California Multi-Agency CIP Benchmarking Study

Annual Report - Update 2004

PUBLICWORKS

WORKS AGE









Justs DB

September 2004



CHAPTER 1 - EXECUTIVE SUMMARY 1 1 А. Introduction 2 B. Study Methodology 3 С. Implementation of Best Management Practices 3 D. Initial Steps to Link Processes to Performance 7 Conclusions of Performance Benchmarkings E. Update 2004 Observations 8 F.

CHAPTER 2 - PARTICIPATING AGENCIES 11 A. Agencies Overall Information 11

| 11. | rigenetes Overan information | 11 |
|-----|--|----|
| | | |
| B. | CIP Projects that will be Awarded and Included in the Database | |
| | (Fiscal Years 2003/2004 Through 2005/2006) | 12 |

CHAPTER 3 - BEST MANAGEMENT PRACTICES IMPLEMENTATION 15

| A. | Introduction | 15 |
|----|--|----|
| B. | Moving toward Linking BMP Implementation to Improved Performance | 15 |
| C. | Challenges to Linking Processes to Performance | 23 |
| D. | Measuring the Impact of Change | 23 |
| E. | Initial Stages of Linking Processes to Performance | 24 |
| F. | Communication on Other Project Delivery Improvements | 29 |

| CH/ | APTER 4 - PERFORMANCE BENCHMARKING | 30 |
|-----|---|------|
| А. | Guiding Principles | 30 |
| B. | Distribution of Projects | 31 |
| C. | Performance Graph Development | 31 |
| CH/ | APTER 5 - CONCLUSIONS AND RECOMMENDATIONS | 34 |
| А. | Performance Data Improvement | 34 |
| В. | Update 2004 Observations | 34 |
| ACK | NOWLEDGEMENTS | I |
| APP | ENDICES | |
| APP | ENDIX A - PERFORMANCE MODELS | A-1 |
| | Curves Group 1 | A-3 |
| | Curves Group 2 | A-13 |
| | Curves Group 3 | A-23 |
| APP | ENDIX B - OUTLIERS IDENTIFICATION | B-1 |
| APP | ENDIX C - MULTI-AGENCY BENCHMARKING DATABASE (UPDATE 2004) | C-1 |
| APP | ENDIX D - PROJECT SIZE NORMALIZATION | D-1 |
| APP | ENDIX E - AGENCIES INDIRECT RATE FACTORS | E-1 |

Chapter 1

Executive Summary









CHAPTER Executive Summary

A. INTRODUCTION

Seven of the largest municipalities in California have been working together over the last three years to identify the costs of delivering capital projects and how to make project delivery more efficient. 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 grew to 453 projects with a total construction value of \$830 million. *Update 2004* now includes project delivery cost data on 595 projects with a construction value of nearly \$1 billion.

The study of the actual project data gives governmental decision makers a valuable tool to more accurately anticipate the true costs of public projects. The study of the processes used in delivering projects and determining the effectiveness of those processes are valuable in reducing project delivery costs.

The intent of this continuing study is to improve the public project delivery process. The specific goals of *Update 2004* were as follows:

- Expand the project database by collecting data on additional projects.
- Verify data previously provided and improve the data collection process.
- Track the implementation of Best Management Practices in order to begin the process of linking the implementation of Best Management Practices to improvements in performance.

 Document and improve inter-agency communications related to project delivery challenges and improvements.

Background

In October 2001, the City of Los Angeles, Department of Public Works, Bureau of Engineering initiated the study with several of the larger cities in California. These cities joined together to form the California Multi-Agency CIP Benchmarking Study Team. After working together for three years, this team has shown that it is possible – and beneficial – for cities to collaborate and to pool their knowledge and experience related to factors that influence project delivery costs.

The study initially involved six agencies with a seventh (City of Oakland) joining the team in 2003. The following agencies are now participating in the study:

- City of Long Beach, Department of Public Works
- City of Los Angeles, Department of Public Works/Bureau of Engineering
- City of Oakland, Public Works Agency
- City of Sacramento, Department of General Services, Department of Transportation, and Department of Utilities
- City of San Diego, Engineering & Capital Projects
- City & County of San Francisco, Department of Public Works/Bureau of Engineering /Bureau of Architecture/Bureau of Construction Management

 City of San Jose, Department of Public Works/City Manager's Office

In 2002, upon initiation of the California Multi-Agency Benchmarking study, it was agreed that all study participants should remain anonymous in order to create a positive, non-competitive team environment, conducive to meeting the study's goals. In order to continue in this spirit, as was the case in the past two years of this study, no projects are identified by name in this document or in the project database and agencies are referred to generically (Agency A, etc), when anonymity is appropriate.

Update 2004 Focus

This document, *Update 2004*, is the result of three years of collaboration. The study has examined <u>process</u>, focusing on business processes related to efficient capital project delivery.

The Study Team examined over 100 processes used in the design and construction management phases of project delivery. Thirty-nine of these processes were identified intuitively (using over 300 person-years of experience among the team members) as those most influential in the delivery of high quality projects. Thirty-one¹ of these practices were identified as directly influencing either design or construction management cost and, ultimately, project delivery cost.

Update 2004 documents the past use, the current use, and the planned implementation of Best Management Practices by each agency in a continuing effort to link the use of improved processes to improved performance.

Update 2004 continued the collection of project delivery costs and project durations. The

historical delivery costs and project durations (referred to in this report as <u>performance data</u>) were plotted against total construction cost in performance curves. *Update 2004* includes an analysis of project cost and schedule data from 595 Capital Improvement Projects (CIP). Performance models previously plotted in the original study and in *Update 2003* have been updated and improved in this study.

The California Multi-Agency CIP Benchmarking Study is intended to be a continuing effort. Future annual updates are expected to refine and improve the conclusions and recommendations as additional project data are collected.

B. STUDY METHODOLOGY

Update 2004 made progress on four goals.

- 1. Enhance the performance database and optimize performance curves (graphs that relate the cost of construction to the costs of project delivery). Performance data on a total of 595 projects with a total construction value of nearly \$1 billion were used to develop the performance benchmarking curves (graphs) for 14 different classifications in four project types (municipal facilities, streets, pipe systems, and parks) showing design, construction management, and overall project delivery costs as a percentage of total construction costs.
- 2. Improve the quality of the data and the data collection effort. The Project Performance Worksheet was put into an electronic format. Agencies re-checked their records and verified data previously provided or made changes where appropriate. The Project Team implemented an outlier identification process assisting agencies to single out and eliminate non-representative projects.

¹ For example, some Best Management Practices ("Train in-house staff to use Green Building Standards") were found to improve client satisfaction (quality) and may not actually reduce project delivery costs.

- 3. Agencies provided information on two stages of Best Management Practices (BMPs) implementation:
 - BMPs implemented prior to May 2004
 - BMPs targeted for implementation after May 2004
- Communications between agencies related to project delivery challenges were documented in a retrievable format and posted on a web site. The communications are accessible by any of the participating agencies.

C. IMPLEMENTATION OF BEST MANAGEMENT PRACTICES

In the original 2002 study, team members identified, discussed, and evaluated processes associated with the effective delivery of capital projects. *Update 2003* studied the practical implementation of these processes.

Update 2004 acknowledges that Best Management Practices related to project delivery may be divided into two types:

- Those that improve public or client satisfaction but may not reduce the cost of project delivery (i.e. training in-house staff to use U.S. Green Building Council design standards may result in decreasing operation and maintenance cost over the life of the project, but the initial cost of design and commissioning may be higher), and,
- Those which are influential in reducing the cost of project delivery. (i.e. providing a clear, precise scope, schedule, and budget to the designer at the start of design will make production of the construction documents more efficient).

In order to facilitate the linking of Best Management Practices implementation with changes in project delivery performance, only the implementation of the practices considered to be influential in reducing project delivery costs were tracked. The Study Team identified 31 BMPs influencing the cost of project delivery as shown in Table A.

D. INITIAL STEPS TO LINK PROCESSES TO PERFORMANCE

The impact of agencies' Best Management Practices implementation progress on projects performance is an important goal of this benchmarking study. This objective will become achievable as the study continues and as more data is collected on the BMPs implementation levels and agencies performance (i.e. project delivery costs).

To initiate the linking of processes to perfomance, *Update 2004* looked into a hypothetical relation between the change (presumably increase) in BMPs implementation rate and the change (presumably decrease) in project delivery cost, as a percentage of total construction cost.

A statistical technique (multi-parameter regression) can identify the concurrent effects of several parameters on one dependent parameter. *Update 2004* proposes implementation of this technique to identify the relation between the Best Management Practices (the independent parameters) and total project delivery cost as a percentage of total construction cost (the dependent parameter). The details of this technique are explained in Chapter 7 and it is concluded that this method could be very useful, contingent to improved performance data reliability and additional breakdown of BMPs rating data.

Table A - IMPLEMENTATION OF BEST MANAGEMENT PRACTICES AND AGENCIES' TOP 5 PRIORITIES

| Process Category | Ref.* | Best Management Practice | ۲ | LB | Ŋ | sc | SD | SF | SJ | Notes |
|---------------------|---------------|--|------|-----------|-----------|-------------------|-----------------|------|---------------|---|
| Janning | 1.a. | Define Capital projects well with respect to scope and budget including community and client approval at the end of the planning phase | > | > | 2004 | > | PI 2004 | > | > | SD: Some Divisions only |
| | 1.b. | Complete Feasibility Studies on projects prior to defining budget and scope | > | > | > | > | PI 2004 © | > | > | LB: When applicable SD: Result of CIP Benchmarking SF: When applicable SJ: Some exceptions |
| | 1.d. | Have a Board/Council project prioritization system | I/N | ľz | ž | GS: GS: TS: | 2004 © | ž | IZ | SD: Result of CIP Benchmarking SC: Done for Transportation. Will do for Facilities in 2004 |
| | 1.e. | Provide design and construction resource loading for CIP projects | > | 2005 © | > | 2004 TS: 2005 | 2004 2 | ž | P (4) | SD: Result of CIP Benchmarking SJ: Staffing model (including Consultants submitted to Budget) |
| | 1.f. | Have a Master Schedule attached to the CIP that identifies start and finish dates for projects | > | 2005 | > | > | I/N | ľź | > | |
| | 1.i. | Show Projects on a Geographical Information System | > | > | 2004 3 | > | > | 4BD | > | LB: Infrastructure only |
| Design | 2.b. | Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start | > | > | > | > | PI 2004 © | > | > | |
| | 2.f. | Define requirements for reliability, maintenance, and operation prior to design initiation | > | 2004 | ľz | 2004 TS: 🗸 | Б | > | > | SD: Some Divisions only (Rest N/I) |
| | 2.i. | Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc.) | > | > | > | √ UT:@ | Ъ | > | > | SD: Some Divisions only , where applicable |
| | A/A | Train in-house staff to use Green Building Standards | > | TBD | ā | > | > | > | > | This BMP was found to improve client satisfaction (quality) and may not reduce project delivery cost directly. SF: When applicable |
| | N/A (2004) | Limit Scope Changes to early stages of design | 2006 | 2005 | 2005 | TS: PI | 2005 | 2005 | 2005 | |
| | N/A (2004) | Scope Changes during design must be accompanied by Budget and Schedule approvals | 2006 | 2005 | 2005 | TS: PI | 2005 | 2005 | 2005 | |
| nstructions: | | | | | | | | | <u>-egenc</u> | |

 \checkmark : Has been implemented

PI: Partially implemented

yyyy: Will be implemented in calendar year "yyyy", \otimes = Priority x for implementation N/I: No plans to implement at this time

TBD: To be determined

*Reference to Process Questionnaire in Appendix C of 2002 Report.

** Sacramento Department of Utilities has different Implementation history. The top 5 priorities are accurate.

| TS: SAC. Department of Transportation JT: SAC. Department of Utilities |
|---|
| |

Table A - IMPLEMENTATION OF BEST MANAGEMENT PRACTICES **AND AGENCIES' TOP 5 PRIORITIES**

| Process Category | Ref.* | Best Management Practice | ΓA | LB | ок | sc | SD | SF | SJ | Notes |
|-----------------------------------|----------|---|-------------|-----------|-----------|----------------------|------------|-------|------|--|
| Quality Assurance / Quality | 3.I.a. | Develop and use a standardized Project Delivery Manual | > | 2005 | 2005 © | 2005 3S:2 UT:2 | ⊾ | > | > | SC: Started in 2003 SD: incorporated into PM training manual and standard primavera schedule template / Descriptions. Details available. as needed. |
| Control | 3.II.b. | Perform a formal Value Engineering Study for projects larger than \$1,000,000 | 2005 (4) | > | ĪZ | > | > | > | 2004 | A: For projects > \$1 million B: On an as-needed bases SC: For projects > \$5 million SF: On an as-needed basis |
| | 3.III.a. | Use a formal Quality Management System | > | 2005 3 | ž | ₫ | PI 2005 | G TBD | 2004 | 5J: For projects > \$5 million 5D: Some Divisions only |
| | 3.III.b. | Perform and use Post Project Reviews to identify lessons learned | 2004 | TBD | > | UT:@ | > | > | ⊡ ⊡ | 5F: On selected projects 5D: On selected projects |
| Construction Management | 4.I.a. | Delegate authority to the City Engineer/Public Works Director or other departments to approve change orders to the contingency amount | > | > | > | 2004 TS: N/I | > | > | > | SF: At Bureau level 3.1: Individual C.O. < \$100,000 5.D: Individual C.O. < \$200,000 |
| | 4.I.m. | Classify types of change orders | 2004 © | 2005 | > | > | PI 2004 | > | 2004 | SD: Only for scope changes versus other types |
| | 4.II.a. | Include a formal Dispute Resolution Procedure in all contract | > | ١٧ | > | > | > | > | > | |
| | 4.III.a. | Use a team building process for projects greater than \$5 million. | > | > | > | > | > | > | > | -B: As-needed |
| | | | | | | | | | | SD: As-needed SF: As-needed 3J: Formal process for projects > \$10 million |
| | 4.IV.a. | Involve the Construction Management Team before completion of | > | 2004 | > | ₫ | | | > | SD: Some Divisions only |
| | | design | • | | | GS: @ | • | • | • | |
| | | | | | | TS:PI | | | | |

Instructions:

 \checkmark : Has been implemented

PI: Partially implemented

yyyy: Will be implemented in calendar year "yyyy", \otimes = Priority x for implementation N/I: No plans to implement at this time

TBD: To be determined

*Reference to Process Questionnaire in Appendix C of 2002 Report.

** Sacramento Department of Utilities has different Implementation history. The top 5 priorities are accurate.

SF: San Francisco SJ: San Jose

SD: San Diego

LA: Los Angeles LB: Long Beach OK: Oakland

Legend:

GS: SAC. Department of General Services TS: SAC. Department of Transportation UT: SAC. Department of Utilities

SC: Sacramento

Table A - IMPLEMENTATION OF BEST MANAGEMENT PRACTICES AND AGENCIES' TOP 5 PRIORITIES

| Process Category | Ref.* | Best Management Practice | LA | LB | УО | sc | SD | SF | SJ | Notes | |
|--|---------------|--|------|------|-----------|---------------------------------|-----------|----------|-----------|--|---|
| Construction Management (Cont'd) | N/A (2003) | Delegate contract awards below council below \$1 million | > | > | > | N/I UT: <u>(</u>) TS:N/I | > | > | > | | |
| | N/A (2003) | On large complex projects establish a pre-qualification process for contractors | > | Ň | 2004 G | > | > | DBT © | > | | |
| | N/A | Make bid documents available online | 2004 | 2004 | ΙX | I/N | ₫ | TBD | ⊒ | SD: System options being evaluated | _ |
| | (2003) | | 6 | 4 | + | S: 2005 | TBD | 6 | 6 | | |
| Project Management | 5.I.f. | Assign a client representative to every project | > | > | > | > | PI TBD | > | > | SD: Only for large projects | |
| 0 | 5.II.a | Provide formal training for Project Managers on a regular basis | > | 2004 | > | 2003 | > | > | > | SD: Yearly PM academy, as funds allow | _ |
| | | | | | _ | GS:4 TS:PI | | | | | |
| | 5.III.a. | Adopt and use a Project Control System on all projects | > | 2004 | ⊒ | ₫ | > | > | > | SD: Project controls incorporated into Primavera | |
| | | | | 6 | | UT: (5) | | | | schedule | _ |
| | N/A | Create in-house project management team for small projects | N | N/I | ⊒ | 2003 | ₫ | I/N | > | SD: Some Divisions only | _ |
| | (2003) | | | | _ | GS: G TS:N/I | TBD | | | | |
| | N/A (2004) | Institutionalization of Project Manager performance and accountability | 2006 | 2005 | 2005 | 2005 | 2005 | 2005 | 2005 | SD: Only non- standardized goals | |
| Consultant Selection and | 6.c. | Include a standard consultant contract in the RFQ/RFP with a standard indemnification clause | > | > | > | > | PI TBD | > | > | SD: Some Divisions only | |
| Use | 6.e. | Delegate authority to the PW Director/City Engineer to approve consultant contracts under \$250,000, when a formal RFP selection process is used | ΪŻ | IX | 2004 © | I/N | > | > | I/N | | |
| | 6.g. | Implement and use a consultant rating system that identifies quality of consultant performance | > | I/N | > | 2004 TS:N/I | > | TBD © | 2004 ① | | |
| Instructions: | | | | | | | | Leg | end: | | |

\[
\lambda]: Has been implemented
\]

PI: Partially implemented

yyyy: Will be implemented in calendar year "yyyy", \otimes = Priority x for implementation

GS: SAC. Department of General Services

SC: Sacramento

TS: SAC. Department of Transportation UT: SAC. Department of Utilities

SF: San Francisco SJ: San Jose

SD: San Diego

LA: Los Angeles LB: Long Beach OK: Oakland

> N/I: No plans to implement at this time TBD: To be determined

** Sacramento Department of Utilities has different Implementation history. The top 5 priorities are accurate. *Reference to Process Questionnaire in Appendix C of 2002 Report.

E. CONCLUSIONS OF PERFORMANCE BENCHMARKING

I. Summary:

The following performance benchmarking conclusions are based upon the *Update 2004* study analysis of project data:

- The percentage of design costs continued to decrease with increasing size of the projects. Design costs averaged 18% of the total construction cost for 595 representative projects completed after 1997, each with total construction cost greater than \$100,000.
- The ratio of costs for construction management continued to decrease as the total construction costs increased. Construction management averaged 16% of the total construction cost for 595 representative projects completed after 1997 and greater than \$100,000 total construction cost.
- Based on the performance data, total project delivery cost (total design cost and construction management cost), for 595 projects greater than \$100,000 total construction cost averaged 34% of the total construction cost.

Table B provides a snapshot of the trend of Design, Construction Management, and Total Project Delivery costs during the past 3 years of this benchmarking study, as project data was accumulated from 239 projects in 2002 to 595 project in 2004.

Table B indicates that projects delivery cost has increased over the three years of the study. The increasing trend appears counter-intuitive, but can be explained by the following factors:

- The agencies now have a better understanding of all of the costs associated with delivering projects and the collection of cost data has improved.
- The average and median total construction cost of the projects on which data has been provided has decreased (2002 TCC Average = \$2.75 million and 2004 TCC Average = \$1.13 million). Smaller projects have proportionately higher project delivery costs.
- Some agencies are experiencing new governmental rules and regulations that increase required project management time. (i.e. new storm water pollution plan requirements, application of LEED design standards, additional art and ADA requirements.)

| Project Delivery | Percentage | e of Total Constru (All Agencies) | ction Cost* |
|----------------------------|------------------------------|--------------------------------------|--------------------------------|
| Phase | 2002 Study (239 Projects) | Update 2003 (453 Projects) | Update Study (595 Projects) |
| Design | 18% | 17% | 18% |
| Construction Management | 14% | 16% | 16% |
| Total Project Delivery | 32% | 33% | 34% |

Table B – Project Delivery Cost Trends (Cumulative Data)

* Rounded off to 2 significant figures.

- Agencies are adding policies related to a higher level of community involvement. Also projects are allowing community requested changes during the course of design and are requiring monthly reporting to the communities.
- Costs previously charged to the General Fund (i.e. plan checks) are now charged to projects due to budget declines and new policies of "Full Cost Recovery" for projects.

It is anticipated that the influence of these factors will be accounted for and mitigated as the team learns more about these factors and identifies methods of data improvement. *Update 2004*, for example, proposed a new technique to account for historical changes in project sizes and indirect factors (refer to "*Chapter 3 – Initial Stages of Linking*" for a proposed data normalization approach).

II. CIP Delivery Data by Type and Classification

Table C shows the updated project delivery cost and duration data for Capital Improvement Projects. Table D summarizes the use of consultants compared with project delivery percentages for all agencies.

III. Change Order Analysis Outcomes

It remains the intent of the Study to provide data that would guide the agencies to also include a reasonable allowance for change orders in project budgets based on project size, type, and classification. During the *Update 2004*, agencies began categorizing change orders into the following categories:

- Changed conditions/unforeseen conditions
- Errors & omissions
- Changes in scope

Performance models were developed and reviewed for each individual category and it was

determined that more data is required before any significant conclusions can be drawn. At this time agencies have categorized change orders within only 20% of the projects included in the database. As a result, the results were inconclusive and further data collection is necessary in order to develop useful change order performance models.

F. UPDATE 2004 OBSERVATIONS

- Spending more on design may decrease total construction cost by reducing change orders, which results in higher design cost as a percentage of total construction cost.
- Maintaining the level of the design effort, while improving BMP's such that construction change order levels are reduced, will result in higher design costs as a percentage of total construction cost.
- It is difficult to quantify improvements by merely looking at performance statistics. The mere fact that all Agencies are looking introspectively at their respective performances and are sharing information with each other, will lead to improvements regardless of the time needed for a statistical relationship to eventually demonstrate this.
- Although the project delivery costs have slightly increased over the past three years, they would have increased even more in the absence of BMP's developed by this benchmarking study. The sharing of the participating Agencies' knowledge and experiences will eventually reverse the Project Delivery costs trend.
- It is not surprising that delivery costs are going up because the complexity of projects is increasing as the direct public participation in the project delivery process increases.
- The size of the projects are growing smaller and the amount of time spent to develop creative funding solutions (phase funding, private donations, fund source swaps, etc) seems to be growing.

| PROJECT TYPE | Total | Design Cost | CM Cost | Total Project | Est. Total | Number of |
|---------------------------|--|-------------|------------|---------------|------------|------------|
| CLASIFICATION | Construction Cost | (% of TCC) | (% of TCC) | Delivery cost | Duration | Projects* |
| Municipal Facilities | (100) | | | (% 01 100) | (Months) | |
| | T00 . 00 FM | 420/ 470/ | 200/ 270/ | 740/ 000/ | 00.45 | |
| LIDIAIIES | 1CC< \$0.5M | 42 % - 47 % | 32% - 37% | 14% - 02% | 36 - 45 | 20 |
| | \$0.5M<1CC<\$3M | 20% - 32% | 21% - 20% | 49% - 50% | 39 - 49 | 28 |
| Deline / Fire Otation | TCC> \$3M | 15% - 19% | 11% - 16% | 26% - 34% | 43 - 52 | |
| Police/ Fire Station | TCC< \$0.5M | 29% - 33% | 15% - 18% | 44% - 50% | 16 - 30 | |
| | \$0.5M <tcc<\$3m< td=""><td>22% - 21%</td><td>12% - 15%</td><td>34% - 40%</td><td>36 - 49</td><td>39</td></tcc<\$3m<> | 22% - 21% | 12% - 15% | 34% - 40% | 36 - 49 | 39 |
| | TCC> \$3M | 16% - 21% | 9% - 12% | 26% - 32% | 53 - 66 | |
| Community Building / | TCC< \$0.5M | 26% - 32% | 23% - 33% | 49% - 60% | 19 - 29 | F 4 |
| Rec. Center/CC/Cym | \$0.5M <tcc<\$3m< td=""><td>22% - 28%</td><td>15% - 24%</td><td>36% - 48%</td><td>30 - 40</td><td>54</td></tcc<\$3m<> | 22% - 28% | 15% - 24% | 36% - 48% | 30 - 40 | 54 |
| Oferente | TCC> \$3M | 18% - 24% | 8% - 17% | 25% - 36% | 40 - 50 | |
| Streets | | 200/ 240/ | 400/ 400/ | 200/ 450/ | | [|
| Grade Separation | ICC< \$0.5M | 20% - 31% | 12% - 10% | 36% - 45% | 14 - 26 | 07 |
| Orace Separation | \$0.5M <tcc<\$3m< td=""><td>20% - 25%</td><td>13% - 19%</td><td>32% - 40%</td><td>35 - 47</td><td>27</td></tcc<\$3m<> | 20% - 25% | 13% - 19% | 32% - 40% | 35 - 47 | 27 |
| Dubling (Datas St. March | TCC> \$3M | 15% - 19% | 13% - 20% | 28% - 36% | 54 - 66 | |
| Bridge (Retrotit, New) | TCC< \$0.5M | 32% - 38% | 19% - 22% | 51% - 58% | 21 - 32 | |
| | \$0.5M <tcc<\$3m< td=""><td>24% - 30%</td><td>16% - 19%</td><td>40% - 47%</td><td>36 - 46</td><td>20</td></tcc<\$3m<> | 24% - 30% | 16% - 19% | 40% - 47% | 36 - 46 | 20 |
| | TCC> \$3M | 17% - 23% | 13% - 16% | 30% - 37% | 49 - 59 | |
| Reconstruction | TCC< \$0.5M | 23% - 28% | 24% - 29% | 47% - 54% | 16 - 22 | |
| | \$0.5M <tcc<\$3m< td=""><td>20% - 25%</td><td>11% - 16%</td><td>31% - 37%</td><td>23 - 29</td><td>23</td></tcc<\$3m<> | 20% - 25% | 11% - 16% | 31% - 37% | 23 - 29 | 23 |
| | TCC> \$3M | 17% - 22% | 0.1% - 4% | 16% - 22% | 30 - 36 | |
| Bike / Pedestrian | TCC< \$0.5M | 28% - 35% | 17% - 20% | 45% - 54% | 18 - 24 | |
| | \$0.5M <tcc<\$3m< td=""><td>11% - 18%</td><td>13% - 17%</td><td>24% - 33%</td><td>27 - 33</td><td>15</td></tcc<\$3m<> | 11% - 18% | 13% - 17% | 24% - 33% | 27 - 33 | 15 |
| | TCC> \$3M | 0.1% - 3% | 10% - 13% | 5% - 14% | 36 - 42 | |
| Signals | TCC< \$0.5M | 16% - 21% | 20% - 27% | 37% - 44% | 16 - 22 | |
| | \$0.5M <tcc<\$3m< td=""><td>10% - 15%</td><td>14% - 20%</td><td>24% - 32%</td><td>33 - 39</td><td>69</td></tcc<\$3m<> | 10% - 15% | 14% - 20% | 24% - 32% | 33 - 39 | 69 |
| | TCC> \$3M | 5% - 10% | 8% - 14% | 13% - 21% | 49 - 55 | |
| Pipes | | | | | 1 | |
| Gravity System | TCC< \$0.5M | 20% - 23% | 18% - 21% | 37% - 42% | 12 - 31 | |
| (Storm Drains, Sewers) | \$0.5M <tcc<\$3m< td=""><td>14% - 17%</td><td>14% - 17%</td><td>28% - 33%</td><td>49 - 68</td><td>133</td></tcc<\$3m<> | 14% - 17% | 14% - 17% | 28% - 33% | 49 - 68 | 133 |
| Jeweis) | TCC> \$3M | 8% - 12% | 11% - 14% | 20% - 25% | 82 - 101 | |
| Pressure Systems | TCC< \$0.5M | 14% - 18% | 14% - 17% | 28% - 33% | 60 - 76 | |
| | \$0.5M <tcc<\$3m< td=""><td>14% - 17%</td><td>11% - 14%</td><td>25% - 30%</td><td>58 - 73</td><td>29</td></tcc<\$3m<> | 14% - 17% | 11% - 14% | 25% - 30% | 58 - 73 | 29 |
| | TCC> \$3M | 14% - 17% | 8% - 12% | 22% - 27% | 55 - 70 | |
| Pump Station | TCC< \$0.5M | 25% - 29% | 35% - 41% | 60% - 69% | 57 - 74 | |
| | \$0.5M <tcc<\$3m< td=""><td>18% - 23%</td><td>24% - 30%</td><td>42% - 51%</td><td>52 - 70</td><td>12</td></tcc<\$3m<> | 18% - 23% | 24% - 30% | 42% - 51% | 52 - 70 | 12 |
| | TCC> \$3M | 13% - 17% | 14% - 20% | 26% - 36% | 49 - 66 | |
| Parks | | | | | | |
| Playgrounds | TCC< \$0.5M | 21% - 26% | 19% - 23% | 41% - 47% | 15 - 18 | |
| | \$0.5M <tcc<\$3m< td=""><td>13% - 17%</td><td>13% - 16%</td><td>26% - 32%</td><td>23 - 26</td><td>71</td></tcc<\$3m<> | 13% - 17% | 13% - 16% | 26% - 32% | 23 - 26 | 71 |
| | TCC> \$3M | 5% - 10% | 7% - 10% | 12% - 18% | 30 - 33 | |
| Sportfields | TCC< \$0.5M | 19% - 23% | 18% - 22% | 37% - 44% | 20 - 27 | |
| | \$0.5M <tcc<\$3m< td=""><td>15% - 18%</td><td>9% - 14%</td><td>24% - 31%</td><td>36 - 43</td><td>13</td></tcc<\$3m<> | 15% - 18% | 9% - 14% | 24% - 31% | 36 - 43 | 13 |
| | TCC> \$3M | 11% - 15% | 2% - 6% | 12% - 20% | 50 - 58 | |
| Restrooms | TCC< \$0.5M | 23% - 28% | 26% - 37% | 49% - 63% | 24 - 32 | |
| | \$0.5M <tcc<\$3m< td=""><td>31% - 37%</td><td>45% - 55%</td><td>76% - 90%</td><td>47 - 56</td><td>15</td></tcc<\$3m<> | 31% - 37% | 45% - 55% | 76% - 90% | 47 - 56 | 15 |
| | TCC> \$3M | 39% - 44% | 61% - 71% | 100% - 114% | 69 - 77 | |

Table C - CIP Delivery Data *

* The values in this Table provide an overall summary of the performance benchmarking results.

Caution is necessary in using this information as a predictive tool, particularly shaded values (R2<0.1).

** This is the number of projects that have duration information. Therefore, for some categories, this number may be less than what is shown in the Projects Distribution Matrix.

Table D - Consultants Usage and Project Delivery Percentages

| | | D | ESIGN | | | CON | STRUCTI | AN MANA | GEMEN | 1 | | PROJE | CT DELIVE | RY | |
|-------------|--------------|-------------|--------------|-------------|-------------|-------------|--------------|------------|------------|---------------|--------------|---------|-------------|------------|-------------|
| | 10H-nl | ISE | Consult | ants | Total % | In-Hou | ISe | Consult | tants | Total | In-Hol | ISe | Consult | ants | Total % |
| AGENCI | (\$) | % of DES | (\$) | % of DES | of TCC** | (\$) | % of CM | (\$) | % of CM | % of TCC** | (\$) | % of PD | (\$) | % of PD | of TCC** |
| Agency A | 17,626,190 | 71.00% | 7,203,150 | 29.00% | 19.30% | 17,835,270 | 98.60% | 260,246 | 1.40% | 16.30% | 35,461,460 | 82.60% | 7,463,396 | 17.40% | 35.60% |
| Agency B | 5,903,406 | 42.20% | 8,086,259 | 57.80% | 18.70% | 4,510,404 | 50.60% | 4,403,598 | 49.40% | 13.00% | 10,413,809 | 45.50% | 12,489,857 | 54.50% | 31.70% |
| Agency C | 19,184,993 | 81.20% | 4,432,419 | 18.80% | 14.60% | 18,483,404 | 91.40% | 1,744,186 | 8.60% | 14.90% | 37,668,397 | 85.90% | 6, 176, 605 | 14.10% | 29.60% |
| Agency D | 30,641,227 | 60.70% | 19,838,691 | 39.30% | 17.60% | 42,436,711 | 93.10% | 3,148,446 | 6.90% | 16.00% | 73,077,938 | 76.10% | 22,987,137 | 23.90% | 33.70% |
| Agency E | 1,676,636 | 39.70% | 2,546,753 | 60.30% | 19.40% | 1,800,846 | 87.60% | 254,113 | 12.40% | 16.00% | 3,477,482 | 55.40% | 2,800,866 | 44.60% | 35.40% |
| Agency F | 11,755,790 | 68.50% | 5,407,431 | 31.50% | 19.50% | 13,427,461 | 95.30% | 655,599 | 4.70% | 18.00% | 25, 183, 251 | 80.60% | 6,063,030 | 19.40% | 37.60% |
| Agency G | 8,737,811 | 62.30% | 5,298,117 | 37.70% | 16.70% | 8,077,350 | 98.90% | 91,944 | 1.10% | 13.30% | 16,815,161 | 75.70% | 5,390,061 | 24.30% | 30.00% |
| OVERALL | 95,526,053 | 64.40% | 52,812,820 | 35.60% | 17.90% | 106,571,446 | 91.00% | 10,558,132 | 9.00% | 15.80% | 202,097,498 | 87.40% | 63,370,952 | 23.90% | 33.70% |
| * TCC=Total | Construction | ר Cost (In | Icluding all | Change | Orders, C | ity Forces, | and Utilitie | es Relocat | ion). | | | | | | |

^{**} All summary DES%, CM%, PD% (as of TCC) are "Averages" of the corresponding category percentages. In-House versus Consultant rations are calculated as percentages of the "Overall" costs. Numbers may be different from the old reports due to some updates.

chapter 2

Participating Agencies





| Information | Population | Area | Website Address | Government Form | G | ⁰³⁻⁰⁴ to FY 0 | 5-06 |
|--|------------------------|-----------------|-----------------------------|---|--------------------|--------------------------|------------------------|
| Agency | | (Sq.mi.) | | | No. of FTE* | No. of Projects | Total** Value (\$M) |
| Long Beach | 461,522 | 50 | http://www.longbeach.gov | Council-Manager established as a Charter City | 81 | 74 | 102 |
| Los Angeles | 3,694,820 | 469 | http://eng.lacity.org | Mayor/Council | 200 | 307 | 1,262 |
| Oakland | 399,484 | 66.25 | http://www.oaklandpw.com | | 95 | 175 | 173 |
| Sacramento | 418,700 | 86 | http://www.pwsacramento.org | City Council-City Manager | | | |
| Department of General Services | | | | | 29 | 29 | 162 |
| Department of Transportation | | | | | 86 | 108 | 139 |
| Department of Utilities | | | | | 29 | 114 | 49 |
| San Diego | 1,277,168 | 342 | http://www.sandiego.gov | Mayor-Council- Manager | 459 ⁽¹⁾ | 864 | 677 |
| San Francisco | 801,377 | 46.7 | http://www.sfdpw.com | Mayor & Board of Supervisors (11 members) | 432 | N/A | 1,840 |
| San Jose | 926,241 | 177 | http://www.sanjoseca.gov | Mayor-Council-City Manager | 330 | 644 | 1,558 |
| * Authorized full time positions. involv | ved with delivery of (| Capital Improve | ment Projects. | | | | |

Agencies Overall Information

** Total Value equals total project cost, to be awarded during FY 2003-2004 Through FY 2005-2006, as broken down in the next section. (1) From the approved FY2004 budget, without traffic operations staff.

Page 11

CIP Projects that will be Awarded and Included in the Database (Fiscal Years 2003-2004 Through 2005-2006)

| | | | | Fiscal | Year | | | |
|----------------------------|------------|-----|------------|--------|------------|--------|------------|--------|
| Program | 2003-04 | | 2004-05 | | 2005-06 | | Total | |
| | TPC* (\$M) | No. | TPC* (\$M) | No. | TPC* (\$M) | No. | TPC* (\$M) | No. |
| I. Long Beach | 6.50 | 15 | 6.15 | 14 | 4.65 | 13 | 17.3 | 43 |
| Municipal Facilities | | | | | | | | |
| Community Development | 0.00 | 0 | 0.50 | 2 | 0.50 | ~ | 1.00 | 4 |
| Public Facilities | 0.50 | 4 | 0.35 | 2 | 0.15 | 2 | 1.00 | 8 |
| Streets | | | | | | | | |
| Public Thoroughfares | 3.00 | ω | 4.00 | 7 | 3.00 | ω | 10.00 | 23 |
| Pipes | | | | | | | | |
| Storm Drains | 2.00 | - | 0.30 | - | 0.00 | 0 | 2.30 | 2 |
| Parks | | | | | | | | |
| Parks, Recreation & Marine | 1.00 | 7 | 1.00 | 7 | 1.00 | 2 | 3.00 | 6 |
| II. Los Angeles | 255.20 | 115 | 444.70 | 122 | 561.60 | 20 | 1261.50 | 307 |
| Municipal Facilities | | | | | | | | |
| Animal Bond | 0.00 | 0 | 81.80 | 7 | 0.00 | 0 | 81.80 | 7 |
| Fire Bond | 84.50 | 7 | 40.10 | 7 | 23.50 | 4 | 148.10 | 18 |
| Library Bond | 0.00 | 0 | 5.00 | ~ | 0.00 | 0 | 5.00 | 1 |
| Municipal Facilities | 19.90 | 1 | 24.60 | 6 | 219.90 | က | 264.40 | 23 |
| Police (Prop Q) | 0.00 | 0 | 98.10 | 5 | 218.50 | 5 | 316.60 | 10 |
| Recreational Fac (Prop K) | 36.70 | 25 | 30.80 | 20 | 38.80 | 17 | 106.30 | 62 |
| Seismic Bond | 1.80 | 2 | 5.00 | ~ | 0.00 | 0 | 6.80 | с С |
| Zoo Bond | 32.40 | 5 | 0.00 | 0 | 0.00 | 0 | 32.40 | 5 |
| Streets | | | | | | | | |
| Bridge Improvement | 14.10 | 1 | 13.10 | ω | 30.10 | 12 | 57.30 | 31 |
| Street Program | 10.20 | 7 | 46.90 | 24 | 21.90 | 14 | 79.00 | 45 |
| Pipes | | | | | | | | |
| Stormwater Program | 4.20 | 26 | 8.80 | 19 | 6.00 | 12 | 19.00 | 57 |
| Wastewater Program | 51.40 | 21 | 90.50 | 21 | 2.90 | с С | 144.80 | 45 |

| | | | | Ficnal | Voar | | | |
|----------------------------------|------------|-----|------------|---------|------------|--------|------------|-----|
| | | | | 1 19001 | I cal | | | |
| Program | 2003-04 | | 2004-05 | | 2005-06 | | Total | |
| | LPC* (\$M) | No. | TPC* (\$M) | No. | TPC* (\$M) | No. | TPC* (\$M) | No. |
| III. Oakland | 58.24 | 60 | 50.49 | 53 | 64.11 | 62 | 172.84 | 175 |
| Municipal Facilities | 11.82 | 9 | 11.10 | 5 | 21.50 | 6 | 44.42 | 20 |
| Streets | 26.09 | 41 | 20.90 | 37 | 18.81 | 33 | 65.80 | 111 |
| Pipes | 11.91 | 9 | 10.48 | 3 | 7.80 | 5 | 30.19 | 14 |
| Parks | 8.43 | 7 | 8.00 | ∞ | 16.00 | 15 | 32.43 | 30 |
| IV. Sacramento | 158.29 | 149 | 120.61 | 102 | 70.85 | 48 | 349.74 | 299 |
| Municipal Facilities | 73.18 | 26 | 62.72 | 36 | 26.00 | 17 | 161.90 | 79 |
| Streets | 70.61 | 83 | 40.39 | 25 | 27.75 | 0 | 138.75 | 108 |
| Pipes | 14.50 | 40 | 17.50 | 41 | 17.10 | 31 | 49.10 | 112 |
| V. San Diego | 224.93 | 226 | 229.78 | 218 | 324.58 | 410 | 779.29 | 864 |
| Municipal Facilities | | | | | | | | |
| Community & Economic Development | 2.11 | ~ | 0.96 | 0 | 2.23 | ~ | 5.30 | 4 |
| Environmental Services | 3.40 | 7 | 4.25 | ო | 6.97 | 5 | 14.62 | 12 |
| Planning | 0.01 | 0 | 0.00 | 0 | 00.0 | 0 | 0.01 | 0 |
| Police | 4.81 | 4 | 7.55 | 9 | 8.95 | 7 | 21.31 | 17 |
| QUALCOMM Stadium | 0.38 | 0 | 0.30 | 0 | 0.30 | 0 | 0.98 | 0 |
| San Diego Fire-Rescue | 5.24 | 4 | 14.68 | 12 | 17.15 | 14 | 37.06 | 30 |
| Streets | | | | | | | | |
| Community & Economic Development | 2.11 | с | 0.96 | ~ | 2.23 | с С | 5.30 | 7 |
| Engineering & Capital Projects | 22.95 | 32 | 50.51 | 72 | 74.96 | 107 | 148.42 | 211 |
| Park & Recreation | 00.00 | 0 | 0.24 | 0 | 00.00 | 0 | 0.24 | 0 |
| Planning | 0.01 | 0 | 0.00 | 0 | 00.0 | 0 | 0.01 | 0 |
| Transportation | 61.93 | 88 | 1.08 | 1 | 11.04 | 15 | 74.05 | 105 |
| Pipes | | | | | | | | |
| Metropolitan Wastewater | 70.45 | 32 | 99.68 | 45 | 87.71 | 39 | 257.84 | 117 |
| Water | 40.77 | 18 | 33.51 | 15 | 65.13 | 29 | 139.41 | 63 |
| Parks | | | | | | | | |
| General Services | 1.41 | 5 | 1.50 | 5 | 0.41 | - | 3.31 | 13 |
| Park & Recreation | 9.37 | 37 | 14.58 | 58 | 47.50 | 189 | 71.44 | 285 |

| | | | | Fiscal | Year | | | |
|----------------------|------------|--------|------------|--------|------------|-----|------------|-------|
| Program | 2003-04 | | 2004-05 | | 2005-06 | | Total | |
| | TPC* (\$M) | No. | TPC* (\$M) | No. | TPC* (\$M) | No. | TPC* (\$M) | No. |
| VI. San Francisco | 257.02 | 46 | 269.40 | 46 | 301.10 | 43 | 827.70 | 135 |
| Municipal Facilities | 121.00 | с С | 91.10 | 7 | 208.20 | 15 | 420.30 | 29 |
| Streets | 16.30 | 6 | 95.40 | 13 | 21.00 | 10 | 132.70 | 32 |
| Pipes | 7.00 | 16 | 4.90 | ω | 4.90 | ω | 16.80 | 32 |
| Parks | 112.90 | 18 | 78.00 | 14 | 67.00 | 10 | 257.90 | 42 |
| VII. San Jose | 709.43 | 342 | 542.17 | 162 | 306.68 | 140 | 1558.29 | 644 |
| Municipal Facilities | | | | | | | | |
| Public Safety Bond | 4.21 | 4 | 71.81 | 7 | 50.56 | 16 | 126.58 | 31 |
| Library Bond | 20.07 | 7 | 45.94 | 4 | 19.74 | 7 | 85.74 | ω |
| Civic Center | 48.03 | с С | | | 0.00 | 0 | 18.03 | n |
| Airport Master Plan | 19.13 | 4 | 331.83 | 6 | 1.17 | ~ | 352.13 | 14 |
| Others | 2.27 | 3 | 38.44 | 3 | 0.00 | 0 | 40.71 | 6 |
| Streets | | | | | | | | |
| Traffic | 57.57 | 69 | 45.85 | 36 | 20.84 | 4 | 124.25 | 109 |
| Airport Master Plan | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 00.00 | 0 |
| Pipes | | | | | | | | |
| Water | 0.44 | 7 | 37.56 | 6 | 0.00 | 0 | 38.00 | 1 |
| Wastewater | 48.35 | 19 | 91.06 | 10 | 40.55 | 9 | 179.96 | 35 |
| Storm Drainage | 0.00 | 0 | 5.63 | 4 | 0.00 | 0 | 5.63 | 4 |
| Parks | | | | | | | | |
| Parks/Rec Facilities | 52.98 | 31 | 28.78 | 31 | 103.21 | 8 | 184.97 | 70 |
| Total All Agencies | 1213.40 | 748 | 1818.01 | 672 | 1562.94 | 683 | 4564.36 | 2,114 |
| | | | | | | | | |

* TPC = Total Project Cost (in \$ Million) including all hard construction costs and all soft costs associated with project delivery, to be awarded within a given fiscal year.

Page 14

chapter 3

Best Management Practices Implementation









JAS DE

16

CHAPTER Best Management Practices Implementation

A. INTRODUCTION

T is the goal of this continuing study to develop hard data which documents that the implementation of certain project delivery processes, Best Management Practices, results in improved project delivery performance. This is a complex goal.

The study began in 2002 by gathering data on project delivery performance (239 projects completed between 1996 and 2001) from the records of the participating agencies. The study went on to identify what project delivery processes were used to deliver those projects and what processes might be implemented to improve project delivery on future projects.

During 2003 and 2004, many of the seven agencies have implemented Best Management Practices. The implementation of the practices has been tracked and project delivery performance data continues to be collected. It is anticipated that performance data will eventually demonstrate that as Best Management Practices were implemented, project delivery costs were reduced. However, obtaining the empirical evidence of this trend is expected to take several years.

B. MOVING TOWARD LINKING BMP IMPLEMENTATION TO IMPROVED PERFORMANCE

I. Progress to May 2004

The seven agencies are actively committed and share the objective of reducing capital project delivery costs. In the first year of the study, the

agencies identified 98 Best Management Practices related to planning, design, quality assurance, construction management, project management, and consultant selection and use. While many of these practices were already commonly used, 39 were used by the agencies only partially or not at all. These 39 practices were targeted for implementation to increase project delivery efficiency. During the second year of the study, 2003, the agencies began making organizational changes needed to adopt the Recommended Best Management Practices. In addition, each participant identified a timeline for full implementation of practices that would improve their agencies' ability to deliver projects. An implementation log was prepared to document the direction, commitment, and future progress of each participant. Beginning in the fall of 2003 and through May of 2004, the agencies made BMP implementation progress as follows:

Long Beach

- Feasibility Studies are now standard procedure on all CIP projects not related to maintenance.
- A standard project schedule and status report format is used on all projects and is available online to department managers.
- Change Orders are classified by type; Differing Site Conditions, Errors & Omissions, Owner requested changes, Contractor Requests, and Other.
- Bid Announcements are made available online.

Los Angeles

- Post Project reviews are now performed and used to capture "lessons learned" on each project.
- Change Orders are classified by type; Differing Site Conditions, Errors & Omissions, Owner Requested Changes, Contractor Requests, and Other.
- Bid Announcements are made available online.

Oakland

- There is a Master Schedule attached to the CIP that identifies project start and finish dates.
- City is training in-house staff to use Green Building Standards.
- 15% is set aside for a construction change order contingency.
- A team building process is used for projects greater than \$5 million.
- Change Order approval authority is delegated to the departments in order to reduce paperwork.
- An in-house project management team has been created for small projects.
- A standard Project Control System has been adopted and is in use on all projects.

Sacramento

- The delivery of smaller projects (under \$250,000 in construction value) has been streamlined by establishing a special project delivery team and processes more appropriate for smaller projects.
- Contracting procedures for "Design-Build" projects have been developed.
- Regular reports (every 3 to 4 months) in

a standard format on project progress are provided to the City Council.

The use of "on-call" consultant contracts has been expanded.

San Diego

- The "CityWorks" GIS based project information system was implemented and put in service for internal City coordination of CIP projects.
- Initial investigations into Project Prioritization & Resource Loading were completed.
- For Water & Sewer, the "AutoSpec" program was converted from the previous paradox format. Enhanced features were added. It is planned to institute this in other divisions' work (Transportation, etc) as well.
- Enhancement and further standardization of the Primavera project control system Department wide.

San Francisco

- The "AutoDocs" program, a computerized tool used to create front end documents, has been improved by adding a graphical interface for users.
- The use of electronic forms and electronic communications to facilitate and expedite project delivery actions (advertisement, award, bid analysis), has been expanded.
- An electronic filing system for project documents has been developed.
- A GREEN Building training program has been implemented for department staff.
- Standard Plans and Specifications have been updated.

San Jose

- Specific design standards for certain types of projects including fire stations, community policing centers, emergency generators, libraries and community centers have been developed.
- A LEED training and certification program has been established for department staff.
- A pre-qualification program for contractors bidding City work has been established for projects with a value in excess of \$10 Million.

From the above, it can be seen that the agencies put process implementation emphasis on Project Management and Construction Management fundamentals during the period 2003 to 2004.

II. BMP's Implementation Plan for May 2004 to May 2005

In 2004, the project team updated the implementation log by indicating which processes had been completely implemented and which were each Agency's current top five implementation priority.

Table E-1 provides a list of the management practices that were identified as either common or recommended best practices during the course of this study, excluding the common best management practices that were fully implemented by all agencies. The top five priorities of each agency are as follow:

Long Beach

Priority #1 – Provide design and construction resource loading for CIP projects

Priority #2 - Define requirements for reliabil-

ity, maintenance, and operation prior to design initiation

Priority #3 – Use a formal Quality Management System

Priority #4 – Make bid documents available online

Priority #5 – Adopt and use a Project Control System on all projects

Los Angeles

Priority #1 - Classify types of change orders

Priority #2 – Perform and use Post Project Reviews to identify lessons learned

Priority #3 – Make bid documents available online

Priority #4 – Perform a formal Value Engineering Study for projects larger than \$1,000,000

Oakland

Priority #1 – Delegate authority to the PW Director/City Engineer to approve consultant contracts under \$250,000, when a formal RFP selection process is used

Priority #2 – Establish construction award limits to support award by the director without Board approval

Priority #3 – Show projects on a Geographical Information System

Priority #4 – Ensure capital projects are well defined with respect to scope and budget at the end of the planning phase

Priority #5 –Establish a pre-qualification process for contractors on large, complex projects

Sacramento

Department of General Services:

Priority #1 – Have a Board/Council project prioritization system

Priority #2 – Develop and use a standardized Project Delivery Manual

Priority #3 – Involve the Construction Management Team before completion of design

Priority #4 – Provide formal training for Project Managers on a regular basis

Priority #5 – Create in-house project management team for small projects

Department of Transportation:

Priority #1 – Develop and use a standardized Project Delivery Manual

Priority #2 – Use formal Quality Management System

Priority #3 – Provide formal training for project managers on a regular basis

Priority #4 – Perform and use post project reviews to identify lessons learned

Priority #5 – Involve the construction management team before the completion of design

Department of Utilities:

Priority #1 – Delegate contract awards below council-level under \$1 million

Priority #2 – Develop and use a standardized Project Delivery Manual

Priority #3 – Perform and use Post Project Reviews to identify lessons learned

Priority #4 – Adapt successful designs to project

sites, whenever possible (e.g. fire stations, gym-nasiums, etc.)

Priority #5 – Adopt and use a Project Control System on all projects

San Diego

Priority #1 – Implement a Board/Council project prioritization system

Priority #2 – Provide design and construction resource loading for CIP projects

Priority #3 – Complete Feasibility Studies on projects prior to defining budget and scope

Priority #4 – Ensure capital projects are well defined with respect to scope and budget at the end of the planning phase

Priority #5 – Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start

San Francisco

Priority #1 – Use a formal Quality Management System

Priority #2 – Implement and use a consultant rating system that identifies quality of consultant performance

Priority #3 – Make bid documents available online

Priority #4 – Show projects on a Geographical Information System

Priority #5 –Establish a pre-qualification process for contractors on large, complex projects

San Jose

Priority #1 – Implement and use a consultant rating system that identifies quality of consultant performance

Priority #2 – Classify types of change orders

Priority #3 – Perform and use Post Project Reviews to identify lessons learned

Priority #4 – Provide design and construction resource loading for CIP projects

Priority #5 – Make bid documents available online

From the above, it can be seen that the agencies have elected to put the process implementation emphasis on Planning, Construction Management, and Quality Assurance practices during the period between 2004 and 2005.

| ICES | |
|---------------|---------|
| PRACT | |
| JENT F | (0 |
| IAGEN | RITIES |
| T MAN | 5 PRIO |
| F BES | , TOP (|
| TION O | NCIES |
| ENTAI | AGE |
| PLEM | AND |
| 1 – M | |
| ble E-1 | |
| La | |

| Process Category | Ref.* | Best Management Practice | ۲V | LB | У | sc | SD | SF | SJ | Notes |
|---------------------|---------------|--|------|------------|-------------|-----------------------|------------|------------|-------|---|
| Planning | 1.a. | Define Capital projects well with respect to scope and budget including community and client approval at the end of the planning phase | > | > | 2004 (4) | > | PI 2004 | > | > | SD: Some Divisions only |
| | 1.b. | Complete Feasibility Studies on projects prior to defining budget and scope | > | > | > | > | PI 2004 | > | > | LB: When applicable SD: Result of CIP Benchmarking SF: When applicable SJ: Some exceptions |
| | 1.d. | Have a Board/Council project prioritization system | ΪŻ | Īž | ž | a ⊖ ≻ S:⊖ TS: ✓ | 2004 © | Z | Ň | SD: Result of CIP Benchmarking SC: Done for Transportation. Will do for Facilities in 2004 |
| | 1.e. | Provide design and construction resource loading for CIP projects | > | 2005 () | > | 2004 TS: 2005 | 2004 | ž | ₫ ⊕ | SD: Result of CIP Benchmarking SJ: Staffing model (including Consultants submitted to Budget) |
| | 1.f. | Have a Master Schedule attached to the CIP that identifies start and finish dates for projects | > | 2005 | > | > | Īž | I/N | > | |
| | 1.i. | Show Projects on a Geographical Information System | > | > | 2004 ③ | > | > | TBD (4) | > | LB: Infrastructure only |
| Design | 2.b. | Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start | > | > | > | > | PI 5004 | > | > | |
| | 2.f. | Define requirements for reliability, maintenance, and operation prior to design initiation | > | 2004 © | ĪZ | 2004 TS: 🗸 | ਙ | > | > | SD: Some Divisions only (Rest N/I) |
| | 2.i. | Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc.) | > | > | > | ≻ .:1 | ਙ | > | > | SD: Some Divisions only , where applicable |
| | A/A | Train in-house staff to use Green Building Standards | > | TBD | Ъ | > | > | > | > | This BMP was found to improve client satisfaction (quality) and may not reduce project delivery cost directly. SF: When applicable |
| | N/A (2004) | Limit Scope Changes to early stages of design | 2006 | 2005 | 2005 | TS: PI | 2005 | 2005 | 2005 | |
| | N/A (2004) | Scope Changes during design must be accompanied by Budget and Schedule approvals | 2006 | 2005 | 2005 | TS: PI | 2005 | 2005 | 2005 | |
| incitoriation! | | | | | | | | - | 00000 | |

Instructions:

\[
\lambda]: Has been implemented
\]

PI: Partially implemented

yyyy: Will be implemented in calendar year "yyyy", \otimes = Priority x for implementation N/I: No plans to implement at this time

TBD: To be determined

*Reference to Process Questionnaire in Appendix C of 2002 Report. ** Sacramento Department of Utilities has different Implementation history. The top 5 priorities are accurate.

| | | AND AGENCIES | , TC | P 5 | PR | IOR | | 2 | | | |
|-----------------------------------|----------|---|-------------|-----------|-----------|----------------------|------------|-------------------|---------------|---|---|
| Process Category | Ref.* | Best Management Practice | ΓA | LB | ОК | sc | SD | SF | SJ | lotes | |
| Quality Assurance / Quality | 3.I.a. | Develop and use a standardized Project Delivery Manual | > | 2005 | 2005 6 | 2005 GS:@ UT:@ | ਙ | > | > | C: Started in 2003 D: incorporated into PM training manual and tandard primavera schedule template / escrintions Details available, as meeded | |
| Control | 3.II.b. | Perform a formal Value Engineering Study for projects larger than \$1,000,000 | 2005 (4) | > | ž | > | > | > | 2004 | A. For projects > \$1 million B: On an as-needed bases C: For projects > \$5 million F: On an as-needed basis J: For projects > \$5 million | 1 |
| | 3.III.a. | Use a formal Quality Management System | > | 2005 © | ž | ਙ | PI 2005 | £ G <u>a</u> ⊖ | 2004 | D: Some Divisions only | |
| | 3.III.b. | Perform and use Post Project Reviews to identify lessons learned | 2004 2 | TBD | > | UT: TS:PI | > | > | ⊡ © | F: On selected projects D: On selected projects | |
| Construction Management | 4.I.a. | Delegate authority to the City Engineer/Public Works Director or other departments to approve change orders to the contingency amount | > | > | > | 2004 TS: N/I | > | > | > | .F: At Bureau level J: Individual C.O. < \$100,000 D: Individual C.O. < \$200,000 | |
| | 4.l.m. | Classify types of change orders | 2004 © | 2005 | > | > | PI 2004 | > | 2004 | D: Only for scope changes versus other types | 1 |
| | 4.II.a. | Include a formal Dispute Resolution Procedure in all contract | > | N/N | > | \ | \ | | | | |
| | 4.III.a. | Use a team building process for projects greater than \$5 million. | > | > | > | > | > | > | > | B: As-needed D: As-needed F: As-needed J: Formal process for projects > \$10 million | |
| | 4.IV.a. | Involve the Construction Management Team before completion of design | > | 2004 | > | PI GS:③ TS:PI | > | > | > | .D: Some Divisions only | 1 |
| Instructions: | | | | | | | | LA: LA: | end: Los ⊿ | ngeles SD: San Diego | |
| √: Has been im | plemen | nted | | | | | | Ë | Long | Beach SF: San Francisco | |
| PI: Partially imp | vlement | ied in the second se | | | | | | ХО | Oakl | and SJ: San Jose | |
| /yyy: Will be im | nplemer | nted in calendar year "yyyy", \otimes = Priority x for i | impleı | menta | tion | | | SC: | Sacr | imento | |
| V/I: No plans to | implen | nent at this time | | | | | | GS: | SAC | Department of General Services | |
| TBD: To be det | erminec | 7 | | | | | | TS: | SAC. | Department of Transportation | |
| *Reference to P | rocess | Questionnaire in Appendix C of 2002 Report. | | | | | | Ë | SAC. | Department of Utilities | |

Table E-1 — IMPLEMENTATION OF BEST MANAGEMENT PRACTICES

*Reference to Process Questionnaire in Appendix C of 2002 Report. ** Sacramento Department of Utilities has different Implementation history. The top 5 priorities are accurate.

| Process Category | Ref.* | Best Management Practice | LA | LB | У | sc | SD | SF | SJ | Notes |
|--|---------------|--|------|------|-----------|------------------------|-----------|------------|----------------------------|--|
| Construction Management (Cont'd) | N/A (2003) | Delegate contract awards below council below \$1 million | > | > | > | N/I UT:() TS:N/I | > | > | > | |
| | N/A (2003) | On large complex projects establish a pre-qualification process for contractors | > | ž | 2004 G | > | > | E G | > | |
| | N/A | Make bid documents available online | 2004 | 2004 | I/N | I/N | ⊾ | TBD | ⊒ | SD: System options being evaluated |
| | (2003) | | 6 | 4 | - | rs: 2005 | TBD | 6 | 6 | |
| Project Management | 5.I.f. | Assign a client representative to every project | > | > | > | > | PI TBD | > | > | SD: Only for large projects |
| | 5.II.a | Provide formal training for Project Managers on a regular basis | > | 2004 | > | 2003 | > | > | > | SD: Yearly PM academy, as funds allow |
| | | | | | | GS:(4) TS:PI | | | | |
| | 5.III.a. | Adopt and use a Project Control System on all projects | | 2004 | ₫ | Ы | | > | > | SD: Project controls incorporated into Primavera |
| | | | • | 6 | | UT: ⑤ | | | | schedule |
| | N/A | Create in-house project management team for small projects | I/N | I/N | ⊒ | 2003 | ⊒ | ΪŹ | > | SD: Some Divisions only |
| | (2003) | | | | | GS:G TS:N/I | TBD | | | |
| | N/A (2004) | Institutionalization of Project Manager performance and accountability | 2006 | 2005 | 2005 | 2005 | 2005 | 2005 | 2005 | SD: Only non- standardized goals |
| Consultant Selection and | 6.c. | Include a standard consultant contract in the RFQ/RFP with a standard indemnification clause | > | > | > | > | PI TBD | > | > | SD: Some Divisions only |
| Use | 6.e. | Delegate authority to the PW Director/City Engineer to approve consultant contracts under \$250,000, when a formal RFP selection process is used | ľz | ž | 2004 © | I/Z | > | > | I/N | |
| | 6.g. | Implement and use a consultant rating system that identifies quality of consultant performance | > | ž | > | 2004 TS:N/I | > | () TBD | 2004 © | |
| Instructions: | | | | | | | | LA: LA: | <mark>end:</mark> Los A | ngeles SD: San Diego |

✓: Has been implemented

PI: Partially implemented

yyyy: Will be implemented in calendar year "yyyy", \otimes = Priority x for implementation

GS: SAC. Department of General Services

SC: Sacramento

LA: Los Angeles LB: Long Beach OK: Oakland TS: SAC. Department of Transportation UT: SAC. Department of Utilities

SF: San Francisco SJ: San Jose

N/I: No plans to implement at this time

TBD: To be determined

** Sacramento Department of Utilities has different Implementation history. The top 5 priorities are accurate. *Reference to Process Questionnaire in Appendix C of 2002 Report.

C. CHALLENGES TO LINKING PROCESSES TO PERFORMANCE

The task of linking changes in processes to changes in performance is challenging. In planning for this exercise, the study team noted the following:

- Quality of the Cost Data While the seven agencies have standardized project delivery data reporting, data collection has not been standardized. Each agency collects data using a cost coding system that may be subject to the common errors of mis-coding or "extended" coding of time to specific project task codes. ("Extended" coding is defined as allocating time to a project task code when the task may be complete but another code may not [yet] be available.) The study team has implemented a procedure to re-run data on projects contributed by each agency to verify and/or correct cost information.
- Lag between implementation and improvement (learning curves, project lead times, etc.) The implementation of Best Management Practices does not result in immediate improved performance. There is a lag between management adopting processes destined to improve performance that can be attributed to the time it takes for staff to learn and apply the processes at the project level. It also takes time to become proficient in the new processes and additional time to see the results in the projects affected which may not be completed for many months.
- Costs of Implementation There may be significant expenses associated with the implementation of new processes by any organization. Agencies may not be able to commit the training, staff, and equipment costs immediately to fully implement a beneficial process.

D. MEASURING THE IMPACT OF CHANGE

The above items may continue to challenge the team's ability to link changes in project delivery costs that result from process change. However, a culture has been created among the seven participating agencies of routinely examining project delivery cost that, in itself, has started to improve project delivery and reduce costs.

It is anticipated that the linking of process implementation to performance improvement will take at least five years. However, the methods of measurement must be planned now. In order to do so, the following must be considered:

- What are the performance objectives for the Design and Construction Management Phases?
- Can the influence of process implementation on performance be measured incrementally or globally?

There is also a distinction that must be made between processes and practices. The implementation of a process within an agency will be followed by a lag time until the process is fully employed and becomes a common practice for all projects within the agency.

Finally, the data does not provide for linking of specific process implementation to specific project performance. A project-specific of this kind is not only impractical, but also unnecessary, since it is the aim of this study to identify and globally implement best management practices that will improve project delivery.

E. INITIAL STAGES OF LINKING PROCESSES TO PERFORMANCE

During the *Update 2004* study, the project team identified a statistical technique that could be used in the future updates to identify and measure the impacts of Best Management Practice implementation upon performance.

The technique requires that Agencies rate their Best Management Practice implementation progress as shown in Table E-2. A comparison between these ratings and the agencies' original ratings (reflected in the 2002 Study report) denotes BMP's implementation progress.

| Table E-2 — BEST MANAGEMENT PRACTICES IMPLEMENTATION RATING |
|---|
| (UPDATE 2004) |

| Process | Ref * | Best Management Practice | LA | LB | ок | | SC | | SD | SE | SI |
|-------------------------|---------------|--|----|----|----|----|-------|------|----|----|----|
| Category | i.el. | | | | | GS | Trnsp | Util | 00 | | 00 |
| Planning | 1.a. | Define Capital projects well with respect to scope and budget including community and client approval at the end of the planning phase | 5 | 2 | 5 | 2 | 5 | 4 | 1 | 5 | 4 |
| | 1.b. | Complete Feasibility Studies on projects prior to defining budget and scope | 5 | 1 | 1 | 2 | 5 | 2 | 1 | 5 | 2 |
| | 1.d. | Have a Board/Council project prioritization system | 0 | 0 | 2 | 0 | 5 | 2 | 1 | 0 | 0 |
| | 1.e. | Provide design and construction resource loading for CIP projects | 5 | 0 | 0 | 1 | 3 | 0 | 1 | 0 | 4 |
| | 1.f. | Have a Master Schedule attached to the CIP that identifies start and finish dates for projects | 5 | 0 | 1 | 2 | 5 | 4 | 0 | 0 | 5 |
| | 1.i. | Show Projects on a Geographical Information System | 5 | 3 | 0 | 4 | 5 | 5 | 5 | 3 | 5 |
| Design | 2.b. | Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start | 5 | 3 | 5 | 2 | 5 | 5 | 1 | 5 | 4 |
| | 2.f. | Define requirements for reliability, maintenance, and operation prior to design initiation | 5 | 2 | 2 | 2 | 3 | 4 | 1 | 3 | 3 |
| | 2.i. | Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc.) | 5 | 3 | 1 | 4 | 5 | 3 | 3 | 4 | 3 |
| | N/A (2004) | Limit Scope Changes to early stages of design | 4 | 1 | 0 | 1 | 3 | 3 | 1 | 3 | 0 |
| | N/A (2004) | Ensure that scope changes during design are accompanied by Budget and Schedule approvals | 5 | 3 | 5 | 3 | 5 | 3 | 1 | 3 | 3 |
| Quality | 3.I.a. | Develop and use a standardized Project Delivery Manual | 5 | 0 | 2 | 2 | 2 | 2 | 3 | 3 | 4 |
| Assurance / Quality | 3.II.b. | Perform a formal Value Engineering Study for projects larger than \$1,000,000 | 1 | 4 | 1 | 3 | 5 | 2 | 1 | 2 | 1 |
| Control | 3.III.a. | Use a formal Quality Management System | 5 | 1 | 0 | 0 | 4 | 0 | 2 | 3 | 1 |
| | 3.III.b. | Perform and use Post Project Reviews to identify lessons learned | 5 | 1 | 3 | 3 | 5 | 3 | 1 | 3 | 3 |
| Construction Manage- | 4.I.a. | Delegate authority to the City Engineer/ Public Works Director or other departments to approve change orders to the contingency amount | 5 | 5 | 5 | 1 | 3 | 4 | 3 | 5 | 5 |
| ment | 4.l.m. | Classify types of change orders | 2 | 4 | 5 | 5 | 5 | 5 | 4 | 5 | 1 |
| | 4.II.a. | Include a formal Dispute Resolution Procedure in all contract agreements | 5 | 0 | 5 | 5 | 5 | 5 | 5 | 0 | 1 |
| | 4.III.a. | Use a team building process for projects greater than \$5 million. | 5 | 4 | 2 | 4 | 5 | 3 | 4 | 2 | 3 |
| | 4.IV.a. | Involve the Construction Management Team before completion of design | 5 | 3 | 5 | 3 | 3 | 4 | 4 | 4 | 5 |
| | N/A (2003) | Delegate contract awards below council level under \$1 million | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 0 |
| | N/A (2003) | Establish a pre-qualification process for contractors on large, complex projects | 5 | 0 | 3 | 4 | 3 | 5 | 2 | 2 | 5 |
| | N/A (2003) | Make bid documents available online | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 |
| Project | 5.I.f. | Assign a client representative to every project | 5 | 5 | 5 | 4 | 5 | 4 | 1 | 5 | 5 |
| Manage- | 5.II.a | Provide formal training for Project Managers on a regular basis | 5 | 2 | 5 | 3 | 5 | 1 | 3 | 5 | 2 |
| ment | 5.III.a. | Adopt and use a Project Control System on all projects | 5 | 3 | 0 | 0 | 3 | 0 | 5 | 4 | 5 |
| | N/A (2003) | Create in-house project management team for small projects | 1 | 0 | 0 | 4 | 4 | 3 | 1 | 0 | 4 |
| | N/A (2004) | Institute Project Manager performance and accountability | 1 | 0 | 0 | 1 | 3 | 5 | 1 | 2 | 3 |
| Consultant Selection | 6.c. | Include a standard consultant contract in the RFQ/RFP with a standard indemnification clause | 5 | 5 | 5 | 5 | 5 | 3 | 3 | 5 | 4 |
| and Use | 6.e. | Delegate authority to the PW Director/City Engineer to approve consultant contracts under \$250,000, when a formal RFP | 0 | 0 | 0 | 0 | 0 | 3 | 5 | 5 | 0 |
| | 6.g. | Implement and use a consultant rating system that identifies quality of consultant performance | 5 | 0 | 0 | 1 | 3 | 1 | 4 | 0 | 5 |
| Implementation | on Scale: | Legend: | | | | | | | | | |

0 = No / Never

3: Up to 60% 1: Up to 20% 4: Up to 80%

5: More than 80%

2: Up to 40% (OR AS DIFFERENT DEFINITION APPLICABLE)

LA: Los Angeles LB: Long Beach OK: Oakland

SD: San Diego SF: San Francisco SJ: San Jose

SC: Sacramento (GS: General Services, Trnsp: Transportation, Util: Utilities)

* Reference to Process Questionnaire in Appendix C of 2002 Report. N/A: Was added in a later year (2003 or 2004, as indicated)

Agencies' performance improvement can be measured using the project delivery percentage data. This data, however, had to be screened so that similar size projects were used as the basis of this linking analysis. A statistical computer algorithm was developed to normalize project sizes during the past three years. Appendix D provides details of this technique.

As Table F-1 shows, about 25% of the data are eliminated (for the linking analysis only) as a result of this technique.

| Update | Total # of Projects | # of Projects Remained | % Deleted |
|--------|------------------------|---------------------------|--------------|
| 2002 | 154 | 92 | 40.3% |
| 2003 | 224 | 203 | 9.4% |
| 2004 | 217 | 153 | 31.1% |
| Total | 595 | 448 | 25.3% |

Table F-1 — Project Size Normalization Impacts on the Number of Projects

The impacts of the project size normalization technique on the project data is summarized in Table F-2. It is observed that agencies' data became more similar and the differences decreased within the three years of data. This technique will be used in the future updates to look at ways to start linking processes to performance.

| | Project Deliv | very (% of To | tal Construc | tion Cost) |
|--------------|-------------------------------|---------------------------|---------------------------|---------------------------|
| Agency | All Updates (595 Projects) | Data Collected 2002 | Data Collected 2003 | Data Collected 2004 |
| Agency A | 35.47% | 40.15% | 37.71% | 30.67% |
| Agency B | 32.67% | 32.14% | 33.44% | 31.93% |
| Agency C | 30.69% | 31.34% | 29.57% | 34.65% |
| Agency D | 34.16% | 29.46% | 36.54% | 34.61% |
| Agency E | 32.16% | 18.19% | 32.91% | 40.34% |
| Agency F | 37.6% | 34.95% | 36.39% | 42.00% |
| Agency G | 29.86% | N/A | 30.64% | 28.32% |
| ALL AGENCIES | 34.50% | 33.58% | 33.85% | 35.92% |

Table F-2 — Project Size Normalization Impacts on the Project Delivery Percentages

In a Second Stage of data normalization, the project team accounted for Agencies Overhead factors changes, as reflected in Appendix E. As an example, if the Overhead factor had increased 20% between 2002 and 2004, the Project Delivery % for 2004 should be divided by 1.20 in order to have the same basis as 2002. The results of Overhead Factor Normalization are provided in Table F-3.

It is noteworthy that the changes in overhead factors were insignificant for all agencies and this kind of normalization is not necessary at this time. The proposed method may be applied at a future year, if significant changes are observed in one or more Agency's Overhead Factors.

| | Project Deliver | y (% of Total Con | struction Cost) |
|----------|-----------------|----------------------|-----------------|
| Agency | Table F-2 | Adjustment Factor | Adjusted |
| Agency A | 30.67% | 0.95 | 29.14% |
| Agency B | 31.93% | 0.83 | 26.50% |
| Agency C | 34.65% | 1.00 | 34.65% |
| Agency D | 34.61% | 0.99 | 34.26% |
| Agency E | 40.34% | 1.00 | 40.34% |
| Agency F | 42.00% | 1.00 | 42.00% |
| Agency G | 28.32% | 1.03 | 29.17% |
| ALL | 35.92% | 0.95 | 34.12% |

Table F-3 — Overhead Factors Normalization Impacts on the Update 2004 Project Delivery Percentages

* See Appendix E for derivation of the Adjustment Factors

Table E-2 and F-3 are the basis of the multi-parameter regression for the linking analysis. As shown in Table F-4, each BMP rate change is defined as an independent variable X_i and the Project Delivery % reduction is the dependent variable (Y). Obviously the BMPs that were not rated at some point (2002 or 2004) cannot be included in the analysis (shown as N/A in table F-4). The regression model will have the form of $Y=b+\sum a_i X_i$, where all a_i 's and b can be defined using the sets of data in Table F-4. A statistical Analysis Of Variance (ANOVA) can be used to verify the significance and measure the effect of each X_i (Best Management Practice) on Y (Project Delivery %).

At this time, only seven sets of data (number of agencies) are available for this multi-parameter regression. In order to make this technique useful, the number of data sets should be increased. This goal can be achieved either by adding new participants or by rating each of the BMPs for each of the 14 project classifications separately (i.e. 14 copies of Table E-2). That would enhance the number of data sets to 14x7=98 which is a good pool of data. This is achievable if a sufficient number of projects is provided in each classification, as is the plan for the future updates.

It is also observed in Table F-4 that the Project Delivery % had an increasing trend for five of the agencies, from 2002 to 2004. When a decreasing (improvement) trend of Project Delivery % for all agencies is observed, the proposed model may be implemented to link processes to performance.

| | | Agency* | | | | | | | |
|---------------|---|-------------------|-----|------|------|-----|-----|-----|-----|
| | | | Α | В | С | D | Е | F | G |
| PD% In | nproved (2004 _{ADJUSTED} – 2002) : | Y | 11 | 0.2 | -3.3 | -5 | -22 | -4 | 1.5 |
| Ref. | Best Management Practice | RATES IMPROVEMENT | | | | | | | |
| 1.a. | Define Capital projects thoroughly with respect to scope and budget, including community and client approval at the end of the planning phase | X1 | -1 | 0.5 | 1 | 0 | 1 | 0 | 1 |
| 1.b. | Complete Feasibility Studies on projects prior to defining budget and scope | X2 | 0 | 0.5 | 3 | 4 | 0 | 0 | 0 |
| 1.d. | Have a Board/Council project prioritization system | X3 | 1 | -2.5 | 0 | 0 | 0 | -1 | 2 |
| 1.e. | Provide design and construction resource loading for CIP projects | X4 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1.f. | Have a Master Schedule attached to the CIP that identifies start and finish dates for projects | X5 | -2 | -1.5 | 0 | 0 | 0 | 0 | 1 |
| 1.i. | Show Projects on a Geographical Information System | X6 | 4 | -0.5 | 1 | 0 | 1 | 1 | 0 |
| 2.b. | Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start | X7 | -1 | -0.5 | 1 | 1 | 2 | 0 | 1 |
| 2.f. | Define requirements for reliability, maintenance, and operation prior to design initiation | X8 | -2 | 1.5 | 0 | 1 | 1 | 0 | 0 |
| 2.i. | Adapt successful designs to project sites whenever possible (e.g. fire stations, gymnasiums, etc.) | X9 | 3 | 1.5 | 1 | 1 | 1 | 1 | 0 |
| N/A | Limit Scope Changes to early stages of design | X10 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| (2004) | | | | | | | | | |
| N/A (2004) | Ensure that scope changes during design must be accompanied by Budget and Schedule approvals | X11 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 3.I.a. | Develop and use a standardized Project Delivery Manual | X12 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| 3.II.b. | Perform a formal Value Engineering Study for projects larger than \$1,000,000 | X13 | 0 | 3 | 1 | -2 | 3 | 0 | 0 |
| 3.III.a. | Use a formal Quality Management System | X14 | 1 | 0 | 0 | 5 | 1 | 0 | 0 |
| 3.III.b. | Perform and use Post Project Reviews to identify lessons learned | X15 | 1 | 1 | 0 | 2 | 1 | 2 | 0 |
| 4.l.a. | Delegate authority to the City Engineer/Public Works Director or other departments to approve change orders to the contingency amount | X16 | -2 | -2 | 0 | 1 | 0 | 1 | 0 |
| 4.l.m. | Classify types of change orders | X17 | 3 | 5 | 0 | -3 | 3 | 1 | 0 |
| 4.II.a. | Include a formal Dispute Resolution Procedure in all contract agreements | X18 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 4.III.a. | Use a team building process for projects greater than \$5 million | X19 | 1 | -0.5 | 1 | 2 | 3 | 2 | 1 |
| 4.IV.a. | Involve the Construction Management Team before completion of design | X20 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| N/A (2003) | Delegate contract awards below council level under\$1 million | X21 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| N/A (2003) | On large complex projects establish a pre-qualification process for contractors | X22 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| N/A | Make bid documents available online | X23 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| (2003) | | | | | | | | | |
| 5.I.f. | Assign a client representative to every project | X24 | -2 | -0.5 | 0 | 3 | 2 | 0 | 2 |
| 5.II.a | Provide formal training for Project Managers on a regular basis | X25 | 0 | 3 | 0 | 0 | 2 | 0 | 4 |
| 5.III.a. | Adopt and use a Project Control System on all projects | X26 | 3 | -3.5 | 0 | 0 | 1 | 0 | 0 |
| N/A | Create in-house project management team for small projects | X27 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| (2003) | | | | | | | | | |
| N/A (2004) | Institute Project Manager performance and accountability | X28 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 6.c. | Include a standard consultant contract in the RFQ/RFP with a standard indemnification | X29 | -2 | 0 | 0 | 2 | 0 | 1 | 5 |
| 6.e. | Delegate authority to the PW Director/City Engineer to approve consultant contracts under \$250.000, when a formal REP selection process is used | X30 | 0 | -4 | 0 | 0 | 0 | -4 | -2 |
| 6.g. | Implement and use a consultant rating system that identifies quality of consultant performance | X31 | 0 | 2 | 0 | 0 | 0 | 5 | 0 |

Table F-4 — Definition of Multi-Parameter Regression Variablesfor Linking Processes to Performance

* For Sacramento, the average of General Services and Transportation 2004 rates were compared with Public Works 2002 rates.

F. COMMUNICATION ON OTHER PROJECT DELIVERY IMPROVE-MENTS

Clear and open communication was key to sharing and developing strategies for Best Management Practice implementation. The project team met every three months. The agenda for each meeting included ample opportunity for discussion and the exchange of ideas. Formal presentations were made by team members who shared their successful experiences with specific process improvement implementation.

The successful open forum communications at the quarterly meetings were enhanced by extensive online discussions on various topics that influence project delivery efficiency. Frequently the online exchanges generated agenda topics for future meetings.

The Study Team set up online access to the discussions between Study Team participants through a system which archived the information on the City of Los Angeles website (http://eng. lacity.org).

г 4 **Chapte**

Performance Benchmarking



116
CHAPTER Performance Benchmarking

A. GUIDING PRINCIPLES

Performance benchmarking involved the collection of documented project costs and the comparison of the actual project delivery costs with total construction costs.

The performance questionnaire was improved to fit the needs of *Update 2004*. Specifically, the form was modified to collect change order data by category. The performance questionnaire form is included in Appendix A. Like the *Update 2003* study, the questionnaires were all uploaded into the project database using a visual basic code. The following criteria applied to *Update 2004* performance benchmarking:

- Costs All projects included in this study have a total construction cost exceeding \$100,000. (i.e. projects less than \$100,000 in value are included in the database, but not included in the study).
- Completion Date Projects included in the study were completed after January 1997. Projects with earlier completion dates were excluded from the analysis, but are still maintained in the database. The database software allows that projects may be sorted and/or filtered by completion dates for specific analyses.
- Representative Projects All of the selected projects are "representative of the agencies" processes". The Project Team identified, reviewed, and corrected or eliminated all projects that had the potential to be outliers in the regression analysis.

- Project Delivery Method All selected projects were delivered through the traditional Design-Bid-Build delivery method. Projects delivered using Design-Build and delivery methods other than Design-Bid-Build are categorically different and are not included in this study (or the database) at this time.
- It was decided to eliminate all Curb Ramp and Resurfacing projects. At the end of the *Update 2003* study, it was concluded that most Ramp projects and Resurfacing projects were delivered using standard and/or repetitive designs or details. Therefore, their delivery costs may be significantly lower and not representative of a uniquely designed project. Therefore these projects should not be studied in the same pool as the other projects. With Resurfacing projects removed, the classification formerly named "Renovation / Resurfacing" was renamed to "Reconstruction".
- "Bridge/Retrofit/Seismic" classification was renamed to "Bridge (Retrofit, New)" for clarity.
- Agencies committed to categorize change orders (i.e. Unforeseen & Changed Conditions, Errors & Omissions, Other/Client Changes, and Credit Change Orders) on as many projects as feasible. This categorization will be used to study change orders.

B. DISTRIBUTION OF PROJECTS

- Total Number of Projects Table J summarizes total number of projects included in the database. While the database contains 787 projects, only 595 fit the study criteria. As a result, column (f) of Table H was the basis for the performance graphs.
- Identification of Non-Representative <u>Projects</u> – The study team continued to use the outlier identification process that was developed in *Update 2003*. As a result of outliers identification, 69 non-representative projects (less than 10% of total number of projects) were selected for exclusion from *Update 2004* study.

In addition, all 25 projects smaller than \$100,000, 13 projects that were completed before 1997, and all 85 Curb Ramp and Resurfacing projects were excluded from this analysis.

<u>Updated Projects Distribution Matrix</u> – Table K summarizes the final *Update 2004* project distribution (595 projects). The table shows a wide distribution of project types and classifications.

C. PERFORMANCE GRAPHS DEVELOPMENT

Project performance data are available in the project database as a "Project Listing" report. Performance data were compiled into a Microsoft Access database. Performance curves were developed and are included in Appendix B. A summary R² Table is also included at the end of Appendix B for reference.

Performance models were studied at both "Project Type" level and "Project Classification" level. The performance modeling results are summarized in Table L. This Table is still a referential tool and is not suitable for predictive purposes yet, since the correlation coefficients are low, particularly for shaded fields. Note that duration information is also merged into Table L.

| Update | TCC < | Completion | Non- | Curb Ramp / | Total | Corresponding Update |
|--------|-----------|-------------|----------------|-------------|-------|-------------------------------|
| Year | \$100,000 | Date < 1997 | Representative | Resurfacing | (e) | 2004 Guidelines |
| | (a) | (b) | (c) | Projects | | (f) = (e) - [(a)+(b)+(c)+(d)] |
| | | | | (d) | | |
| 2002 | 25 | 7 | 12 | 41 | 239 | 154 |
| 2003 | 0 | 6 | 25 | 31 | 286 | 224 |
| 2004 | 1 | 0 | 32 | 13 | 262 | 217 |
| Total | 25 | 13 | 69 | 85 | 787 | 595 |

Table J — Update 2004 Projects

Basis for Update 2004

| Matrix |
|-------------------|
| Distribution |
| Projects I |
| able K — |

| PROJECT TYPE | Total Construction | Design Cost | CM Cost | Total Project | Est Total | Number of | |
|------------------------|---|---|------------|---------------------------|-----------|------------|--|
| CLASIFICATION | Cost (TCC) | (% of TCC) | (% of TCC) | Delivery cost | Duration | Proiects** | |
| | | (,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | (| (% of TCC) | (Months) | , | |
| Municipal Facilities | | | | | | | |
| Libraries | TCC< \$0.5M | 42% - 47% | 32% - 37% | 74% - 82% | 36 - 45 | | |
| | \$0.5M <tcc<\$3m< td=""><td>28% - 32%</td><td>21% - 26%</td><td>49% - 56%</td><td>39 - 49</td><td>28</td></tcc<\$3m<> | 28% - 32% | 21% - 26% | 49% - 56% | 39 - 49 | 28 | |
| | TCC> \$3M | 15% - 19% | 11% - 16% | 26% - 34% | 43 - 52 | | |
| Police/ Fire Station | TCC< \$0.5M | 29% - 33% | 15% - 18% | 44% - 50% | 16 - 30 | | |
| | \$0.5M <tcc<\$3m< td=""><td>22% - 27%</td><td>12% - 15%</td><td>34% - 40%</td><td>36 - 49</td><td>39</td></tcc<\$3m<> | 22% - 27% | 12% - 15% | 34% - 40% | 36 - 49 | 39 | |
| | TCC> \$3M | 16% - 21% | 9% - 12% | 26% - 32% | 53 - 66 | | |
| Community Building / | TCC< \$0.5M | 26% - 32% | 23% - 33% | 49% - 60% | 19 - 29 | | |
| Rec. Center/CC/Gym | \$0.5M <tcc<\$3m< td=""><td>22% - 28%</td><td>15% - 24%</td><td>36% - 48%</td><td>30 - 40</td><td>54</td></tcc<\$3m<> | 22% - 28% | 15% - 24% | 36% - 48% | 30 - 40 | 54 | |
| | TCC> \$3M | 18% - <u>24%</u> | 8% - 17% | 25 <u>%</u> - <u>36</u> % | 40 - 50 | | |
| Streets | | | | | | | |
| Widening / New / | TCC< \$0.5M | 26% - 31% | 12% - 18% | 38% - 45% | 14 - 26 | | |
| Grade Separation | \$0.5M <tcc<\$3m< td=""><td>20% - 25%</td><td>13% - 19%</td><td>32% - 40%</td><td>35 - 47</td><td>27</td></tcc<\$3m<> | 20% - 25% | 13% - 19% | 32% - 40% | 35 - 47 | 27 | |
| | TCC> \$3M | 15% - 19% | 13% - 20% | 28% - 36% | 54 - 66 | | |
| Bridge (Retrofit, New) | TCC< \$0.5M | 32% - 38% | 19% - 22% | 51% - 58% | 21 - 32 | | |
| | \$0.5M <tcc<\$3m< td=""><td>24% - 30%</td><td>16% - 19%</td><td>40% - 47%</td><td>36 - 46</td><td>20</td></tcc<\$3m<> | 24% - 30% | 16% - 19% | 40% - 47% | 36 - 46 | 20 | |
| | TCC> \$3M | 17% - 23% | 13% - 16% | 30% - 37% | 49 - 59 | | |
| Reconstruction | TCC< \$0.5M | 23% - 28% | 24% - 29% | 47% - 54% | 16 - 22 | | |
| 1 | \$0.5M <tcc<\$3m< td=""><td>20% - 25%</td><td>11% - 16%</td><td>31% - 37%</td><td>23 - 29</td><td>23</td></tcc<\$3m<> | 20% - 25% | 11% - 16% | 31% - 37% | 23 - 29 | 23 | |
| | TCC> \$3M | 17% - 22% | 0.1% - 4% | 16% - 22% | 30 - 36 | | |
| Bike / Pedestrian | TCC< \$0.5M | 28% - 35% | 17% - 20% | 45% - 54% | 18 - 24 | | |
| - | \$0.5M <tcc<\$3m< td=""><td>11% - 18%</td><td>13% - 17%</td><td>24% - 33%</td><td>27 - 33</td><td>15</td></tcc<\$3m<> | 11% - 18% | 13% - 17% | 24% - 33% | 27 - 33 | 15 | |
| 1 | TCC> \$3M | 0.1% - 3% | 10% - 13% | 5% - 14% | 36 - 42 | | |
| Signals | TCC< \$0.5M | 16% - 21% | 20% - 27% | 37% - 44% | 16 - 22 | | |
| | \$0.5M <tcc<\$3m< td=""><td>10% - 15%</td><td>14% - 20%</td><td>24% - 32%</td><td>33 - 39</td><td colspan="2">69</td></tcc<\$3m<> | 10% - 15% | 14% - 20% | 24% - 32% | 33 - 39 | 69 | |
| | TCC> \$3M | 5% - 10% | 8% - 14% | 13% - 21% | 49 - 55 | · | |
| Pipes | | | | | | | |
| Gravity System | TCC< \$0.5M | 20% - 23% | 18% - 21% | 37% - 42% | 12 - 31 | | |
| (Storm Drains, | \$0.5M <tcc<\$3m< td=""><td>14% - 17%</td><td>14% - 17%</td><td>28% - 33%</td><td>49 - 68</td><td>133</td></tcc<\$3m<> | 14% - 17% | 14% - 17% | 28% - 33% | 49 - 68 | 133 | |
| Sewers) | TCC> \$3M | 8% - 12% | 11% - 14% | 20% - 25% | 82 - 101 | | |
| Pressure Systems | TCC< \$0.5M | 14% - 18% | 14% - 17% | 28% - 33% | 60 - 76 | | |
| - | \$0.5M <tcc<\$3m< td=""><td>14% - 17%</td><td>11% - 14%</td><td>25% - 30%</td><td>58 - 73</td><td>29</td></tcc<\$3m<> | 14% - 17% | 11% - 14% | 25% - 30% | 58 - 73 | 29 | |
| | TCC> \$3M | 14% - 17% | 8% - 12% | 22% - 27% | 55 - 70 | | |
| Pump Station | TCC< \$0.5M | 25% - 29% | 35% - 41% | 60% - 69% | 57 - 74 | | |
| | \$0.5M <tcc<\$3m< td=""><td>18% - 23%</td><td>24% - 30%</td><td>42% - 51%</td><td>52 - 70</td><td>12</td></tcc<\$3m<> | 18% - 23% | 24% - 30% | 42% - 51% | 52 - 70 | 12 | |
| l | TCC> \$3M | 13% - 17% | 14% - 20% | 26% - 36% | 49 - 66 | | |
| Parks | | | | | | | |
| Playgrounds | TCC< \$0.5M | 21% - 26% | 19% - 23% | 41% - 47% | 15 - 18 | | |
| | \$0.5M <tcc<\$3m< td=""><td>13% - 17%</td><td>13% - 16%</td><td>26% - 32%</td><td>23 - 26</td><td>71</td></tcc<\$3m<> | 13% - 17% | 13% - 16% | 26% - 32% | 23 - 26 | 71 | |
| | TCC> \$3M | 5% - 10% | 7% - 10% | 12% - 18% | 30 - 33 | | |
| Sportfields | TCC< \$0.5M | 19% - 23% | 18% - 22% | 37% - 44% | 20 - 27 | | |
| | \$0.5M <tcc<\$3m< td=""><td>15% - 18%</td><td>9% - 14%</td><td>24% - 31%</td><td>36 - 43</td><td>13</td></tcc<\$3m<> | 15% - 18% | 9% - 14% | 24% - 31% | 36 - 43 | 13 | |
| | TCC> \$3M | 11% - 15% | 2% - 6% | 12% - 20% | 50 - 58 | | |
| Restrooms | TCC< \$0.5M | 23% - 28% | 26% - 37% | 49% - 63% | 24 - 32 | | |
| | \$0.5M <tcc<\$3m< td=""><td>31% - 37%</td><td>45% - 55%</td><td>76% - 90%</td><td>47 - 56</td><td>15</td></tcc<\$3m<> | 31% - 37% | 45% - 55% | 76% - 90% | 47 - 56 | 15 | |
| | TCC> \$3M | 39% - 44% | 61% - 71% | 100% - 114% | 69 - 77 | | |

Table L — CIP Delivery Data *

* The values in this table provide an overall summary of the performance benchmarking results. Caution is necessary in using this information as a predictive tool, particularly shaded values ($R^{2} \leq R^{2}$ Critical or $R^{2} \leq 0.1$). ** This is the number of projects that have duration information. Therefore, for some categories, this number may be less

than what is shown in the Projects Distribution Matrix.

chapter 5

Conclusions and Recommendations



OAKLAND PUBLIC WORKS AGENCY

















DED

CHAPTER Conclusions and Recommendations

A. PERFORMANCE DATA IMPROVEMENT

The results of the performance benchmarking showed there are outstanding data gaps that need to be filled. Most agencies provide a large number of small projects (less than \$5 million) and a few large projects (more than \$10 million). As a result, there are data gaps in the medium size project range in nearly all the graphs. The performance models are mainly driven by a large number of very small and a small number of large projects. The models can be made more reliable if more data are collected for average size projects.

It is also observed that agencies do not contribute data similarly to the various classifications. More reliable models will be developed as the distribution of the number of projects becomes more uniform among all classifications for each agency.

Further review of agencies data collection procedures is warranted. While Agencies' overall project delivery percentages are more similar to each other compared to *Update 2003*, there is still a need to improve confidence in the data. This will be achieved by an ongoing review of agencies data collection procedures.

B. UPDATE 2004 OBSERVATIONS

Spending more on design may decrease total construction cost by reducing change orders which results in higher design cost as a percentage of total construction cost.

- Maintaining the level of design effort, while improving BMP's such that construction change order levels are reduced will result in higher design costs as a percentage of total construction cost.
- It is difficult to quantify improvements by merely looking at performance statistics. The mere fact that all Agencies are looking introspectively at their respective performances and are sharing information with each other, will lead to improvements regardless of the time needed for a statistical relationship to eventually demonstrate this.
- Although the project delivery costs have slightly increased over the past three years, they would have increased even more in the absence of the BMP's developed by this benchmarking study. The sharing of the participating Agencies' knowledge and experiences will eventually reverse the Project Delivery costs trend.
- It is not surprising that delivery costs are going up because the complexity of project requirements are increasing as the direct public participation in the project delivery process increases.
- The size of the projects are growing smaller and the amount of time spent to develop creative funding solutions (phase funding, private donations, fund source swaps, etc) seems to be growing.



















Acknowledgements

The participation and contribution of the following individuals to the third phase of the California Multi-Agency CIP Benchmarking Study is gratefully acknowledged. This work would not have been possible without the contributions made by these people.

Study Team:

Gary Lee Moore, P.E., City Engineer City of Los Angeles, Department of Public Works, Bureau of Engineering 650 South Spring Street, Suite 200 Los Angeles, CA 90014 (213) 847-8766 (213) 847-9603 (Fax) gmoore@eng.lacity.org

Alex J. Vidaurrazaga, Principal Civil Engineer, S.E. City of Los Angeles, Department of Public Works, Bureau of Engineering Structural Engineering Division 650 South Spring Street, Suite 400 Los Angeles, CA 90014 (213) 847-8773 (213) 847-8999 (Fax) avidaurr@eng.lacity.org

Joseph Wojslaw, P.E., EED Consultant Manager MWH, Inc. 12000 Vista Del Mar, Pregerson Building, Suite 200 Playa Del Rey, CA 90293 (310) 648-6102 (310)648-6155 (Fax) jwojslaw@eng.lacity.org

Bill Lacher, CCM, LEED Vanir Construction Management, Inc. 3435 Wilshire Boulevard, Suite 2050 Los Angeles, CA 90010-2006 (213) 487-1145 (213) 487-1051 (Fax) bill.lacher@vanir.com Ali Nowroozi, Ph.D., Consultant Project Controls Engineer Tajann Engineering and Construction, Inc. 321 S. Lilac Court Anaheim Hills, CA 92808 (323) 481-4671 (714) 637-0502 (Fax) anowrooz@tajann.com

Project Team:

Christine Andersen, Director City of Long Beach, Department of Public Works 333 W. Ocean Blvd., 9th Floor Long Beach, CA 90802 (562) 570-6641

Mark Christoffels, City Engineer City of Long Beach, Department of Public Works 333 W. Ocean Blvd., 9th Floor Long Beach, CA 90802 (562) 570-6771 (562) 570-6012 (Fax) machris@longbeach.gov

Edward Villanueva, Administrative Analyst City of Long Beach, Department of Public Works 333 W. Ocean Blvd., 9th Floor Long Beach, CA 90802 (562) 570-6465 (562) 570-6012 (Fax) edvilla@longbeach.gov

Roger Beaman, Administrative Analyst City of Long Beach, Department of Public Works 333 W. Ocean Blvd., 10th Floor Long Beach, CA 90802 (562) 570-6895 (562) 570-6012 (Fax)

Raul Godinez, P.E., Director City of Oakland, Public Works Agency 250 Frank H. Ogawa Plaza, Suite 4314 Oakland, CA 94612 (510) 238-4470 (510) 238-6412 rgodinez@oaklandnet.com Michael Neary, P.E., Engineering Division Manager City of Oakland, Public Works Agency 250 Frank H. Ogawa Plaza, Suite 4314 Oakland, CA 94612 (510) 238-6659 (510) 238-7227 mjneary@oaklandnet.com

David Lau, P.E., Project Delivery Manager City of Oakland, Public Works Agency 250 Frank H. Ogawa Plaza, Suite 4314 Oakland, CA 94612 (510) 238-7131 (510) 238-2085 dwlau@oaklandnet.com

Gus Amirzehni, Project Manager City of Oakland, Public Works Agency 250 Frank H. Ogawa Plaza, Suite 4314 Oakland, CA 94612 (510) 238-6601 (510) 238-7227 gamirzehni@oaklandnet.com

Fran Halbakken, Planning and Policy Manager City of Sacramento, Department of Transportation 660 J Street, Suite 250 Sacramento, CA 95814 (916) 264-7194 (916) 264-5573 (Fax) fhalbakken@cityofsacramento.org

Bob Williamson, Supervising Architect City of Sacramento, Department of General Services 927 10th Street Sacramento, CA 95814 (916) 808-8430 (916) 808-8357 (Fax) bwilliamson@cityofsacramento.org

Nicholas Theocharides, Engineering Division Manager City of Sacramento, Department of Transportation 927 10th Street Sacramento, CA 95814 (916) 359-7400 (916) 808-8357 (Fax) nicholas@cityofsacramento.org Cherisse M. Knapp, CPA, Senior Accountant Auditor City of Sacramento, Department of Transportation 927 10th Street Sacramento, CA 95814 (916) 808-2680 (916) 264-8357 (Fax) cKnapp@cityofsacramento.org

Shirley Wong, Analyst City of Sacramento, Department of Public Works 927 10th Street Sacramento, CA 95814 (916) 264-5879 swong@cityofsacramento.org

Robin Borre, Analyst City of Sacramento, Department of Public Works 927 10th Street Sacramento, CA 95814 (916) 264-5760 rborre@cityofsacramento.org

David Brent, Engineering Division Manager City of Sacramento, Department of Utilities, Engineering Services 1395 35th Avenue Sacramento, CA 95822 (916) 264-1420 (916) 264-1497 dbrent@cityofsacramento.org

Richard S. Batha, Supervising Engineer City of Sacramento, Department of Utilities, Engineering Services 1395 35th Avenue Sacramento, CA 95822 (916) 264-1448 (916) 264-1497 rbatha@cityofsacramento.org

Frank Belock, P.E., Director City of San Diego Engineering & Capital Projects Department 202 "C" Street, MS 9B San Diego, CA 92101 (619) 236-6274 (619) 533-4736 (Fax) fbelock@sandiego.gov Patti Boekamp, P.E., Chief Deputy Director
City of San Diego
Engineering & Capital Projects Department, Transportation Engineering
Division
1010 2nd Avenue, Suite 1200, MS 612
San Diego, CA 92101
(619) 533-3173 (619) 533-3071 (Fax)
pboekamp@sandiego.gov

Darren Greenhalgh, P.E., Senior Civil Engineer City of San Diego Engineering & Capital Projects Department, Architectural Engineering and Contract Services Division 1010 2nd Avenue, Suite 1400, MS 614 San Diego, CA 92101 (619) 533-3104 (619) 533-3112 (Fax) dxg@sandiego.gov

Richard Leja, P.E., Senior Civil Engineer City of San Diego Engineering & Capital Projects Department, Transportation Engineering Division 1010 2nd Avenue, Suite 1200, MS 611 San Diego, CA 92101 (619) 533-3764 (619) 533-3071 (Fax) rleja@sandiego.gov

George Qsar, P.E., Senior Civil Engineer City of San Diego Engineering & Capital Projects Department, Field Engineering Division 9485 Aero Drive San Diego, CA 92123 (858) 627-3240 (858) 627-3297 gqsar@sandiego.gov

Jeffrey A. Shoaf, P.E., Senior Civil EngineerCity of San Diego Engineering & Capital Projects Department, Water & Sewer Design Division 600 B Street, Suite 800, MS 908A San Diego, CA 92101 (619) 533-5109 (619) 533-5176 (Fax) jshoaf@sandiego.gov. Edwin M. Lee, Director of Public Works City and County of San Francisco, Department of Public Works City Hall, Room 348 1 Dr. Carlton B. Goodlett Place San Francisco, CA 94102 (415) 554-6920 (415) 554-6944 (Fax) Edwin.Lee@sfdpw.org

Robert Beck, Acting Deputy Director of Public Works
City and County of San Francisco
City Hall, Room 348
1 Dr. Carlton B. Goodlett Place
San Francisco, CA 94102
(415) 554-6940 (415) 554-6944 (Fax)
Robert.Beck@sfdpw.org

Nelson Wong, Bureau Manager City and County of San Francisco, Dept. of Public Works, Bureau of Engineering 30 Van Ness Avenue, 5th Floor San Francisco, CA 94102 (415) 558-4517 (415) 558-4519 (Fax) Nelson.Wong@sfdpw.org

Steven T. Lee, Electrical Engineer
City and County of San Francisco, Dept. of Public Works, Bureau of Engineering
30 Van Ness Avenue, 5th Floor
San Francisco, CA 94102
(415) 558-5226 (415) 558-4590 (Fax)
Steven.Lee@sfdpw.org

Katy Allen, P.E., Director City of San Jose, Department of Public Works 801 N. First Street, Room 320 San Jose, CA 95110 (408) 277-4339 (408) 277-3156 (Fax) katy.allen@sanjoseca.gov

David D. Sykes, P.E., Assistant Director 801 N. First Street, Room 320 San Jose, CA 95110 (408) 277-5768 (408) 277-3156 (FAX) david.sykes@sanjoseca.gov Kevin S. Briggs, P.E., Senior Engineer City of San Jose, Department of Public Works 801 N. First Street, Room 350 San Jose, CA 95110 (408) 277-2972 (408) 277-3869 (Fax) kevin.briggs@ sanjoseca.gov

Lisa Cheung, CIP Specialist City of San Jose, Office of the City Manager 675 N. First Street, Suite 675 San Jose, CA 95112 (408) 794-1471 (408) 293-3967 lisa.cheung@sanjoseca.gov

Dennis Tam, Associate Engineer 801 N. First Street, Room 350 San Jose, CA 95110 (408) 277-4685 (408) 277-3869 (FAX) dennis.tam@sanjoseca.gov



INTS DR

16

LON





PERFORMANCE QUESTIONNAIRE



| ORDERS | Changed Conditions: All Credit Change Orders | | in the Documents: | | Client Changes: | _ \$ - | |
|-------------------------------|--|--|-------------------|--|-----------------|--------|--|
| UTILITY RELOCATION COST | | | | | | | |
| CITY FORCES CONSTRUCTION | | | | | | | |
| TOTAL CONSTRUCTION COST (TCC) | | | | | | | |
| LAND ACQUISITION | | | | | | | |
| | | | | | | | |
| PROJECT CON | IPLETION DATE | | | | | | |

(1) Agency costs include other direct costs and can be listed underneath. This value is locked and it is calculated from its items (Rows 14 - 18)

Annual Report Update 2004 California Multi-Agency CIP Benchmarking Study

CURVES GROUP 1

Design Cost / Construction Cost

Versus

Total Construction Cost

Municipal Facilities - All Classification



Design Percentage Versus Total Construction Cost

Municipal Facilities - Libraries





Municipal Facilities - Police / Fire Station



Design Percentage Versus Total Construction Cost

Municipal Facilities - Community Bldg./Rec. Center/CC/Gym

Design Percentage Versus Total Construction Cost







Design Percentage Versus Total Construction Cost









Design Percentage Versus Total Construction Cost



Streets - Reconstruction









Design Percentage Versus Total Construction Cost

Streets - Signals*



* One Signal project had zero Total Construction Cost and was excluded from this



Design Percentage Versus Total Construction Cost



Pipe Systems - Gravity System (Storm Drains, Sewers)

Design Percentage Versus Total Construction Cost









Pipe Systems - Pump Stations









Design Percentage Versus Total Construction Cost

Parks - Playgrounds

Design Percentage Versus Total Construction Cost







Design Percentage Versus Total Construction Cost







CURVES GROUP 2

Construction Management Cost / Construction Cost

Versus

Total Construction Cost



Municipal Facilities - All Classification



Construction Management Percentage Versus Total Construction Cost

Municipal Facilities - Libraries









Construction Management Percentage Versus Total Construction Cost

Municipal Facilities - Community Bldg./Rec. Center/CC/Gym*

Construction Management Percentage Versus Total Construction Cost







Construction Management Percentage Versus Total Construction Cost

Streets - Widening / New / Grade Separation*









Construction Management Percentage Versus Total Construction Cost



Construction Management Percentage Versus Total Construction Cost







Construction Management Percentage Versus Total Construction Cost

Streets - Signals *









Construction Management Percentage Versus Total Construction Cost

Pipe Systems - Gravity System (Storm Drains, Sewers)

Construction Management Percentage Versus Total Construction Cost







Construction Management Percentage Versus Total Construction Cost

Pipe Systems - Pump Stations









Construction Management Percentage Versus Total Construction Cost

Parks - Playgrounds

Construction Management Percentage Versus Total Construction Cost






Construction Management Percentage Versus Total Construction Cost

Parks - Restrooms





CURVES GROUP 3

Delivery Cost / Construction Cost

Versus

Total Construction Cost

Page A-23





Project Delivery Percentage Versus Total Construction Cost

Municipal Facilities - Libraries





Municipal Facilities - Police / Fire Station



Project Delivery Percentage Versus Total Construction Cost

Municipal Facilities - Community Bldg./Rec. Center/CC/Gym

Project Delivery Percentage Versus Total Construction Cost







Project Delivery Percentage Versus Total Construction Cost



Project Delivery Percentage Versus Total Construction Cost









Streets - Reconstruction









Project Delivery Percentage Versus Total Construction Cost

Streets - Signals*

Project Delivery Percentage Versus Total Construction Cost







Project Delivery Percentage Versus Total Construction Cost

Pipe Systems - Gravity System (Storm Drains, Sewers)

Project Delivery Percentage Versus Total Construction Cost







Project Delivery Percentage Versus Total Construction Cost

Pipe Systems - Pump Stations









Project Delivery Percentage Versus Total Construction Cost

Parks - Playgrounds

Project Delivery Percentage Versus Total Construction Cost







Project Delivery Percentage Versus Total Construction Cost







| PROJECT TYPE CLASSIFICATION | DESIGN % VS TCC | CONSTRUCTION MANAGEMENT % VS TCC | PROJECT DELIVERY % VS TCC |
|--|--------------------|--|---------------------------------|
| Municipal Facilities | 0.1731 | 0.0986 | 0.2189 |
| Libraries | 0.4562 | 0.2298 | 0.4610 |
| Police/Fire Station | 0.3634 | 0.2463 | 0.4221 |
| Community Building/Recreation Center/ Children Center/Gymnasium | 0.0727 | 0.1015 | 0.1639 |
| Streets | 0.0449 | 0.0742 | 0.1198 |
| Widening/New/Grade Separation | 0.2516 | 0.0029 | 0.0698 |
| Bridge (Retrofit, New) | 0.2430 | 0.1378 | 0.3583 |
| Reconstruction | 0.0292 | 0.5640 | 0.4816 |
| Bike/Pedestrian | 0.3878 | 0.0735 | 0.3653 |
| Signals | 0.1003 | 0.0690 | 0.1513 |
| Pipe Systems | 0.1242 | 0.0542 | 0.1414 |
| Gravity System (Storm Drains, Sewers) | 0.2108 | 0.1069 | 0.2949 |
| Pressure Systems | 0.0001 | 0.0469 | 0.0192 |
| Pump Station | 0.1618 | 0.3164 | 0.3147 |
| Parks | 0.0476 | 0.0149 | 0.0396 |
| Playgrounds | 0.1351 | 0.1190 | 0.2178 |
| Sport fields | 0.0593 | 0.1571 | 0.1379 |
| Restrooms | 0.1650 | 0.1957 | 0.2440 |

Performance Graphs R² Results

* TCC=Total Construction Cost (Including all Change Orders)

Page A-33



Outliers Identification



ALS DR

16

APPENDIX B Identification

utliers, in a regression model, are considered to be the data points that are "too far" from the regression curve. The classic criteria to find statistical outliers are based on the following rule of thumb²:

Point Distance from trend-line $\notin [Q^1 - 1.5(Q_3 - Q_1), Q_3 + 1.5(Q_3 - Q_1)] \Rightarrow$ outlier point

Where: $Qi = i^{th}$ Quartile of the data set.

Alternatively, Confidence Interval (CI) may be used to improve the correlation coefficient more effectively. In this technique, a confidence interval around the regression curve is defined and all the points outside this range are considered as outliers (see Figure C-1).

Selection of the confidence interval is based on the trade-off between the number of data points that can be set aside and the improvement that can be achieved. The more data points excluded, the more R^2 will improve. However, the model becomes unrealistic if too many data points are excluded.

It is noteworthy that, in this study, outliers' identification was merely a tool to *identify* projects with too high or too low project delivery costs, compared to the general trend. This provides a tool to distinguish the projects that have the potential to be abnormal (not-representative) projects. Under no circumstances should statistical outliers be used as the basis of project elimination without other justification. Subsequently, selection of the CI is arbitrary and is defined based on acceptability of maximum and minimum project delivery costs. For example, practical experience has shown that a project with more that 50% project delivery cost has the potential to be a non-representative project. Therefore the upper bound curve should not go beyond 50% in figure C-1. The team reviewed all performance curves and it was found that, in general, a 51% confidence interval ($\mu \pm 0.75\sigma$) identifies the acceptable range in all graphs. In other words, the projects beyond [$\mu - 0.75\sigma$, $\mu +$ 0.75 σ] are worth reviewing for possible abnormal behavior (i.e. non-standard delivery process).

A computer program was developed to apply this outliers identification technique to all total project delivery performance models. A list of all outliers (75 projects) was shared with the Project Team, 34 of which were found to be abnormal projects. The abnormal (non-representative) projects were all projects with total project delivery higher than 50% or smaller than 15%.

² See Appendix B-II of Phase I report for details of this technique.



Figure C-1 Municipal Facilities - Libraries Design Percentage Versus Total Construction Cost

Appendix **C**

Multi-Agency Benchmarking Database [Update 2004]













JAIS PK

16

LON

APPENDIX Multi-Agency Benchmarking Database - Update 2004

The study team continues to use CALBM database for the purpose of this study. Again, for the specific purposes of the Update 2004 study, some modifications were necessary to the project database.

Upon execution of the database program, the Multi-Agency logo appears on the monitor, as shown in Figure C-1.

The user has the option of opening a form for data entry/review or benchmarking models development or opening a report:

Project Data Form, as shown in figure C-2,

can be used to review all project data that are provided by various agencies and to add new project data.

Form is a tool to develop instantaneous performance models based on the criteria that are selected from the form options. For example, Figure C-4 is the performance model that was developed based on the potions selected in figure C-3. This form is the most useful feature of the database and was the main tool to perform performance benchmarking in 2002, 2003, and 2004 benchmarking studies.



Figure C-1. CALBM Database View

🖉 Wiczesett Access Blene Beparts Help CIII Ourves SI Projecte Data 8 PROJECT DATA FORM Agenty Concellingeneraties Project Hane: COMMAED COAM ST Project Type Type Municipal Facilies - Chair Connurse Edg. Rec. EarnerCC/Sym ٠ New / Robats New Construction · Constanty Prome Project Indes . Junification | (A two story 2017) og it Type V avinal shaher that Folds 77 kannels 5 o halp sportkæred. Description 11902309 Contents PLANNING DESCH CONSTRUCTION TOTAL 00UAR \$0F100* OCULAR 2:0F102 DOLLAR 2:0F102 00U48 \$1FT00* 11 0.0% 173.560 1.58 1441.18 011 \$727,740 14 23 Agency Labor Other Costs 11 0.05 **9**3 1.05 1282,634 525 1387.634 523 Subschal Agency 10 0.01 1279.560 5.5% \$715,910 HIL 1925,270 1241 13 0.0% \$413,225 122 10 \$415,225 \$22 Constants. 510 0.01 935735 1271 \$115.510 27.5% TOTAL 95 14.13 31,414615 Datim 0 Monte 17 Miette To Marike 32 Mode \$4572,926 AMOUNT OF CONSTRUCTION CONTRACT COST OF CHANGE OFFICES 1545.135 UT LITY RELOCATION COSTS 10 DITY FORCES CONSTRUCTION 10 ***TOTAL CONSTRUCTION COST (TCC)** 15,119,526 CONTRACT COMPLETION DATE (HONTH YEAR) February 2012 Records 14 | + | [" 5 > | > | > | > = | = / 323 **July 2003**

Figure C-2. Project Data Form

Figure C-3. Curves Form





Figure C-4. Performance Model: Output of Figure C-3

Numerous reports are available as shown in figure C-5. These reports get updated instantly as additional data are added to the database. Many of the CALBM reports are used in 2002, 2003, and 2004 studies reports.

A detailed explanation of the CALBM database is provided in the project manual as a "README" file in the database package available at: http://eng.lacity.org/cabm.



Figure C-5. Various Reports Available in the CALBM Database



Project Size Normalization



APPENDIX Project Size Normalization

The analysis of impacts of Best Management Practices implementation upon performance improvement starts with comparing the data between different years of this study. In order to ensure an appropriate comparison, all changed conditions should be accounted for and their impacts should be eliminated.

During the *Update 2004*, it was found that different project sizes were contributed during the past three years. Agencies acknowledged that smaller project sizes were provided during 2004 compared to the past two years. The other criteria changes (e.g. deleting all Resurfacing and Ramp Projects, eliminating projects smaller than \$100,000 and projects completed before 2007) also resulted in different project size distributions in the three consecutive years. As a result, a biased trend in project delivery percentage through the past three years was observed.

To study variations of project sizes, histograms of project data for the past three years and for all current data were developed and compared. The cumulative histogram, as shown in Figure D-1, indicates the percentage of projects that are smaller than a given size. For example, Figure D-1 shows that in the 2002 Study only 40% of the projects were smaller than \$1 million, while in *Update 2003* this number increased to about 63% and in 2004 as many as 75% of the projects were smaller than \$1 million.

The goal of the Normalization Algorithm is to bring the three histograms of 2002, 2003, and 2004 closer to each other and to the global curve (All Updates). To achieve this goal the following algorithm was used:

- 1. Use the "All Updates" data set histogram as the base
- 2. Find the Sum of Square of Errors (SSE) of each data set (2002, 2003, 2004) histogram compared to the base
- 3. Remove one project in the 2002 data set (Save as TEMP)
- 4. Update 2002 Histogram and the corresponding SSE
- 5. If the new SSE is larger that the original one, bring TEMP back. If not, delete TEMP permanently
- 6. Repeat steps 3 5 for one project in 2003 data set
- Repeat steps 3 5 for one project in 2004 data set
- 8. Repeat steps 3 7 for another project

Upon implementation of this algorithm, about 25% of the projects were eliminated, resulting in histograms for all four data sets that are almost identical (Figure D-2).

| Update | Total # of Projects | # of Projects Remained | % Deleted |
|--------|---------------------------|------------------------------|--------------|
| 2002 | 154 | 92 | 40.3% |
| 2003 | 224 | 203 | 9.4% |
| 2004 | 217 | 153 | 31.1% |
| Total | 595 | 448 | 25.3% |

Project Size Normalization Impacts on the Number of Projects



Appendix E

Agencies Indirect Rate Factors



APPENDIX E Agencies Indirect Rate Factors

| AGENCIES MULTIPI | LIERS | / ADMI | IN ITEN | IS MAT | TRIX (L | JPDATI | E 2004) |
|--|--------------------|------------------------------|------------------|-----------------------------|--------------------|---|--|
| Agency | Fringe Benefits | Compen- sated Time Off | City Overhead | Depart- ment Overhead | Agency Overhead | Indirect Rate Factor ⁽¹⁾ | Entity Receives General Fund Support For Projects (Yes / No) |
| City of Long Beach Department of Public Works | 38.60% | 19.40% | 4.4% | 11.9% | 72.7% | 147.00% | YES |
| City of Los Angeles Department of Public Works/ Bureau of Engineering | 19.41% | 18.38% | 29.94% | 26.31% | 52.79% | 146.83% | YES |
| City of Oakland Public Works Agency | 42.24% | 21.93% | 28.29% | 7.89% | 13.23% | 113.58% | ON |
| City of Sacramento Department of General Services Department of Transportation | 30.00% | 18.70% | 40.95% | 6.67% | 75.16% | 194.44% | YES |
| Department of Utilities | 36.90% | 18.70% | N/A | N/A | N/A | 86.90% | NO |
| City of San Diego Public Buildings & Parks/Field | 27.70% | 15.50% | 12.00% | 60.80% | 4.00% | 120.10% | ON |
| Iransportation & Drainage Design/ Field | 2/./0%0 | 14./0% | 4/.90% | 51.80% | 4.60% | 126.60% | |
| Water/Wastewater Facilities/Field | 27.50% | 13.50% | 11.90% | 51.50% | 4.30% | 108.70% | |
| City and County of San Francisco Department of Public Works/ Bureau of Engineering/Bureau of CM/ Bureau of Architecture | 15.43% | 25.04% | 19.16% | 38.68% | 75.85% | 155.00% | ON |
| City of San Jose Department of Public Works | 26.79% | 25.00% | 40.86% | 13.00% | Included | 148.00% | ON |
| | | - L | | | - L | - 1:tc | 1:0C |

This value may be different from the Summation of the overhead values. The compounding formula is different for different Agencies.
Not included in the Indirect Rate because it is not charged to these projects.

Indirect Rate Factors Adjustment from Update 2002 to Update 2004

| Agency | Indirect Rate Factor | | Adjustment |
|---------------|----------------------|-------------|------------|
| | Update 2002 | Update 2004 | Factor |
| Long Beach | 147.00% | 147.00% | 1.00 |
| Los Angeles | 144.72% | 146.83% | 0.99 |
| Oakland | 116.96% | 113.58% | 1.03 |
| Sacramento | 116.42% | 140.67% | 0.83 |
| San Diego | 112.47% | 118.47% | 0.95 |
| San Francisco | 155.00% | 155.00% | 1.00 |
| San Jose | 148.00% | 148.00% | 1.00 |

* Sacramento Update 2004 indirect rate factor is the average of the three department values.

Participating Agencies:

City of Long Beach, Department of Public Works

City of Los Angeles, Department of Public Works/







• City of Oakland, Public Works Agency

Bureau of Engineering



• City of Sacramento, Department of General Services, Department of Transportation, Department of Utilities



City of San Diego, Engineering & Capital Projects





- City & County of San Francisco, Department of Public Works/ Bureau of Engineering/ Bureau of Construction Management/ Bureau of Architecture
- City of San Jose, Department of Public Works

September 2004 http://eng.lacity.org