.

Stakeholder Input

This project approach is also conducive to developing solutions for projects that may require stakeholder input. Stakeholders should be brought in at the beginning of a project to meet the expert panel and to listen to an overview of the desired outcomes. Third parties should be encouraged to provide input. Utilities should expect that regulatory agencies may be hesitant to provide input prior to a permit being submitted, but if they are invited to meet with known experts in the industry, they usually will participate and some guidance can be gained. It is also good to remember that third party groups can be adversarial, but if they are provided with an opportunity to give input, they can become partners in the project.

Facilitation

As described, it is obvious that an expert panel can be quite pricey. However, the following steps can be used to effectively organize the workshops and provide an environment to meet the defined expectations:

1. Send each of the experts an information package to review prior to the first workshop that includes all applicable drawings, monthly operating data, previous master plans and/or reports for the facility, and any other related information to help the panel become familiar with the facilities.
2. A web site is used to develop a place where all pertinent and team contact information is held.
3. A third party facilitator should be used to ensure that the workshop stays within the agenda. The facilitator should not be associated with either the project or the firms involved, but have some good technical knowledge about the water and sewer industry, and a good communication style.

4. Develop an agenda for each workshop with scheduled time and session responsibilities. The first workshop should provide time for introductions, project backgrounds, and a site visit to get everyone familiar with the project and on the same page. Additionally, time should be provided for open discussion among the experts.

5. Keep notes during the workshop.

6. Breaks are very important and can further develop ideas in smaller groups.

7. The workshops should be no longer than two days with the second day ending mid-afternoon so that traveling panel members can travel home on the second day. This will help with travel-related project costs.

8. All resulting action items should be reviewed at the end of each workshop and specific tasks given to the team members, as appropriate.

Again, the focus of each of the workshops hosted by JEA was to formulate ideas and to develop a methodology for assessing and solving process problems. JEA did not expect finished project deliverables from workshop setting, so more time was provided to allow each expert to finish their assigned tasks. Additionally, email and teleconferences were used during the time between workshops to review completed work and to address specific issues.

Any utility implementing an expert panel to perform projects should recognize the importance of open communication.

**Documentation**

The facilitator was assigned the task of preparing and maintaining meeting minutes. A list of assignments was generated from those minutes. Each assignment resulted in a technical memorandum and each of the memorandums was maintained by the facilitator and JEA. The process became a real time master plan. It did not require the preparation of an extensive publication to be used effectively.

The next step was the development of Preliminary Design Reports (PDRs). The reports communicated the technical findings of each of the engineering firms, but the reports were more useful to JEA since the protocol and technical approach had already been agreed upon. Once the documents were complete, the endorsement process by the expert panel was more efficient because they were able to focus on the technical information instead of being concerned about its format and technical protocols.

**Implementation/Results**

The PDR’s developed by the firms and approved by the panel were used to prepare construction permit applications for the improvements established by the panel. JEA chose to prepare the permit applications but each firm provided input to the permit application.
CALIFORNIA’S FIRST DESIGN-BUILD-OWN-OPERATE BIOSOLIDS RECYCLING FACILITY, SACRAMENTO REGIONAL COUNTY SANITATION DISTRICT; MATHER, CALIFORNIA
(Reprinted with permission of Ruben Robles, Principal Civil Engineer for the District)

Introduction

The Sacramento Regional County Sanitation District (District) has implemented a unique project with the private sector in an innovative application of biosolids management techniques. In order to comply with a regulatory directive, while attempting to achieve a balanced portfolio of biosolids management options that include beneficial reuse, the District has chosen to implement California’s first Design-Build-Own-Operate (DBOO) project for a biosolids application. Specifically, the District has engaged the private sector for the design, construction, operation and ownership of a Biosolids Recycling Facility (BRF). Compared to the conventional design-bid-build approach, the DBOO public-private partnership model is yielding measurable benefits to the District in the form of cost savings, schedule efficiency, financing flexibility, technical innovation and a balanced transfer of risk.

In early 2005, the BRF began processing a minimum of 20 dry tons of biosolids per day, transforming digested solids to a marketable, “beneficial reuse” product. Via a competitive procurement process, the District has contractually engaged a private contractor to finance, design, construct, own and operate the BRF for a period of 20 years. The procurement process involved the development and issuance of multi-stage technical bidding documents that described the BRF requirements in terms of performance standards mandated by the District. Through the issuance of both a Request for Qualifications (RFQ) and a Request for Proposals (RFP), the evaluation process ensured the District selected only the most proven and qualified team for implementation of this project.

Project Background

The Sacramento Regional County Sanitation District, formed in 1973, provides wastewater conveyance and treatment to businesses and residents in the urbanized areas of Sacramento County, California. The District owns and operates the Sacramento Regional Wastewater Treatment Plant (SRWTP), a 181 million gallon per day (MGD) primary/secondary treatment facility serving more than 250 square miles and over 1.2 million residents. The District continues to grow, with up to 8,000 new customer connections to the system each year.

The SRWTP utilizes a primary/secondary pure oxygen biological wastewater treatment process. Anaerobically digested primary and waste activated sludge is stored for up to five years in facultative sludge lagoons called Solids Storage Basins (SSBs). The biosolids are then “harvested” by District staff and pumped to Dedicated Land Disposal (DLD) units where they are injected below the soil surface to complete the treatment and disposal process. The SRWTP currently produces approximately 27,000 dry tons of anaerobically digested biosolids annually.

The Central Valley Regional Water Quality Control Board (RWQCB) mandated that the District’s use of unlined DLD units posed a threat to groundwater quality in the area. Subsequently, the RWQCB required the District to discontinue use of the unlined DLD units by November of 2001.
In response to the regulatory action, the District Board approved a biosolids management approach which included two major elements. One element involved lining three of the five existing DLDs with high-density polyethylene (HDPE) liner and leachate collection system (L-DLDs). The other element of the District’s long-term biosolids management strategy was the DBOO procurement for the BRF. The District identified the BRF as a suitable companion to the DLD disposal method for a number of reasons, but primarily because the District is interested in a diversified biosolids management program. The BRF approach has taken advantage of the private sector’s experience and expertise, while providing an environmentally responsible method for biosolids management. The BRF capacity originally considered was 20 and 45 dry ton per day, which have approximately equal capacities to manage biosolids as 1 or 2 L-DLDs respectively.

The environmental stewardship motto of the District, “Wastewater Treatment – Technology in Balance with Nature”, reflects the District’s mission of providing wastewater conveyance and treatment in a manner that simultaneously protects public health and the environment. The inclusion of the BRF in the District’s long-term biosolids management strategy also allows the District to use a flexible “portfolio approach” to biosolids management, taking advantage of unique benefits inherent in each management option (L-DLD and BRF) such as cost effectiveness, reliability and technological innovation.

DBOO Procurement

Because the District has historically used the design-bid-build model for infrastructure projects, staff was not experienced with the intricacies of the DBOO procurement process. District staff began exploring the design-build option by developing in house expertise and knowledge with respect to the DB procurement. This included attending workshop, conferences and other design-build training opportunities. This education allowed the District to be better informed when it chose a consultant to assist with the design-build procurement.

Due to the highly specialized nature of the work contemplated, and the small number of similar projects completed in the United States, only a limited number of firms had the expertise and experience to successfully complete the proposed consultant services. Requests for Qualifications were sent to many firms. Based on the District’s evaluation of the statement of qualifications (SOQ) received, a Request for Proposal was sent to five firms, with three firms submitting proposals. The statement of qualifications (SOQ) were evaluated using the criteria presented in Table D.1 on the following page:
Table D.1
Proposal evaluation criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weight</th>
<th>Maximum Score</th>
<th>Weighted Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsiveness to request for proposals</td>
<td>1.0</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Project overview and approach</td>
<td>1.5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Firm Qualifications</td>
<td>1.5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Project Team Qualifications</td>
<td>2.5</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>Scope of Services</td>
<td>1.5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Project Schedule</td>
<td>0.5</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Staff allocations to tasks</td>
<td>1.0</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Other items not covered by the categories</td>
<td>0.5</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>above, such as proprietary information,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>conflict of interest, and insurance, etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Points</strong></td>
<td></td>
<td></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The major tasks in the scope of services include:

- Procurement Strategy Development
- Technical Needs Assessment
- Request for Qualifications Development
- Assistance with Evaluation of Statements of Qualifications
- Pilot Test Program Development
- Request for Proposals Development
- Draft Service Agreement Development
- Assistance with Proposal Evaluation

L-DLDs vs. BRF

In the DBOO BRF procurement, the BRF teams not only competed against each other for selection as the winning team. They also competed against the onsite L-DLD project. District staff assessed the L-DLD and BRF projects for the overall benefit to the District with respect to cost, risk management, and overall reliability of the biosolids management program. Table D.2 below provides potential project combinations.

Table D.2
Potential project combinations

<table>
<thead>
<tr>
<th>Project Type</th>
<th>Capacity Combination 1</th>
<th>Capacity Combination 2</th>
<th>Capacity Combination 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRF Capacity</td>
<td>0</td>
<td>20 dry tons/day</td>
<td>45 dry tons/day</td>
</tr>
<tr>
<td>Lined DLDs</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
The District provided the BRF proposing teams with preliminary cost estimates for L-DLD project and associated infrastructure. The price ceilings included a small added premium that the District would be willing to pay, for the benefit of recycling and the diversification the BRF would provide. But, the BRF project costs should not exceed these price ceiling numbers otherwise recycling to the BRF would be cost prohibitive as compared to the L-DLD project. District staff presented the recommended balance between BRF and L-DLD to the District Board for approval.

The optimal balance for the District between on-site disposal of biosolids to the lined DLDs, versus recycling to the BRF, was determined to be the lining of 3 DLDs, and the design-build by a private company of a 20 dtpd BRF. This is providing the District with a good balance of reliable on-site disposal of biosolids, with a more costly but environmentally beneficial option of biosolids recycling.

Figure D.1 Sacramento Regional County Sanitation District Biosolids Management Program

The DBOO Public-Private Partnership

Adding to the uniqueness of the District’s BRF project is the DBOO project delivery method that was utilized to select a private sector team to design, finance, construct, operate and own the BRF under a 20 year public-private service agreement. The first of its kind in California, the District’s DBOO established a precedent for all public-private partnerships to follow, particularly those that utilize private sector financing and ownership considerations.

The District considered both traditional and non-traditional approaches to implementing the BRF project. However, in contrast to conventional project delivery methods (i.e. design-bid-build), the DBOO public-private partnership is providing measurable benefits to the District in a number of key areas. Specifically:
The DBOO approach allowed the District to transfer an optimum and balanced amount of risk to the private sector team. Should the DBOO team have failed to deliver and operate the BRF that met the specific performance standards mandated by the District, the District was under no contractual obligation to make payments to the private sector team towards operations fees or the capital component of the BRF. Conversely, under the conventional design-bid-build approach using public financing (e.g. bonds), the District would be obligated to repay the bondholders regardless of the performance of the BRF.

The DBOO approach allowed most of the technological risk to be transferred to the private sector. Because the BRF facilities are owned and operated by the private sector team for a finite contractual period, the District is under no obligation to continue the use of the BRF technology at the end of the contract term. This is an important consideration as biosolids treatment technologies could evolve over the next decades. Under the DBOO approach, the District will be able to switch to a better or improved technology, if available, at the end of the contract term.

The DBOO approach provided scheduling and financial efficiencies by combining design, construction and operation responsibilities under one team umbrella. The DBOO approach has been demonstrated to provide life cycle cost savings of 20 to 30% over the traditional project delivery method.

The DBOO approach encouraged and rewarded more innovative “outside of the box” thinking than the traditional approach, ensuring the District’s solution was thoughtful and current – an important benefit considering the dynamics of the biosolids recycling market.

The DBOO approach allowed the District to preserve public sector funds for other projects. Because the BRF was financed by the private sector, the District used the $20 million in BRF capital costs for other purposes. While the District’s cost of money is lower than that of the private sector, private financing serves as an insurance policy against technology or project failure.

The DBOO Procurement – Phase I

In order to identify and subsequently engage the most qualified team to implement the BRF project, the District implemented a competitive procurement process. Utilizing a two-stage selection process, this procurement methodology helped ensure the District received thoughtful, high-quality proposal submittals from only the most qualified teams.

The first phase of the procurement involved the development and issuance of a Request for Qualifications (RFQ) and the evaluation of the Statement of Qualifications (SOQ) submitted by interested teams. The first phase is depicted in the flowchart on the following page.
Figure D.2 Qualifications process diagram
**Request for Qualifications.** The RFQ document was the first bidding document issued to teams interested in the District’s BRF DBOO project. The RFQ provided a description of the project as well as the specific qualifications and experience the team(s) must possess in order to continue in the selection process. The RFQ identified both “minimum” and “enhanced” qualification requirements as well as the evaluation criteria and selection methodology.

**Minimum Qualifications Review.** The District’s Selection Committee evaluated the Statements of Qualification (SOQs) in accordance with the minimum qualification requirements presented in the RFQ. This process ensured the immediate elimination of unqualified DBOO teams.

The table below presents the Minimum Qualifications that were required by the District during the RFQ/SOQ phase of the procurement.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Minimum Qualifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design, Construction, and Operation Experience</td>
<td>Team must demonstrate relevant design, construction and operation experience in environmental management applications. Team must demonstrate that it has worked together in the design, construction, and operation of at least (one) environmental management facility similar in scale to the facility being proposed.</td>
</tr>
<tr>
<td>Biosolids Experience</td>
<td>Team must demonstrate relevant design, construction, operations and maintenance experience of biosolids recycling/beneficial use facilities. Team must demonstrate experience with biosolids processing technology and product marketing on at least (one) project that has processed a minimum of five (5) dry tons per day of input biosolids on a continuous basis.</td>
</tr>
<tr>
<td>Technology</td>
<td>Proposed biosolids technology must have processed a minimum of five (5) dry tons per day of input solids on a continuous basis at a single facility. Demonstrate that the proposed technology produces a marketable product. The technology must demonstrate ability to meet the Part 503 Regulations, if applicable.</td>
</tr>
<tr>
<td>Key Project Personnel</td>
<td>Proposed program/project manager and facility manager must have experience with the design, construction and operation of biosolids management facilities.</td>
</tr>
</tbody>
</table>
### Table D.3 (Continued)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Minimum Qualifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonding and Insurance Capabilities</td>
<td>Team must demonstrate the ability to provide:</td>
</tr>
<tr>
<td></td>
<td><strong>SURETY BONDS</strong></td>
</tr>
<tr>
<td></td>
<td>Performance and payment bonds from an acceptable surety company in the following amounts:</td>
</tr>
<tr>
<td></td>
<td>Construction Bond (labor and materials): $13 million</td>
</tr>
<tr>
<td></td>
<td>Performance Bond: $20 million</td>
</tr>
<tr>
<td></td>
<td><strong>INSURANCE covering:</strong></td>
</tr>
<tr>
<td></td>
<td>Workers compensation and employers liability;</td>
</tr>
<tr>
<td></td>
<td>Liability arising from errors or omissions in design or other professional services which cause either failure of the BRF to perform as guaranteed or injury to persons or their property;</td>
</tr>
<tr>
<td></td>
<td>Liability arising from other services and operations usually covered under general and automobile liability policies, including products liability;</td>
</tr>
<tr>
<td></td>
<td>Pollution liability for environmental impairment arising from all services under the contract;</td>
</tr>
<tr>
<td></td>
<td>Builders risk and delay in start-up on an all risk basis, including flood and earthquake, during construction, with coverage for machinery breakdown and testing;</td>
</tr>
<tr>
<td></td>
<td>Direct damage, including machinery breakdown, on an all risk basis, including flood and earthquake, after completion during the operation and maintenance phase of the contract;</td>
</tr>
<tr>
<td></td>
<td>(i) At least $3,000,000 for any liability coverage under B and D above,</td>
</tr>
<tr>
<td></td>
<td>(ii) At least $10,000,000 for liability coverage under C above in a combination of primary and excess policies,</td>
</tr>
<tr>
<td></td>
<td>(iii) The full insurable value at risk of property on a replacement cost basis,</td>
</tr>
<tr>
<td></td>
<td>(iv) The limits required can be increased by the District at the time of the RFP or during the service agreement to cover increased costs;</td>
</tr>
<tr>
<td></td>
<td>Extensions of policy provisions to cover the interest of the District, such as additional insured, loss payee, cancellation notice, certificates of insurance and other requirements to be provided in the RFP.</td>
</tr>
<tr>
<td>Project Guarantor Net Worth</td>
<td>Project Guarantor must demonstrate a positive net worth.</td>
</tr>
<tr>
<td>Financial</td>
<td>Proposer Team must demonstrate the ability to secure private or internal financing to develop the project.</td>
</tr>
</tbody>
</table>

(continued)
### Table D.3 (Continued)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Minimum Qualifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criminal and Financial Disclosure.</td>
<td>Each team member may not have filed for bankruptcy in the past three (3) years or have</td>
</tr>
<tr>
<td></td>
<td>been convicted of a felony or fraud.</td>
</tr>
<tr>
<td>Sole Source Responsibility</td>
<td>Team member must provide sole source (design, construction, financing and operation)</td>
</tr>
<tr>
<td></td>
<td>responsibility and project guarantee.</td>
</tr>
<tr>
<td>Performance, Price and Schedule Guarantees</td>
<td>Team must demonstrate willingness to accept performance guarantees with a demonstrated</td>
</tr>
<tr>
<td></td>
<td>ability and willingness to complete the design and construction of the facilities by</td>
</tr>
<tr>
<td></td>
<td>summer 2003 at a guaranteed price.</td>
</tr>
<tr>
<td>Conflict of Interest</td>
<td>The proposing team shall disclose any actual, apparent, or potential conflicts of</td>
</tr>
<tr>
<td></td>
<td>interest that are present or could develop with respect to the scope of services covered</td>
</tr>
<tr>
<td></td>
<td>by this RFQ and any parties to this solicitation, or any third parties. The existence</td>
</tr>
<tr>
<td></td>
<td>of such conflicts of interests will not automatically disqualify any proposing team</td>
</tr>
<tr>
<td></td>
<td>from consideration. The District will evaluate such disclosures and determine whether</td>
</tr>
<tr>
<td></td>
<td>they are disqualifying or subject to possible mitigation measures.</td>
</tr>
</tbody>
</table>

Enhanced Qualifications Evaluation. DBOO teams meeting the minimum qualifications were further evaluated based on a second set of criteria in order to allow SRCSD to point-rank the SOQ submittals and allow supportable elimination of all but the four to six most qualified DBOO teams.

Optional Field Test. To ensure that SRCSD gave good consideration to new and emerging technologies, at its option, SRCSD could require a field test to allow private companies the chance to demonstrate their technologies. This process was only going to be used for a team that was otherwise qualified, but did not have a fully proven technology, or one with multiple installations.

The Qualifications Process flow chart shows that if a team met the enhanced qualifications, and was among the highest 4 to 6 ranked teams, it was short-listed and identified as an “A” team. For teams that did not have installations with their technology or otherwise had a relatively unproven system, SRCSD could have required field testing. These teams were identified as “B” teams. If any of these teams had passed the field test, they would have then joined the A teams, and if highly ranked, would have been short-listed.

Development of Request for Qualifications Document. In addition to the procurement criteria described above, SRCSD included additional specific requirements in the RFQ in the following areas:

- Technology Requirements
  - Any BRF technology and/or operating solution utilizing on-site “open air” composting (e.g., windrow or aerated static pile) was not considered. All composting performed on-site was required to be in sealed vessels or within...
buildings. Off-site composting solutions were considered. The District makes strong efforts to maintain its good neighbor policy, and therefore chose not to consider biosolids management options that have the significant potential for odors.

- All BRF technologies and/or operating solutions were required to utilize Best Available Control Technology (BACT) odor and emissions control and biosolids containment methods.
- Any BRF technology and/or operating solutions requiring on-site air drying of biosolids (e.g., drying beds) were not considered.
- Any BRF technology and/or operating solutions utilizing Class B land application were not considered. The District specifically chose to exclude Class B land application as a recycling option due to the continued changing of regulations and the increasing number of bans on land application at the local regulatory level in California.
- Any BRF technology and/or operating solution utilizing landfill disposal was not considered. Landfill disposal is considered an emergency backup solution to the primary method of biosolids beneficial reuse, and if necessary, would be implemented directly by the District.

- **Authority to Procure** – The District is employed the DBOO procurement approach under the authority of Government Code 5956.
- **Length of Service Contract** – The service contract was originally envisioned to have a minimum duration of 15 years, with five (5) one year extensions at the District’s option. The District chose a longer contract term because the private company can amortize its capital costs over a sufficiently long period as to make the project economically viable.
- **Marketing** – The District decided that the private sector can best market the product because they have the infrastructure in place to market the product.

### The DBOO Procurement – Phase II

The second phase of the procurement process included the development and issuance of the Request for Proposals (RFP) document, and the subsequent evaluation of the proposals submitted by the teams short-listed during the first phase of the procurement. The second phase is depicted in the flowchart on the following page.
Figure D.3 Draft Proposal Process

Request for Proposals (RFP). Pre-qualified bidders were asked to submit detailed technical and financial proposals for the scope of work described in the RFP document. The RFP provided greater detail concerning the BRF design, construction and operational requirements, the selection process and the formulae that was used to calculate the life-cycle cost associated with each proposal.

Proposal Evaluation. Proposals received in response to the RFP were evaluated by the District’s Selection Committee based on the qualitative and quantitative evaluation criteria developed in accordance with the District’s mission, goals and objectives for the BRF project. The criteria developed by the District, along with the associated weightings are presented in Table D.4 on the following page.
Table D.4
Proposal evaluation criteria and weightings

<table>
<thead>
<tr>
<th>Evaluation Criterion</th>
<th>Weighting Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Reliability and Viability</td>
<td>20%</td>
</tr>
<tr>
<td>Environmental Impacts</td>
<td>15%</td>
</tr>
<tr>
<td>Price Competitiveness of Service Fee</td>
<td>40%</td>
</tr>
<tr>
<td>Proposer Financial Qualifications, Financial Plan, Legal Standing, and Contract Position</td>
<td>20%</td>
</tr>
<tr>
<td>Proposer Team Experience</td>
<td>5%</td>
</tr>
</tbody>
</table>

**Development of Request for Proposal Document.** The following are important criteria that were part of the RFP document:

- **California Environmental Quality Act (CEQA)** – The Company was responsible for CEQA compliance with the exception of vernal pools and endangered species. The original intent was for the Company to be responsible for all environmental mitigation, but due to the length of time it was expected to take to mitigate for the vernal pools and endangered species, the District decided that it would mitigate these factors so as not to delay the project.

- **Permitting** – The company was responsible for obtaining all necessary permits for the design, construction, and operation of the BRF. This is consistent with the Company being responsible for all facets of the DB project. All energy costs are treated as a pass through cost to the District. The District shall bear the risk of increased energy costs and the winning firm shall bear the energy consumption risk.

- **Energy** – All energy costs are treated as a pass through cost to the District. The District shall bear the risk of increased energy costs, while the Company shall bear the energy consumption risk. If the Company exceeds the maximum energy consumption, it shall be responsible for paying these excess costs.

- **BRF Reversion** – The Company shall own the BRF during the service term. At the conclusion of the service term, ownership of the BRF shall revert to the District at no additional cost, per Government Code 5956.

- **Performance Requirements** – The District prescribed performance specifications for finished product, return flows, transportation of material, noise requirements, odor and air pollution control, and a variety of other parameters. In general, this was a performance-based procurement. As long as the Company meets the performance specifications, it is up to the Company how that is accomplished.
Project Implementation

The District issued the RFQ in July of 2000 to over 100 interested parties, receiving 14 SOQs in response to the solicitation. The proposed technologies and associated beneficial reuse products ranged from heat dried to glass aggregate products. Utilizing the SOQ evaluation process and criteria presented in the RFQ, the District’s Selection Committee selected five proposer teams and four technologies for further consideration. The teams representing the following technologies in Table D.5 were then considered “short-listed” and were invited to submit proposals.

<table>
<thead>
<tr>
<th>Proposed Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Drying Pelletization</td>
</tr>
<tr>
<td>Chemical Stabilization</td>
</tr>
<tr>
<td>Glass aggregate</td>
</tr>
<tr>
<td>In-Vessel Composting</td>
</tr>
</tbody>
</table>

In April 2001, the District issued the RFP document to the short-listed teams. Proposals were due to the District in June of 2001. Using the financial information provided in the proposal for the 20 and 45 dtpd facility sizes, costs to construct lined-DLDs, along with other qualitative data, the District determined the optimum BRF size for its needs is 20 dtpd. A combination of three lined DLDs, along with a 20 dtpd BRF, provides a high level of biosolids program reliability and diversification, and is also consistent with the District’s recycling ethic.

Site Visit & Technology Review

To assist the District’s Selection Committee in selecting the strongest private sector team and most viable biosolids management technology, a number of District staff conducted site visits to the technologies being considered. This allowed the District team to speak directly with the project owner and operator. One member of the District team included the biosolids operations manager. This was important because he brought back to the selection committee key operational and maintenance information. This will be most important when the facility reverts to District ownership at the end of the contract term. Table D.6 on the following page is a list of facilities that were visited during the technology tour:

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Table D.6
Proposal team facility site visits

<table>
<thead>
<tr>
<th>Proposal Team</th>
<th>Facility Location</th>
<th>Technology</th>
<th>Avg Quantity of Finished Product Generated (dtpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth Tech</td>
<td>Kingwood, Texas</td>
<td>Bioset Psteurization</td>
<td>10</td>
</tr>
<tr>
<td>Earth Tech</td>
<td>Kissimmee, Florida</td>
<td>Bioset Psteurization</td>
<td>28</td>
</tr>
<tr>
<td>Synagro</td>
<td>Baltimore, Maryland</td>
<td>Sequhers Pelletizer</td>
<td>55</td>
</tr>
<tr>
<td>Synagro</td>
<td>Bayville, New Jersey</td>
<td>Andritz Drum Dryer</td>
<td>25</td>
</tr>
<tr>
<td>USFOS</td>
<td>Forest City North Carolina</td>
<td>SludgeMASTER Dragon Dryer</td>
<td>10</td>
</tr>
<tr>
<td>USFOS</td>
<td>Toronto, Canada</td>
<td>Sequhers Pelletizer</td>
<td>80 (capacity) (not yet operational)</td>
</tr>
</tbody>
</table>

In November, 2001, the District Board approved the review team recommendation to begin negotiations with the highest ranked team for a 20 year biosolids management contract. The District Board approved a 20 year services contract in June 2002. The Company then began the 12 month development period to obtain necessary permits and develop the facility design. Following the development period the Company began the 18 month construction and performance test period. As stated, the BRF passed performance testing and became fully operational in early 2005.

Contract Negotiations

In negotiating with the Company there were a number of issues that posed challenges in developing contract language that was acceptable to both parties. The philosophy the District developed was that the party that is best able to manage a particular contract risk should do so. The District did not take the approach of trying to transfer all risk to the private sector. This approach would not only be unacceptable to the Company, but also carries with it a significant cost in the form of a risk premium. Following is a discussion of some of the key contractual issues.

Default by Company or District

This was probably one of the more complicated areas that had to be negotiated. What added to the complexity was that the Company will is providing financing through a private lender. This lender is essentially a third party to the agreement because they must protect their financial interests. The impact of this is that the lender required a guarantee of debt repayment if one of the parties defaults. For example, should the District default, it would be responsible for debt repayment and purchase of the BRF. In like manner, should the Company default, the lender wants the debt paid. But, the Company would like to transfer this risk to the District, a risk the District was unwilling to accept. A mutually agreeable solution was developed, but this is one example of the complexities of the contact, and the desire by both parties to minimize risk exposure.

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Electricity/Natural Gas

Both of these utilities are a pass through costs, meaning the District pays for electricity and natural gas directly to the utility or as a reimbursement to the company. The decision was made that the Company will take on the risk of consumption because they are best able to control this risk. The Company provided an annual maximum consumption number for electricity and natural gas. If the Company exceeds the consumption number, it is responsible for paying the overage. The price risk of electricity/natural gas is on the District. Should the price of electricity/natural gas increase significantly, the District cost for processing biosolids will increase.

Project Costs

Table D.7 and Table D.8, below, are a summary of estimated project costs:

Table D.7
BRF facility estimated capital costs

<table>
<thead>
<tr>
<th>BRF Capital Costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Improvements</td>
<td>$1.2 M</td>
</tr>
<tr>
<td>Facility:</td>
<td></td>
</tr>
<tr>
<td>- Engineering &amp; Design</td>
<td>$1.1 M</td>
</tr>
<tr>
<td>- Permitting</td>
<td>$0.1 M</td>
</tr>
<tr>
<td>- Equipment</td>
<td>$6.4 M</td>
</tr>
<tr>
<td>- Construction</td>
<td>$6.1 M</td>
</tr>
<tr>
<td></td>
<td>$13.7 M</td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
<tr>
<td>- Financing Cost</td>
<td>$3.0 M</td>
</tr>
<tr>
<td>- Admin, insurance, acceptance</td>
<td>$1.8 M</td>
</tr>
<tr>
<td></td>
<td>$4.8 M</td>
</tr>
<tr>
<td><strong>Total Fixed Design Build Price</strong></td>
<td>$19.7 M</td>
</tr>
</tbody>
</table>

Table D.8
BRF facility estimated O&M costs

<table>
<thead>
<tr>
<th>BRF Annual Operations &amp; Maintenance Costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>O &amp; M Cost</td>
<td>$2.4 M (2002 $)</td>
</tr>
<tr>
<td>Electricity</td>
<td>$0.2 M</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>$0.4 M</td>
</tr>
</tbody>
</table>

The District pays the company a monthly service fee. This is based on a capital cost component being amortized over 20 years, plus the operations & maintenance costs.
It is important to note the economies of scale that can be achieved with a facility with larger capacity to process solids. Table D.9, below, is a summary of the originally proposed project costs for both the 20 and 45 dtpd facilities.

Table D.9
Originally proposed BRF project costs

<table>
<thead>
<tr>
<th>Facility Size</th>
<th>Total Fixed Design-Build Price</th>
<th>Annual O &amp; M Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 DTPD BRF:</td>
<td>$21.2 M ($19.7 M Contract Cost)</td>
<td>$2.5 M ($2.5 M Contract Cost)</td>
</tr>
<tr>
<td>45 DTPD BRF:</td>
<td>$24.8 M</td>
<td>$3.2 M</td>
</tr>
</tbody>
</table>

This cost summary indicates that for 17% additional capital, and a 28% increase in annual O&M, a facility of more than twice the capacity can be constructed and operated. The District made a conscience decision to select the smaller facility. While the cost per dry ton to process solids with the larger facility are significantly less, it still makes the overall District biosolids program more costly because the L-DLDs are relatively inexpensive to construct and operate.

Lessons Learned

While all capital improvement projects require significant effort to implement, the District’s BRF project contains additional challenges:

- The DBOO approach for a BRF had never been implemented in California; therefore, the District had no local examples to analyze.
- The biosolids recycling market is dynamic. Some of the technologies under consideration have yet to be thoroughly proven.
- Biosolids regulations at all levels; federal, state, and local, are all becoming more stringent, therefore technology and marketing risk must be carefully considered.
- The overall success of the project is dependent on the DBOO team’s ability to adhere to strict performance standards identified by the District for operations, emissions and product marketing.

Conclusions

SRCSD has learned a great deal about designing and implementing a design-build project, including:

- Risk should be allocated to the entity (private sector or District) that is best able to manage that risk. Misallocating risk will result in an inefficient market situation that will either place the public stakeholders’ interests at risk or cause an unnecessary
financial penalty in the form of inflated service fees charged by the private sector team.

- The procurement process must be structured, thorough and strictly followed, especially in terms of communications protocol. Any deviations to the procurement process could be grounds for challenge by an unsuccessful bidder.
- Continuous communication, in accordance with the procurement process, between the public and private sector participants is crucial in ensuring the receipt of thoughtful, comprehensive proposals.
- The public sector project manager must be actively involved in every phase of the procurement process, and specifically the contract negotiation process. The negotiation process should not be delegated to an outside consultant or legal team because no one is going to know the needs of the agency better than in-house staff.
- From the District’s perspective, a DBOO is suitable for some applications within its wastewater business. One criterion would be that the contractor must be able to operate fairly autonomously from the public sector operation and not have significant interaction or impact on the rest of the treatment processes. But, there are many opportunities for using design-build alone to deliver capital projects. It would be expected that in most cases the District would own and operate the facilities.

Based on the experiences to date, the District is confident that this environmentally conscious process to manage its biosolids, coupled with an innovative project delivery approach, will continue to result in the long-term viability and sustainability of the biosolids management program.

MASSACHUSETTS WATER RESOURCES AUTHORITY DEMAND REDUCTION

About MWRA

The Massachusetts Water Resources Authority (MWRA) is a water and wastewater wholesale provider to 61 communities in the greater Boston area, serving 2.5 million people (about 2.2 million for water and 2.3 million for wastewater). Its service area is a combination of urban and suburban characteristics. It is experiencing modest growth (just under 1% per year) through a combination of service area expansion and modest organic growth. It has been experiencing declining total and per capita water use for a number of years. Much of the service area is old, with over half of the 6,000 miles of distribution network being unlined cast iron pipe, some over 140 years old. MWRA’s water supply comes from protected watersheds and is unfiltered. MWRA is a state agency and an independent authority with a substantial amount of autonomy. It has a dedicated Board of Directors.

The Capital Improvement Program

For many years, MWRA had a sizeable annual capital improvement program (CIP) spending some $6 billion over 20 years. Its CIP is in the process of declining from annual expenditures of $500 million to $200 million over the next five years. Figure D.4 is MWRA’s CIP forecast for the next 5 years. Because of its sizeable capital expenditures in the past, debt service currently accounts for 60% of its annual budget. MWRA forecasts rates for a 10-year
period. Their forecast calls for annual rate increases of 7 to 9% due to three factors—increases in operations and maintenance costs, old debt service (some of the old debt was backloaded and will be increasing in the future) and new debt service. MWRA’s biggest CIP drivers have been:

- Regulations (about 80%)
- Repair and replacement of both plant and lines
- Modernization and automation

![MWRA's Five-Year Capital Improvement Plan](image)

**Figure D.4 MWRA’s Five-Year Capital Improvement Plan**

Based on the MWRA’s 2006 Master Plan, it is clear that going forward, the repair and replacement (asset management) will consume the largest portion of capital expenditures.

In terms of control over the capital process, MWRA has a substantial in-house capability from planning and design, construction management (CM), inspection and closeout. However, it employs a mix of in-house and outsourcing strategies depending on the size of the project and other considerations. **Figure D.5** is an organization chart highlighting the departments involved in CIP development and execution.
Figure D.5  MWRA’s Organizational Chart

MWRA Board Commitment to Non-Construction Alternatives

Whenever a utility is considering a line of action outside the norm, leadership and support from the top is crucial. MWRA’s Board of Directors has been aggressive in pursuing non-construction alternatives. In one of the case studies to be described below, this commitment was supported by a negotiated consent decree that required a parallel process evaluating both construction and non-construction alternatives before a decision could be made. The Board took a number of additional actions in furthering non-construction alternatives:

- Insisted that equal attention be paid to both construction and non-construction alternatives
- Elevating the status of non-construction alternatives by hiring a Water Engineering Department manager tasked to evaluate non-construction alternatives, at an organization level comparable or above that of the design and construction staff
- Requiring detailed formal quarterly progress reports on the evaluation of non-construction alternatives
- In one telling example the Board demanded that the name of the project be changed from “Treatment Plant” to “Treatment Plan”
Connecticut River Diversion

In 1984, when MWRA was created, MWRA was drawing 340 million gallons per day (MGD) on a safe yield of 300 MGD. Eight alternatives for solving this problem were being considered. When this list was drawn up, flood skimming the Connecticut River was the preferred alternative; conservation was a listed alternative but not preferred. At the same time that decisions were being considered on water supply, MWRA was in the process of siting their regional wastewater treatment plant (now known as Deer Island). Mindful of the relationship between water supply and wastewater treatment (much of the water supplied comes back as wastewater to be treated) the Board deferred a decision on the Connecticut River diversion instead opting for a three-year (3) trial period during which MWRA performed the following:

- Leak detection (this included surveying pipes for customers and providing incentives for repairing leaks)
- Operating more efficiently, including replacement of master meters
- Performing industrial audits of large customers
- Installation of more efficient residential plumbing fixtures with post installation audits
- School education and public outreach
- Security changes in the state plumbing code to require 1.6 gallon per flush toilets

As part of the program planning, MWRA investigated the residential demand management efforts of other water utilities and the power industry. In the water industry at that time, the current practice for such programs consisted of simply providing kits for free and (infrequently) doing follow-up calls to customers to track penetration rates. Electric utilities typically tracked spending per account. MWRA decided that the best measurement of effectiveness was dollars per gallon of reduced demand, and that results were likely to be achieved by paying contractors for installation (it is too easy for a customer to report a self-installation over the phone without actually doing it). The MWRA program consisted of a kit consisting of toilet dams, showerheads and faucet aerators (total cost was $4 per kit), paying contractors for installation as well as some in home educational efforts

Result

Within four years, demand had dropped about 10%, exceeding the demand reduction target at a modest cost. Depending on the construction alternative, the resulting savings are between $300 and $500 million. The CIP process has not changed because of this success but the “stories” resulting from this success have created a culture that is supportive of looking at alternatives. In addition to the cost savings, some other benefits of pursuing non-construction alternatives include:

- MWRA didn’t have to spend its political capital to pursue the Connecticut River diversion
- MWRA was recognized as an environmental organization with a 94% positive customer service rating
Could this have been improved? Because there was so much slack in the system (demand has continued to drop as more efficient water using fixtures find their way into homes), the program never needed to be fine-tuned. It is possible that a more focused effort on industrial water use reduction would yield even more savings. Advice for other utilities? Three essentials for a successful program are:

- Board attention
- GM attention
- A reporting mechanism using robust metrics that gets to underlying interests.

Analysis of Connecticut River Diversion

This case study presents a number of interesting parallels to other case studies:

- Support from the top is essential and, in all cases, efforts were driven from the top
- Non-construction alternatives were elevated to a status equal to the conventional “bricks and mortar” approach
- Recognition of the relationship between water and wastewater. Demand reduction saves money twice. In the case of New York City, it did more than that. In New York, the influent streams to their wastewater treatment plants were so dilute that treatment effectiveness was weakened. After demand management, the stronger influent stream resulted in improved wastewater treatment.
- As was the case in Los Angeles, a simple but robust metric quickly lead to an effective solution.
- Both MWRA and New York paid contractors for installation.

MWRA and New York were both beneficiaries of a long term indoor per capita water use reduction that resulted from tighter building codes (beginning in the mid 1970s) which forced manufacturers to produce more efficient water fixtures. The U.S. Geological Survey estimated that per capita indoor water use declined by 25% from 1975 to 2000 (USGS 2004). An easy way for any utility to implement non-construction alternatives is to update per capita design standards. Many designers and utilities are using old design standards, which result in oversized facilities. MWRA has lowered their design standard to 65 gallons per capita per day.

Filtration Avoidance

In the mid-’90s, MWRA was faced with the possibility of needing to build a filtration plant to meet regulations. MWRA identified three alternatives:

- Construct a filtration plant (estimated additional cost $180-250 million)
- Add watershed protection to existing processes
- Combine watershed protection with more powerful disinfection

With the Board actively supporting non-construction alternatives, MWRA analyzed the parameters of the problem and identified that watershed protection was not enough. It was necessary to pursue water quality improvement. The final strategy consisted of:
• Purchase of land, including paying payment in lieu of taxes (PILOT) on owned land
• Providing technical assistance to communities in the watershed area
• Convincing the state legislature to limit development in the watershed area
• Covering landfills and taking measures to keep birds way from open reservoirs

MWRA credits its success in this effort with early involvement of the watershed communities.

Filtration avoidance was not pursued solely for economic reasons. Economic analysis was difficult to do and the alternatives analyzed could drive the solution. The final decision actually resulted in a revised allocation of resources with the money that would have been spent on filtration being used on the following combination:

• Ozone treatment
• Continued enhanced watershed protection
• Replacement and rehabilitation of both MWRA and community old unlined cast iron distribution mains (A program of $250 million in 0% interest loans was initiated to encourage communities to do cleaning and lining).

The recommended program was disputed by EPA and ultimately defended in Federal Court. Key to MWRA’s eventual success was that the program was not simply focused on reducing the costs of treatment, but on allocating resources to those portions of the water system which most needed improvement. This balanced investment profile yielded the highest water quality improvements for a similar investment.

DESIGN-BUILD SOMETIMES HAS PROBLEMS, ZONE 7 WATER AGENCY; LIVERMORE, CALIFORNIA

About Zone 7 Water Agency

Zone 7 Water Agency (Zone 7) is short for the Alameda County Flood Control and Water Conservation District, Zone 7. Established by the California Legislature in 1954, Zone 7 is responsible for providing flood control and water resources to the Livermore-Amador Valley. As a wholesaler, Zone 7 sells treated water primarily to four retail water agencies - the cities of Livermore and Pleasanton, the California Water Service Company, and the Dublin San Ramon Services District. Additionally, it also sells untreated water directly to agricultural and other customers. Through its wholesale customers, Zone 7 provides drinking water to approximately 200,000 people in its service area.

Background

Zone 7, to increase its drinking water treatment production capacity and meet more stringent standards for water quality, sought to accomplish those two goals through a new 8 mgd water treatment plant expansion at the 12 mgd Patterson Pass Water Treatment Plant site. Zone 7 was exploring opportunities to expedite getting its planned new water treatment plant into operation and thought that it would be the ideal candidate for design-build alternative project delivery.
The Situation

The project was to design and construct an 8 million gallon per day (mgd) ultrafiltration membrane water treatment plant alongside the existing 12 mgd conventional water treatment plant using design-build as the alternative project delivery mechanism. While the ultrafiltration plant was completed and has been operational since October 2003, Zone 7 experienced many challenges with the design-build approach that proponents of the approach did not seem to discuss.

The project required efficient communication and coordination among the various team members and stakeholders in the project:

- Zone & (the owner)
- the design-builder
- subcontractor UF supplier/manufacturer
- subcontractor NaOCl on-site generation supplier
- owner’s technical representative and CM
- Zone 7 operations groups

Original Project Schedule

Figure D.6, on the following page, presents the estimated project schedule at the start of the plant expansion

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
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</thead>
<tbody>
<tr>
<td>Certify WTP EIR</td>
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<tr>
<td>Bid Period</td>
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<tr>
<td>Preliminary Design</td>
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<tr>
<td>Ongoing Design</td>
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<td>⭐</td>
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<tr>
<td>Construction</td>
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<td></td>
<td></td>
<td>⭐</td>
</tr>
<tr>
<td>Startup/Commissioning</td>
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<td></td>
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<tr>
<td>In Service</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>⭐</td>
</tr>
</tbody>
</table>

Figure D.6 Estimated project schedule at the start of the plant expansion

Final Project Schedule

Figure D.7, below presents the estimated project schedule at the start of the plant expansion
Drawbacks Experienced in Design Build

As a result of its experience, Zone 7 identified the following drawbacks to using the design-build alternative project delivery methodology:

- contract and change order constraints
- handing off too much design control
- dealing with problems late rather than early on
- new construction at an existing site

**Contract and Change Order Constraints**

The project used cutting-edge technology that it made it more difficult to foresee problems during construction.

Another issue that Zone 7 did not consider was that its own design standards were higher and more comprehensive than general industry accepted design standards for similar plants. That left it in the position of not being able to accept a considerable amount of the design presented by the design-builder. This was compounded by the fact that Zone 7 was reluctant to issue change orders early into the project because it wanted to avoid setting a precedent that would be the basis for future claims of extra work.

**Handing Off Too Much Design Control**

One of the advantages of design-build is that it creates a single entity with responsibility and authority for the coordination of design and construction that allows the team to resolve potential design-construction conflicts earlier into the design process. However, it sometimes seemed to Zone 7 as if its design-builder used the delivery method and team organization to take short cuts rather than facilitate schedule efficiency.

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**Figure D.7 Final project schedule**

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- handing off too much design control
- dealing with problems late rather than early on
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The evolving design as construction began made it more difficult for the design-builder to properly check on O&M, engineering, and safety preferences or standards by the client. The design-builder drove the design instead of addressing some of those issues at the start of the project, where applicable. Zone 7 was also concerned that the design-builder did not appear to be aware of all the issues associated with its design due to internal communication structures or lack thereof. Can a design-builder be aware of everything?

**Dealing with Problems Late Rather than Early On**

Another advertised advantage of design-build is that it can identify design problems earlier into the project due to the participation of construction team members. However, this requires good internal communication between those two areas and between the design-builder and the client. This did not occur during the project and led to an inordinate amount of design issues during construction.

Even in design-build, major design approaches and issues have to be resolved before construction can begin. A design still has to be comprehensive and majority completed to allow an early start on site work, layout, utilities and foundation/building structures. When a majority complete design did not occur, it led to reactive rather than proactive solutions. Instead of identifying potential conflicts during design, they were not addressed until construction began, which led to schedule delays. The time pressure on the design-builder exacerbated the problems with taking design shortcuts and putting off addressing some design issues until later to give the perception of making progress. It was a penny-wise, pound-foolish proposition.

**New Construction at an Existing Site**

Construction at a greenfield site is dramatically different from construction at an existing site with a functioning plant that has to stay in service. The new construction can affect the existing facilities, especially when major electrical work to power the new facility needs to be conducted. The design-build team did not work with the owner to identify problems with new construction affecting existing facilities. That also translated into not properly assessing the extent of the effects that new construction had on existing facilities. Zone 7 had service outage request and construction activity coordination forms to help the design-build team get access to whatever it needed at the construction site to perform work. However, too many service outage requests became disruptive for the existing facilities.

**Conclusion**

When using design-build for projects, several conditions must be met to give you the best chance of achieving your goals through this alternative project delivery methodology:

- the design-builder must have a good internal communication and coordination process
- the design-builder must have good communication and coordination with the client
- design standards and/or project performance criteria must be clearly stated in the RFP – some utilities have tough internal standards due to their particular circumstances
- while design-build saves time, you can not take short cuts in the design process
• the project schedule should identify and account for potential conflicts/risks at the construction site if it is not a greenfield site.
APPENDIX E
SCENARIO PLANNING EXAMPLES

MANAGING DISTRIBUTION SYSTEM EXTENSION/REPLACEMENT COSTS

Background

Your service area includes a moderate size City – population 225,000. Some parts of the City are well over 100 years old. There was a post World War II growth spurt after which growth stayed relatively low – mostly infill and replacement. The suburbs have recently become a haven for retirement home complexes and annual growth has just exceeded 1%. Because of indoor fixture efficiencies, it appears that your water plants will be adequate – per capita consumption has been in a gradual decline for the past 20 years. Max hour demand is not dropping; however, you can barely meet fire flow requirements on hot summer days.

The CIP forecast your consulting engineers have provided shows significant increases for distribution system extensions and replacements, and new pump station and rehabs. Your Chief Finance Officer tells you that the implication of this CIP is double-digit rate increases for the foreseeable future (at least 5 to 10 years out). Based on your recent experiences with actual bids you are worried that it might turn out even worse – actual bids (when you get them) are always over engineers estimate and materials price increases are eating you up.

You are still in the very early stages of developing an asset management system. You can come up with a reasonably accurate vintage distribution of your distribution and transmission system, but have done virtually nothing on condition assessments. Your CIP forecast is based primarily on age, adjusted by experience (leaks and main breaks). The GIS mapping of your system is only about two-thirds complete.

Discussion

Given these facts (plus additional assumptions that you can add) what can you, as a capital projects manager, do to make this affordable? Identify, in priority order:

- Which best practices might be the best for you to adopt to meet your objective?
- Which parts of your program should you focus on – project selection, project development, project execution?
- Which other members of your utility management team would you enlist to help you meet this goal?

MANAGING CAPITAL PROJECTS IN A BOOMING AREA

Background

You are the capital projects manager of a growing utility in a booming area. Rates stayed affordable through the late ‘70s, ‘80s and ‘90s because impact fees (or system development charges) and developers contributions took care of much of your capital needs. You are no
longer experiencing the hyper growth of that period, but your area is still growing. Unfortunately, your CIP is getting bigger every year:

- Some of the facilities built during your early growth spurt need to be replaced
- Increased environmental regulation is requiring modifications to equipment and processes
- On a unit basis, the cost of providing service to new housing is increasing every year.

Your biggest problem, however, is that you are only one of many agencies putting out work for a close to fully booked set of contractors. Not too long ago, you put out some jobs for bids at the same time that some major roadwork and buildings were being bid. Your bids came in at two times the engineers estimate. The work needs to get done but your City Council is unlikely to put up with the rate implications of such huge increases in your capital costs.

Discussion

Given these facts (plus additional assumptions that you can add) what can you, as a capital projects manager, do to make this affordable? Identify, in priority order:

- Which best practices might be the best for you to adopt to meet your objective?
- What strategies could you adopt to keep costs reasonable?
- Which parts of your program should you focus on – project selection, project development, project execution? Risk allocation in your contracts?
- Would you consider alternative project delivery?
- Which other members of your utility management team would you enlist to help you meet this goal?

MANAGING CAPITAL PROJECTS WITH AN AGING WORKFORCE

Background

You have recently been brought in to manage a large utility with a significant in-house capital program capability. Your in house personnel can do everything from design, CM, project closeout, inspection etc. In addition to the contracts you place on work that you manage as CM, you also contract out major projects to joint ventures. The prevailing philosophy seems to be the project manager is king. Everybody runs projects their way.

The capital program has become a source of increasing concern as it has steadily grown over the past decade. There are signs of problems – actual to budget percentages on capital projects are usually in the 60% to 70% range. The CIP is driven by high profile and regulatory work. As a result of this continued focus on a few large jobs, smaller jobs seem to never get finished. No one seems to be happy – the regulators are all over your back, it is becoming harder to site facilities etc. When you look around at your senior program managers, another problem becomes evident – all of the senior people are within a few years of being eligible to retire. You are running the risk of losing all of your expertise within the next five years.
Discussion

Given these facts (plus additional assumptions that you can add) what can you, as a capital projects manager, do to resolve this situation? Identify, in priority order:

- What are the most important things for you to focus on?
- Which best practices might be the best for you to adopt to meet your objective?
- Which parts of your program should you focus on?
- Which other members of your utility management team would you enlist to help you meet this goal?
BIBLIOGRAPHY and ADDITIONAL READING


American Society of Civil Engineers and Environmental Protection Agency. 2004. *Sanitary Sewer Overflow Solutions*. Washington, DC.


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### ABBREVIATIONS AND ACRONYMS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>A/E</td>
<td>Architect/Engineer</td>
</tr>
<tr>
<td>AACE</td>
<td>American Association of Cost Estimating</td>
</tr>
<tr>
<td>ACE</td>
<td>Annual Conference and Exposition (AWWA)</td>
</tr>
<tr>
<td>ACEC</td>
<td>American Council of Engineering Companies</td>
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<tr>
<td>AGC</td>
<td>Associated General Contractors</td>
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<td>AMC</td>
<td>Asset Management Committee (at SPU)</td>
</tr>
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<td>ASCE</td>
<td>American Society of Civil Engineers</td>
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<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
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<tr>
<td>ASME-ITI</td>
<td>ASME Innovative Technologies, Inc.</td>
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<td>ASR</td>
<td>Aquifer storage and retrieval</td>
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<td>AWWA</td>
<td>American Water Works Association</td>
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<td>BCI</td>
<td>Building Cost Index</td>
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<tr>
<td>BEDC</td>
<td>Bureau of Design and Construction (DEP)</td>
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<td>BNR</td>
<td>Biological nutrient removal</td>
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<tr>
<td>BOE</td>
<td>see LABOE</td>
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<td>BRF</td>
<td>Biosolids Reclamation Facility</td>
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<td>BuSan</td>
<td>Bureau of Sanitation (City of Los Angeles)</td>
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<tr>
<td>CAD</td>
<td>Computer-aided design</td>
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<td>CADD</td>
<td>Computer-aided design and drafting</td>
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<td>CAE</td>
<td>Computer-aided engineering</td>
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<td>Construction Cost Index</td>
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<td>CDO</td>
<td>Cease and Desist Order (issued by EPA)</td>
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<td>CEU</td>
<td>Continuing education credit</td>
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<td>CGL</td>
<td>Commercial general liability</td>
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<td>Construction Industry Institute</td>
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<td>CIP</td>
<td>Capital Improvement Program</td>
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<td>Construction Management</td>
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<td>CM-at-Risk</td>
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<td>Critical success factors</td>
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<td>DBB</td>
<td>Design-bid-build</td>
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<td>DBO</td>
<td>Design-build-operate</td>
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<td>DBOO</td>
<td>Design-build-own-operate</td>
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<td>DLD</td>
<td>Dedicated land disposal</td>
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<td>DEP</td>
<td>Department of Environmental Protection (City of New York)</td>
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<td>DHS</td>
<td>Department of Homeland Security</td>
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<td>DPW</td>
<td>Department of Public Works (City of Los Angeles)</td>
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<td>dtpd</td>
<td>Dry ton per day</td>
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<td>Environmental impact report</td>
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<td>Engineering News Record</td>
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<td>GIS</td>
<td>Geographic information systems</td>
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<td>HDPE</td>
<td>High-density polyethylene</td>
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<tr>
<td>I&amp;A</td>
<td>Innovative and Alternative (technologies or processes)</td>
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<td>IOU</td>
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<td>Lean Construction Institute</td>
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<td>Million gallons per day</td>
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<td>WPCP</td>
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