CIP Benchmarking Study

California Multi-Agency CIP Benchmarking Study

Annual Report - Update 2004







Department of PUBLIC WORKS CITY OF SACRAMENTO

OAKLAND PUBLIC WORKS AGENCY

CITY OF SAN JOSE CAPITAL OF SILICON VALLEY

CITY OF LONG BEACH

September 2004

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Department of PUBLIC WORKS
CITY OF SACRAMENTO

OAKLAND
PUBLIC WORKS AGENCY

CITY OF SAN JOSE
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CHAPTER 1 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 process, 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-one[1] 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 performance data) 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
4. 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	LA	LB	OK	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 ④	✓	✓	SD: Some Divisions only
	1.b.	Complete Feasibility Studies on projects prior to defining budget and scope	✓	✓	✓	✓	PI 2004 ③	✓	✓	LB: When applicable SD: Result of CIP Benchmarking SF: When applicable SJ: Some exceptions
	1.d.	Have a Board/Council project prioritization system	N/I	N/I	N/I	PI GS:① TS:✓	2004 ①	N/I	N/I	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 ①	✓	2004 TS: 2005	2004 ②	N/I	PI 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	✓	✓	N/I	N/I	✓	
	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 2004 ⑤	✓	✓	
	2.f.	Define requirements for reliability, maintenance, and operation prior to design initiation	✓	2004 ②	N/I	2004 TS:✓	PI	✓	✓	SD: Some Divisions only (Rest N/I)
	2.i.	Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc.)	✓	✓	✓	✓ UT:④	PI	✓	✓	SD: Some Divisions only , where applicable
	N/A	Train in-house staff to use Green Building Standards	✓	TBD	PI	✓	✓	✓	✓	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	

Instructions:

✓: Has been implemented
PI: Partially implemented
***yyyy: Will be implemented in calendar year "yyyy", ⊗ = 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.***

Legend:

LA: Los Angeles
LB: Long Beach
OK: Oakland
SC: Sacramento
GS: SAC. Department of General Services
TS: SAC. Department of Transportation
UT: SAC. Department of Utilities
SD: San Diego
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Process Category	Ref.*	Best Management Practice	LA	LB	OK	SC	SD	SF	SJ	Notes
Quality Assurance / Quality Control	3.I.a.	Develop and use a standardized Project Delivery Manual	✓	2005	2005 ⑥	2005 GS:② UT:②	PI	✓	✓	SC: Started in 2003 SD: incorporated into PM training manual and standard primavera schedule template / descriptions. Details available, as needed.
	3.II.b.	Perform a formal Value Engineering Study for projects larger than $1,000,000	2005 ④	✓	N/I	✓	✓	✓	2004	LA: For projects > $1 million LB: On an as-needed bases SC: For projects > $5 million SF: On an as-needed basis SJ: For projects > $5 million
	3.III.a.	Use a formal Quality Management System	✓	2005 ③	N/I	PI	PI 2005	TBD ①	2004	SD: Some Divisions only
	3.III.b.	Perform and use Post Project Reviews to identify lessons learned	2004 ②	TBD	✓	✓ UT:③ TS:PI	✓	✓	PI ③	SF: On selected projects SD: 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 SJ: Individual C.O. < $100,000 SD: Individual C.O. < $200,000
	4.I.m.	Classify types of change orders	2004 ①	2005	✓	✓	PI 2004	✓	2004 ②	SD: Only for scope changes versus other types
	4.II.a.	Include a formal Dispute Resolution Procedure in all contract	✓	N/I	✓	✓	✓	✓	✓	
	4.III.a.	Use a team building process for projects greater than $5 million.	✓	✓	✓	✓	✓	✓	✓	LB: As-needed SD: As-needed SF: As-needed SJ: Formal process for projects > $10 million
	4.IV.a.	Involve the Construction Management Team before completion of design	✓	2004	✓	PI GS:③ TS:PI	✓	✓	✓	SD: Some Divisions only

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Process Category	Ref.*	Best Management Practice	LA	LB	OK	SC	SD	SF	SJ	Notes
Construction Management (Cont'd)	N/A (2003)	Delegate contract awards below council below $1 million	✓	✓	✓	N/I UT:① TS:N/I	✓	✓	✓	
	N/A (2003)	On large complex projects establish a pre-qualification process for contractors	✓	N/I	2004 ⑤	✓	✓	TBD ⑤	✓	
	N/A (2003)	Make bid documents available online	2004 ③	2004 ④	N/I	N/I TS: 2005	PI TBD	TBD ③	PI ⑤	SD: System options being evaluated
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 GS:④ TS:PI	✓	✓	✓	SD: Yearly PM academy, as funds allow
	5.III.a.	Adopt and use a Project Control System on all projects	✓	2004 ⑤	PI	PI UT:⑤	✓	✓	✓	SD: Project controls incorporated into Primavera schedule
	N/A (2003)	Create in-house project management team for small projects	N/I	N/I	PI	2003 GS:⑤ TS:N/I	PI TBD	N/I	✓	SD: Some Divisions only
	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 Use	6.c.	Include a standard consultant contract in the RFQ/RFP with a standard indemnification clause	✓	✓	✓	✓	PI TBD	✓	✓	SD: Some Divisions only
	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	N/I	N/I	2004 ①	N/I	✓	✓	N/I	
	6.g.	Implement and use a consultant rating system that identifies quality of consultant performance	✓	N/I	✓	2004 TS:N/I	✓	TBD ②	2004 ①	

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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.)

Table B – Project Delivery Cost Trends (Cumulative Data)

Project Delivery Phase	Percentage of Total Construction Cost* (All Agencies)		
	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%

* 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.

*Table C - CIP Delivery Data **

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

* 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

AGENCY*	DESIGN					CONSTRUCTION MANAGEMENT					PROJECT DELIVERY				
	In-House		Consultants		Total % of TCC**	In-House		Consultants		Total % of TCC**	In-House		Consultants		Total % of TCC**
	($)	% of DES	($)	% of DES		($)	% of CM	($)	% of CM		($)	% of PD	($)	% of PD	
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 Cost (Including all Change Orders, City Forces, and Utilities Relocation).

** 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








Department of PUBLICWORKS
CITY OF SACRAMENTO

OAKLAND
PUBLIC WORKS AGENCY

CITY OF
SAN JOSE
CAPITAL OF SILICON VALLEY

Agencies Overall Information

Information / Agency	Population	Area (Sq.mi.)	Website Address	Government Form	FY 03-04 to FY 05-06		
					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	700	307	1,262
Oakland	399,484	66.25	http://www.oaklandpw.com		95	175	173
Sacramento	418,700	98	http://www.pwsacramento.org	City Council-City Manager			
Department of General Services					29	79	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	779
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, involved with delivery of Capital Improvement Projects.

** 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.

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

Program	Fiscal Year							
	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	1.00	4
Public Facilities	0.50	4	0.35	2	0.15	2	1.00	8
Streets								
Public Thoroughfares	3.00	8	4.00	7	3.00	8	10.00	23
Pipes								
Storm Drains	2.00	1	0.30	1	0.00	0	2.30	2
Parks								
Parks, Recreation & Marine	1.00	2	1.00	2	1.00	2	3.00	6
II. Los Angeles	***255.20***	***115***	***444.70***	***122***	***561.60***	***70***	***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	1	0.00	0	5.00	1
Municipal Facilities	19.90	11	24.60	9	219.90	3	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	1	0.00	0	6.80	3
Zoo Bond	32.40	5	0.00	0	0.00	0	32.40	5
Streets								
Bridge Improvement	14.10	11	13.10	8	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	3	144.80	45

Program	Fiscal Year							
	2003-04		2004-05		2005-06		Total	
	TPC* ($M)	No.	TPC* ($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	6	11.10	5	21.50	9	44.42	20
Streets	26.09	41	20.90	37	18.81	33	65.80	111
Pipes	11.91	6	10.48	3	7.80	5	30.19	14
Parks	8.43	7	8.00	8	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	1	0.96	0	2.23	1	5.30	4
Environmental Services	3.40	2	4.25	3	6.97	5	14.62	12
Planning	0.01	0	0.00	0	0.00	0	0.01	0
Police	4.81	4	7.55	6	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	3	0.96	1	2.23	3	5.30	7
Engineering & Capital Projects	22.95	32	50.51	72	74.96	107	148.42	211
Park & Recreation	0.00	0	0.24	0	0.00	0	0.24	0
Planning	0.01	0	0.00	0	0.00	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	1	3.31	13
Park & Recreation	9.37	37	14.58	58	47.50	189	71.44	285

Program	Fiscal Year							
	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	3	91.10	11	208.20	15	420.30	29
Streets	16.30	9	95.40	13	21.00	10	132.70	32
Pipes	7.00	16	4.90	8	4.90	8	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	11	50.56	16	126.58	31
Library Bond	20.07	2	45.94	4	19.74	2	85.74	8
Civic Center	48.03	3			0.00	0	18.03	3
Airport Master Plan	19.13	4	331.83	9	1.17	1	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	0.00	0
Pipes								
Water	0.44	2	37.56	9	0.00	0	38.00	11
Wastewater	48.35	19	91.06	10	40.55	6	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.

Chapter 3

Best Management Practices Implementation








Department of PUBLICWORKS
CITY OF SACRAMENTO

OAKLAND
PUBLIC WORKS AGENCY

CITY OF
SAN JOSE
CAPITAL OF SILICON VALLEY

CHAPTER 3 Best Management Practices Implementation

A. INTRODUCTION

It 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 reliability, 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, gymnasiums, 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.

Table E-1 — IMPLEMENTATION OF BEST MANAGEMENT PRACTICES AND AGENCIES' TOP 5 PRIORITIES

Process Category	Ref.*	Best Management Practice	LA	LB	OK	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 ④	✓	✓	SD: Some Divisions only
	1.b.	Complete Feasibility Studies on projects prior to defining budget and scope	✓	✓	✓	✓	PI 2004 ③	✓	✓	LB: When applicable SD: Result of CIP Benchmarking SF: When applicable SJ: Some exceptions
	1.d.	Have a Board/Council project prioritization system	N/I	N/I	N/I	PI GS:① TS:✓	2004 ①	N/I	N/I	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 ①	✓	2004 TS: 2005	2004 ②	N/I	PI 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	✓	✓	N/I	N/I	✓	
	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 2004 ⑤	✓	✓	
	2.f.	Define requirements for reliability, maintenance, and operation prior to design initiation	✓	2004 ②	N/I	2004 TS:✓	PI	✓	✓	SD: Some Divisions only (Rest N/I)
	2.i.	Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc.)	✓	✓	✓	✓ UT:④	PI	✓	✓	SD: Some Divisions only , where applicable
	N/A	Train in-house staff to use Green Building Standards	✓	TBD	PI	✓	✓	✓	✓	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	

Instructions:

✓: Has been implemented
PI: Partially implemented
***yyyy: Will be implemented in calendar year "yyyy", ⊗ = 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.***

Legend:

LA: Los Angeles
LB: Long Beach
OK: Oakland
SC: Sacramento
SD: San Diego
SF: San Francisco
SJ: San Jose
GS: SAC. Department of General Services
TS: SAC. Department of Transportation
UT: SAC. Department of Utilities

Table E-1 — IMPLEMENTATION OF BEST MANAGEMENT PRACTICES AND AGENCIES' TOP 5 PRIORITIES

Process Category	Ref.*	Best Management Practice	LA	LB	OK	SC	SD	SF	SJ	Notes
Quality Assurance / Quality Control	3.I.a.	Develop and use a standardized Project Delivery Manual	✓	2005	2005 ⑥	2005 GS:② UT:②	PI	✓	✓	SC: Started in 2003 SD: incorporated into PM training manual and standard primavera schedule template / descriptions. Details available, as needed.
	3.II.b.	Perform a formal Value Engineering Study for projects larger than $1,000,000	2005 ④	✓	N/I	✓	✓	✓	2004	LA: For projects > $1 million LB: On an as-needed bases SC: For projects > $5 million SF: On an as-needed basis SJ: For projects > $5 million
	3.III.a.	Use a formal Quality Management System	✓	2005 ③	N/I	PI	PI 2005	TBD ①	2004	SD: Some Divisions only
	3.III.b.	Perform and use Post Project Reviews to identify lessons learned	2004 ②	TBD	✓	✓ UT:③ TS:PI	✓	✓	PI ③	SF: On selected projects SD: 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 SJ: Individual C.O. < $100,000 SD: Individual C.O. < $200,000
	4.I.m.	Classify types of change orders	2004 ①	2005	✓	✓	PI 2004	✓	2004 ②	SD: Only for scope changes versus other types
	4.II.a.	Include a formal Dispute Resolution Procedure in all contract	✓	N/I	✓	✓	✓	✓	✓	
	4.III.a.	Use a team building process for projects greater than $5 million.	✓	✓	✓	✓	✓	✓	✓	LB: As-needed SD: As-needed SF: As-needed SJ: Formal process for projects > $10 million
	4.IV.a.	Involve the Construction Management Team before completion of design	✓	2004	✓	PI GS:③ TS:PI	✓	✓	✓	SD: Some Divisions only

Instructions:

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PI: Partially implemented
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Process Category	Ref.*	Best Management Practice	LA	LB	OK	SC	SD	SF	SJ	Notes
Construction Management (Cont'd)	N/A (2003)	Delegate contract awards below council below $1 million	✓	✓	✓	N/I UT:① TS:N/I	✓	✓	✓	
	N/A (2003)	On large complex projects establish a pre-qualification process for contractors	✓	N/I	2004 ⑤	✓	✓	TBD ⑤	✓	
	N/A (2003)	Make bid documents available online	2004 ③	2004 ④	N/I	N/I TS: 2005	PI TBD	TBD ③	PI ⑤	SD: System options being evaluated
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 GS:④ TS:PI	✓	✓	✓	SD: Yearly PM academy, as funds allow
	5.III.a.	Adopt and use a Project Control System on all projects	✓	2004 ⑤	PI	PI UT:⑤	✓	✓	✓	SD: Project controls incorporated into Primavera schedule
	N/A (2003)	Create in-house project management team for small projects	N/I	N/I	PI	2003 GS:⑤ TS:N/I	PI TBD	N/I	✓	SD: Some Divisions only
	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 Use	6.c.	Include a standard consultant contract in the RFQ/RFP with a standard indemnification clause	✓	✓	✓	✓	PI TBD	✓	✓	SD: Some Divisions only
	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	N/I	N/I	2004 ①	N/I	✓	✓	N/I	
	6.g.	Implement and use a consultant rating system that identifies quality of consultant performance	✓	N/I	✓	2004 TS:N/I	✓	TBD ②	2004 ①	

Instructions:

✓: Has been implemented
PI: Partially implemented
***yyyy: Will be implemented in calendar year "yyyy", ⊗ = 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.***

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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 Category	Ref.*	Best Management Practice	LA	LB	OK	SC			SD	SF	SJ
						GS	Trnsp	Util			
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 Assurance / Quality Control	3.I.a.	Develop and use a standardized Project Delivery Manual	5	0	2	2	2	2	3	3	4
	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
	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-ment	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
	4.I.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 Manage-ment	5.I.f.	Assign a client representative to every project	5	5	5	4	5	4	1	5	5
	5.II.a	Provide formal training for Project Managers on a regular basis	5	2	5	3	5	1	3	5	2
	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 and Use	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
	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 Scale:

0 = No / Never
1: Up to 20%
2: Up to 40%
3: Up to 60%
4: Up to 80%
5: More than 80%
(OR AS DIFFERENT DEFINITION APPLICABLE)

Legend:

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.

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

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%

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.

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

Agency	Project Delivery (% of Total Construction Cost)			
	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%

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.

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

Agency	Project Delivery (% of Total Construction Cost)		
	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%

* 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.

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

			Agency*						
			A	B	C	D	E	F	G
PD% Improved ($2004_{ADJUSTED}$ – 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 (2004)	Limit Scope Changes to early stages of design	X10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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.I.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.I.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 (2003)	Make bid documents available online	X23	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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 (2003)	Create in-house project management team for small projects	X27	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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 clause	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 RFP 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

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

F. COMMUNICATION ON OTHER PROJECT DELIVERY IMPROVEMENTS

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).

Chapter 4

Performance Benchmarking








SEAL OF THE CITY AND COUNTY OF SAN FRANCISCO

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PUBLIC WORKS
CITY OF SACRAMENTO

OAKLAND
PUBLIC WORKS AGENCY

CITY OF
SAN JOSE
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CHAPTER 4 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 Projects – 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.

- Updated Projects Distribution Matrix – 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 R^2 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.

Table J — Update 2004 Projects

Update Year	TCC ≤ $100,000 (a)	Completion Date < 1997 (b)	Non-Representative (c)	Curb Ramp / Resurfacing Projects (d)	Total (e)	Corresponding Update 2004 Guidelines (f) = (e) – [(a)+(b)+(c)+(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**

^^^^^^
Basis for Update 2004

Table K — Projects Distribution Matrix

Project Type / Agency	Long Beach	Los Angeles	Oakland	Sacramento	San Diego	San Francisco	San Jose	Total All Agencies
Municipal Facilities	**8**	**36**	**15**	**13**	**8**	**19**	**24**	**123**
Libraries	0	19	3	1	3	2	2	30
Police/Fire Station	2	9	9	1	2	11	5	39
Community Bldg./Rec. Center/CC/Gym	6	8	3	11	3	6	17	54
Streets	**11**	**17**	**27**	**29**	**34**	**27**	**35**	**180**
Widening/New/Grade Separation	1	3	2	11	13	3	6	39
Bridge (Retrofit, New)	0	13	0	1	5	3	1	23
Reconstruction	3	1	9	4	2	3	2	24
Bike/Pedestrian	1	0	4	3	3	3	5	19
Signals	6	0	12	10	11	15	21	75
Pipe Systems	**0**	**51**	**19**	**0**	**68**	**34**	**20**	**192**
Gravity System (Storm Drains, Sewers)	0	38	18	0	41	22	20	139
Pressure Systems	0	0	0	0	23	6	0	29
Pump Stations	0	13	1	0	4	6	0	24
Parks	**6**	**1**	**7**	**0**	**7**	**24**	**55**	**100**
Playgrounds	2	0	3	0	1	21	44	71
Sportfields	1	1	3	0	3	1	5	14
Restrooms	3	0	1	0	3	2	6	15
Total All Types	**25**	**105**	**68**	**42**	**117**	**104**	**134**	**595**

*Table L — CIP Delivery Data **

PROJECT TYPE CLASIFICATION	Total Construction Cost (TCC)	Design Cost (% of TCC)	CM Cost (% of TCC)	Total Project Delivery cost (% of TCC)	Est. Total Duration (Months)	Number of Projects**
Municipal Facilities						
Libraries	TCC< $0.5M	42% - 47%	32% - 37%	74% - 82%	36 - 45	
	$0.5M<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	22% - 27%	12% - 15%	34% - 40%	36 - 49	39
	TCC> $3M	16% - 21%	9% - 12%	26% - 32%	53 - 66	
Community Building / Rec. Center/CC/Gym	TCC< $0.5M	26% - 32%	23% - 33%	49% - 60%	19 - 29	
	$0.5M<TCC<$3M	22% - 28%	15% - 24%	36% - 48%	30 - 40	54
	TCC> $3M	18% - 24%	8% - 17%	25% - 36%	40 - 50	
Streets						
Widening / New / Grade Separation	TCC< $0.5M	26% - 31%	12% - 18%	38% - 45%	14 - 26	
	$0.5M<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	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	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	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	10% - 15%	14% - 20%	24% - 32%	33 - 39	69
	TCC> $3M	5% - 10%	8% - 14%	13% - 21%	49 - 55	
Pipes						
Gravity System (Storm Drains, Sewers)	TCC< $0.5M	20% - 23%	18% - 21%	37% - 42%	12 - 31	
	$0.5M<TCC<$3M	14% - 17%	14% - 17%	28% - 33%	49 - 68	133
	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	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	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	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	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	31% - 37%	45% - 55%	76% - 90%	47 - 56	15
	TCC> $3M	39% - 44%	61% - 71%	100% - 114%	69 - 77	

* 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







CHAPTER 5 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

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.

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Appendix A

Performance Models







APPENDIX A

Performance Models

PERFORMANCE QUESTIONNAIRE

Agency: | **Project Name:**

Project type:

New/Rehab Index:

Description:

Comments:

	Planning		Design		Construction		Total	
	DOLLAR	**% of TCC***	**DOLLAR**	**% of TCC***	**DOLLAR**	**% of TCC***	**DOLLAR**	**% of TCC***
AGENCY LABOR								
AGENCY COSTS(1)								
Art Fees								
SUB-TOTAL AGENCY								
CONSULTANT								
TOTALS								
PHASE DURATION		Months		Months		Months		

AMOUNT OF CONSTRUCTION CONTRACT						
COST OF CHANGE ORDERS	Unforeseen & Changed Conditions:		Errors & Ommissions in the Documents:		Other / Client Changes:	$ -
	All Credit Change Orders					
UTILITY RELOCATION COST						
CITY FORCES CONSTRUCTION						
TOTAL CONSTRUCTION COST (TCC)						
LAND ACQUISITION						
PROJECT COMPLETION 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)

CURVES GROUP 1

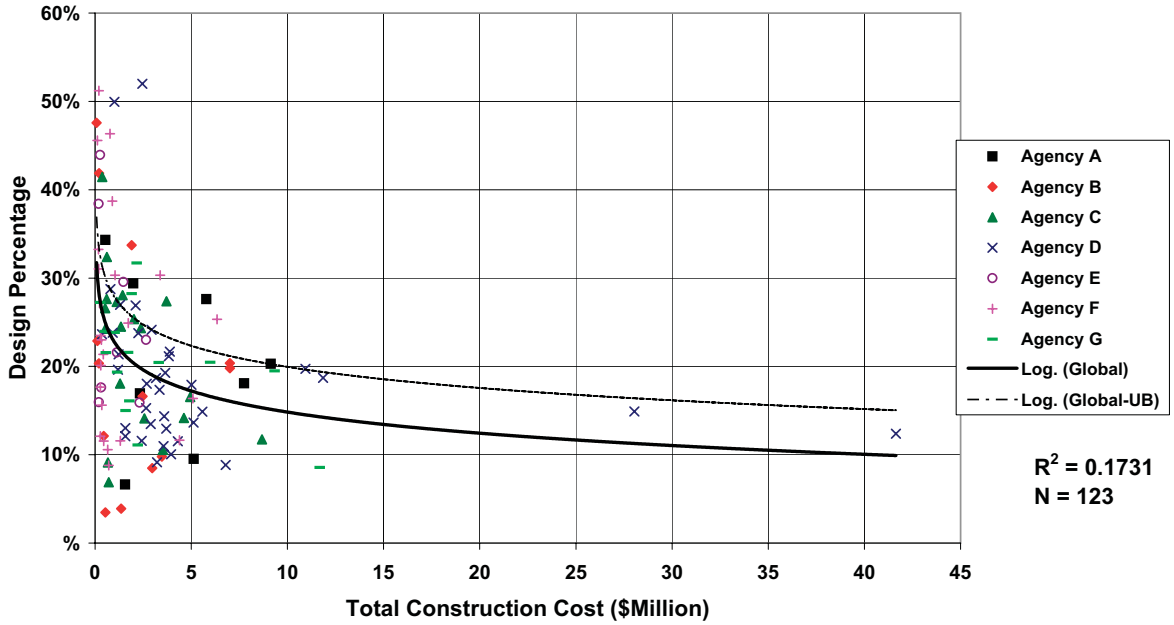
Design Cost / Construction Cost

Versus

Total Construction Cost

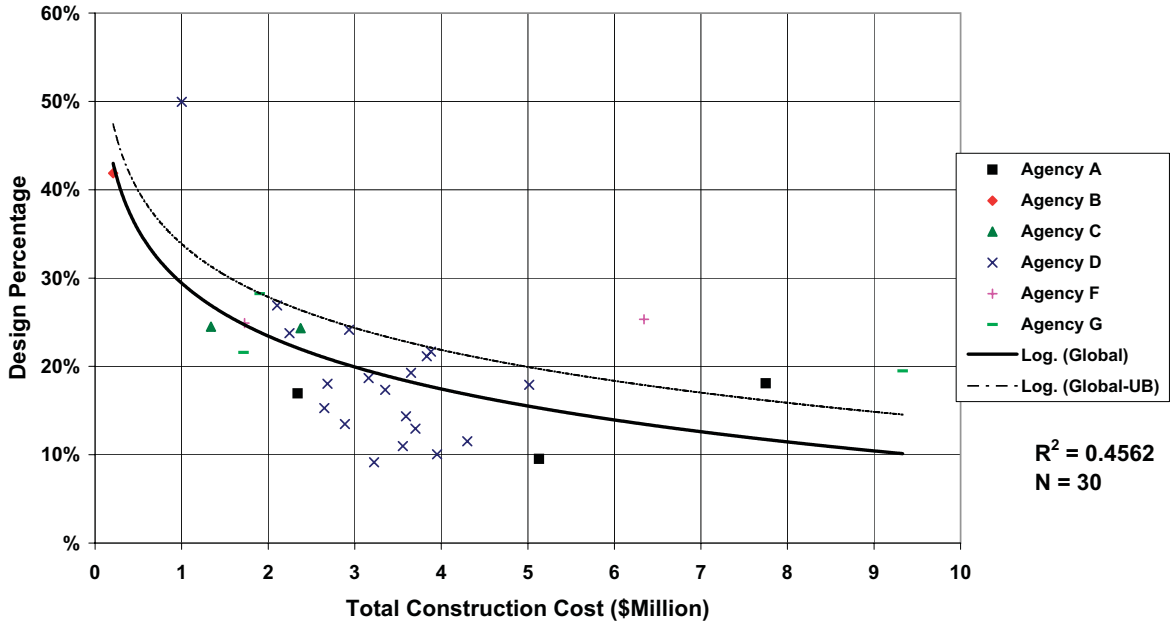
Municipal Facilities - All Classification

Design Percentage Versus Total Construction Cost



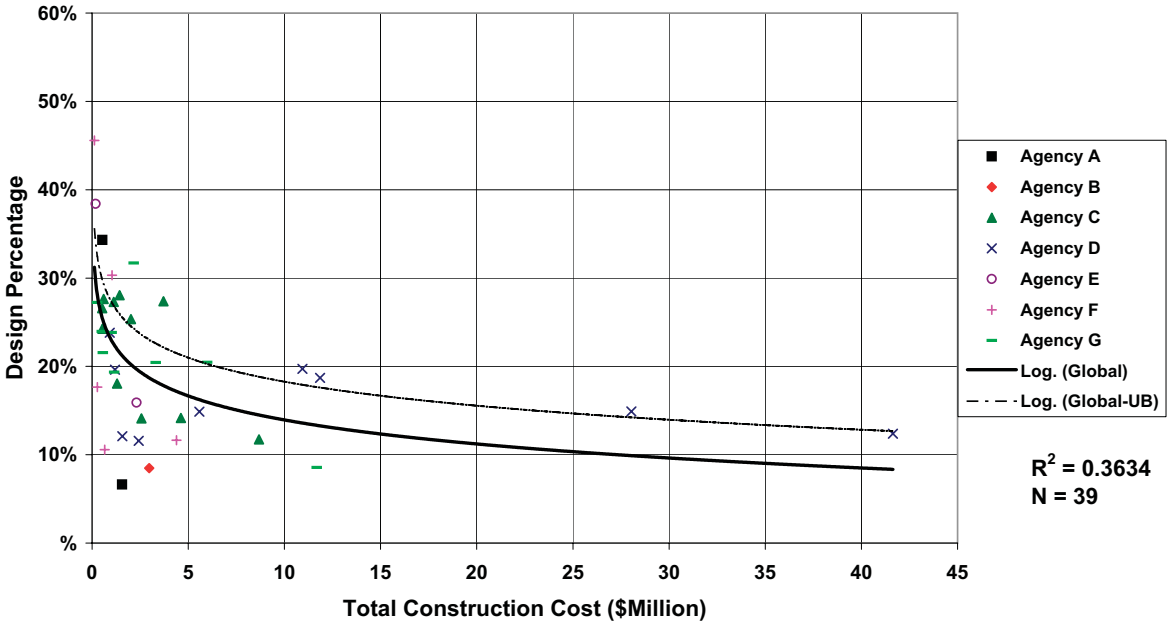
Municipal Facilities - Libraries

Design Percentage Versus Total Construction Cost



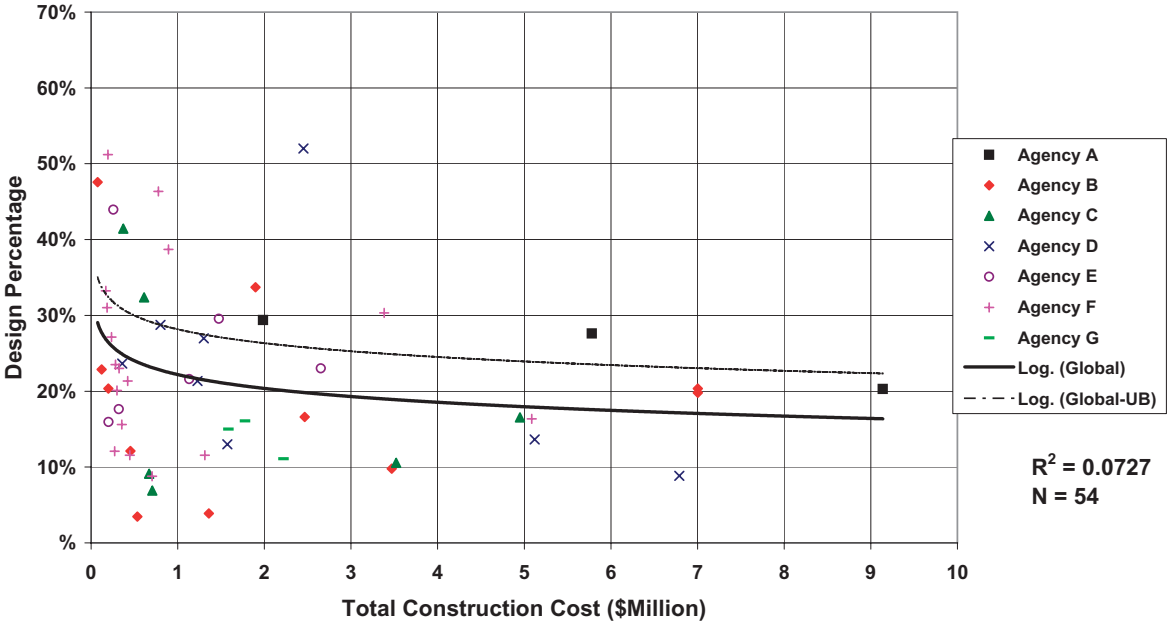
Municipal Facilities - Police / Fire Station

Design Percentage Versus Total Construction Cost



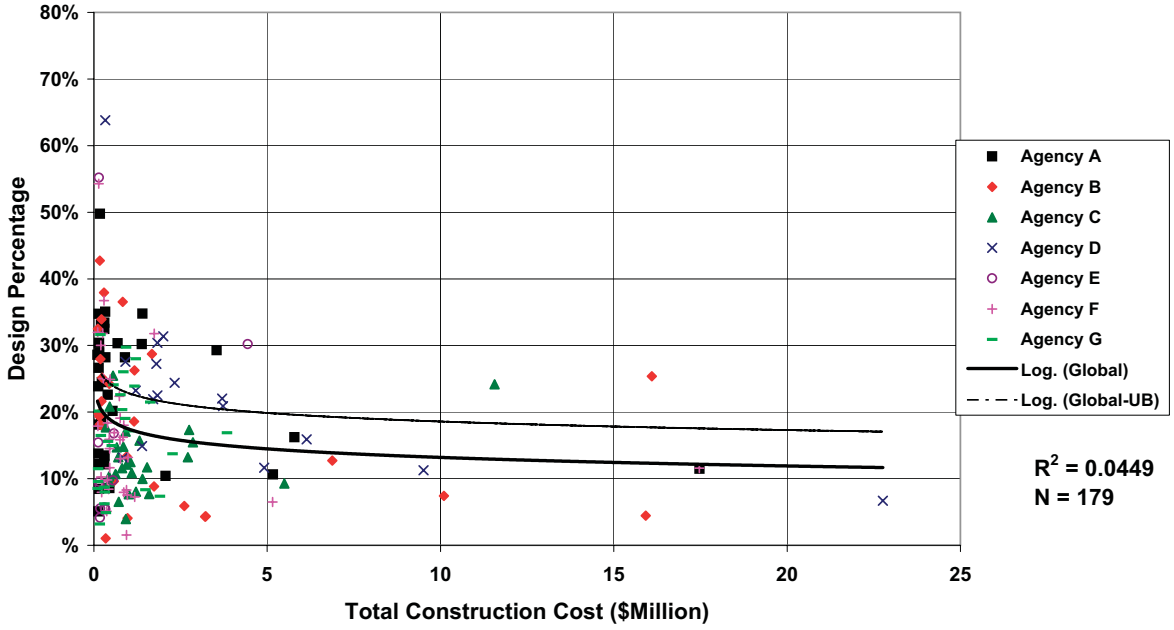
Municipal Facilities - Community Bldg./Rec. Center/CC/Gym

Design Percentage Versus Total Construction Cost



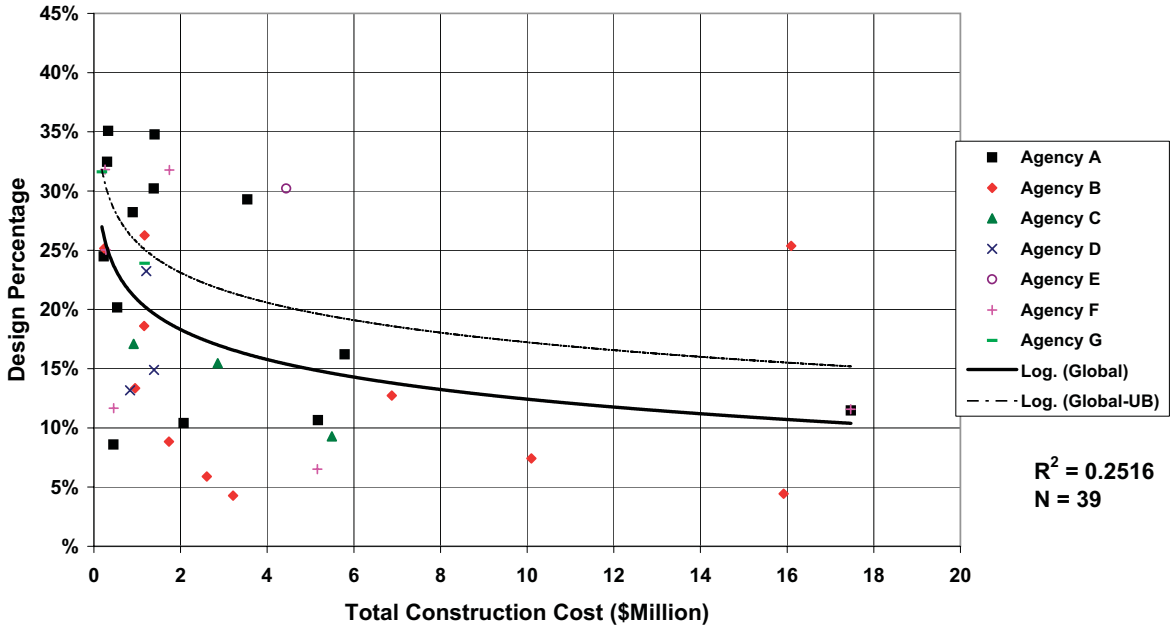
Streets - All Classification

Design Percentage Versus Total Construction Cost



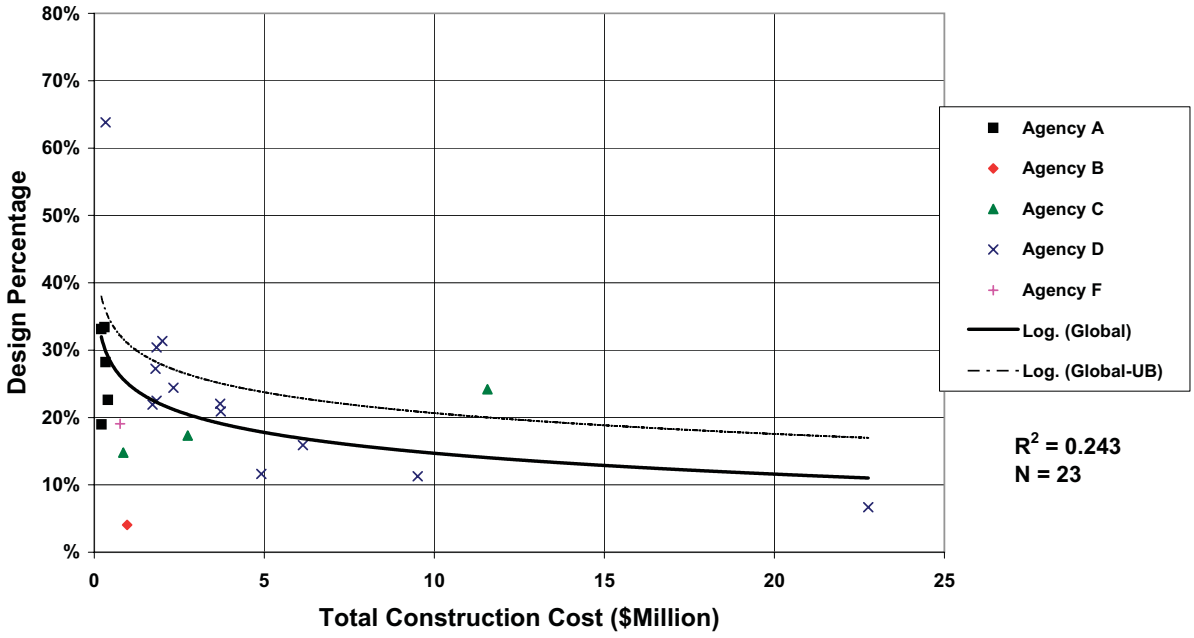
Streets - Widening / New / Grade Separation

Design Percentage Versus Total Construction Cost



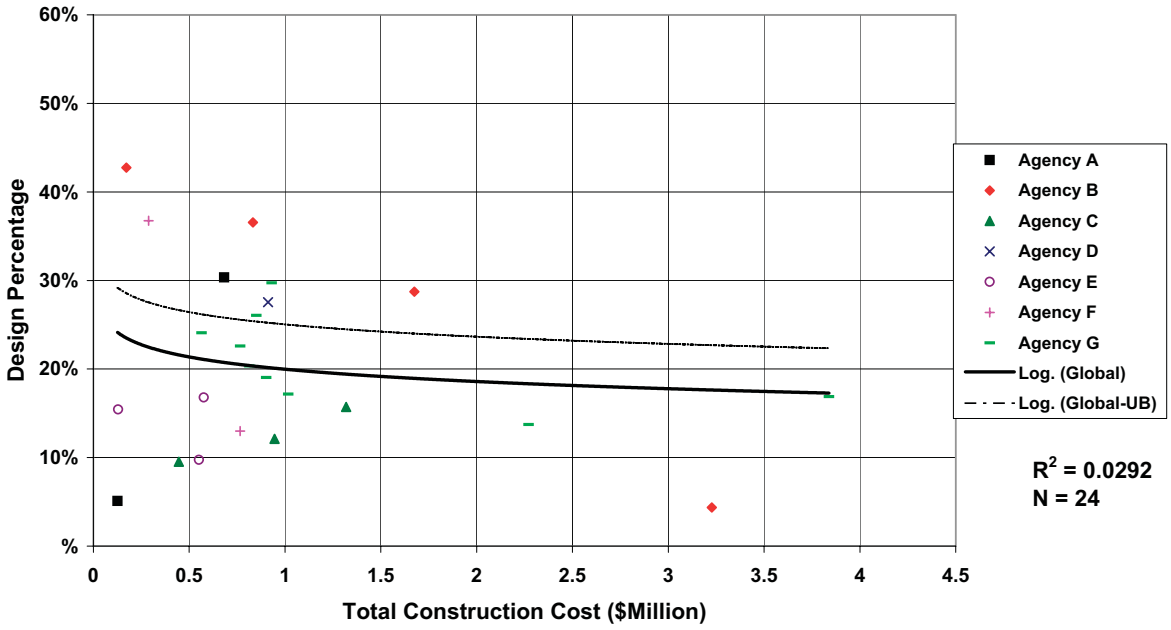
Streets - Bridges (Retrofit, New)

Design Percentage Versus Total Construction Cost



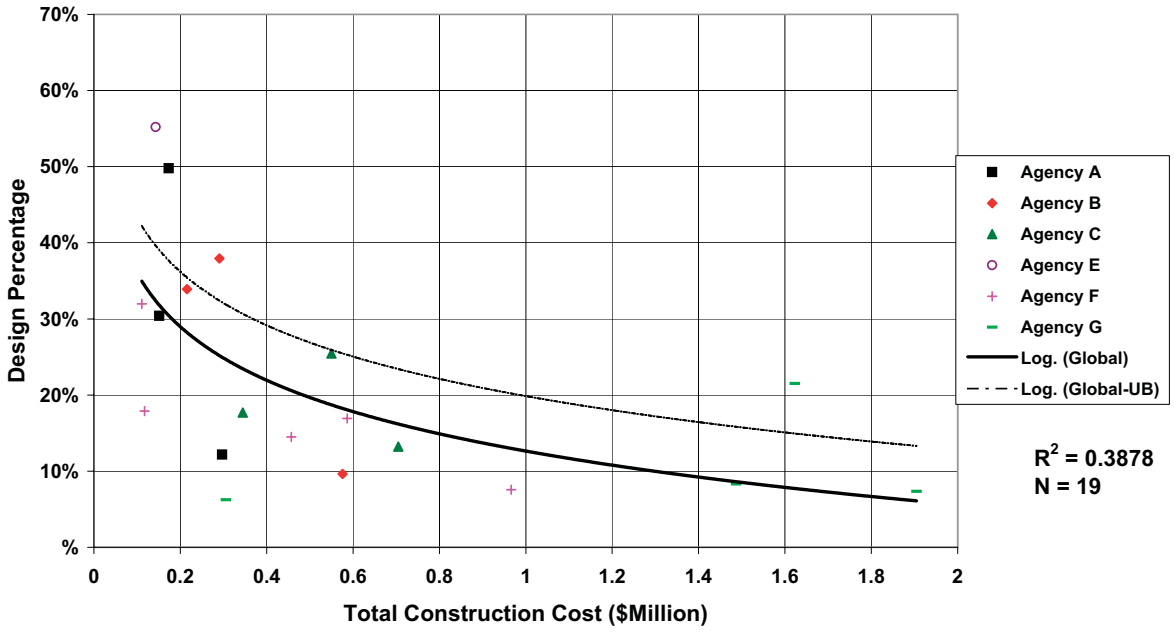
Streets - Reconstruction

Design Percentage Versus Total Construction Cost



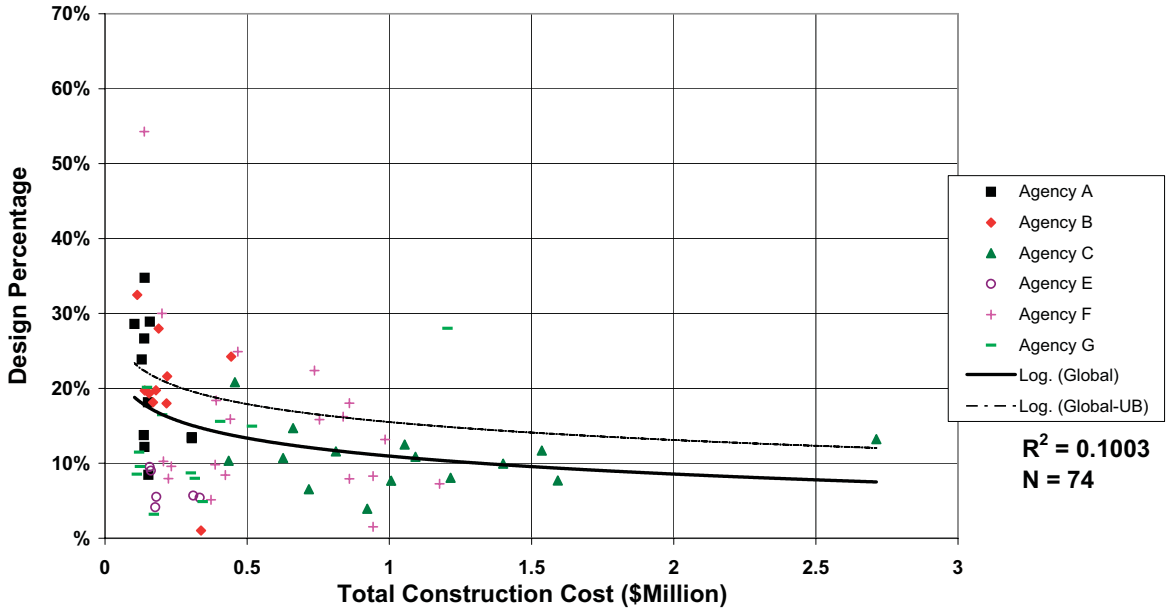
Streets - Bike / Pedestrian

Design Percentage Versus Total Construction Cost



Streets - Signals*

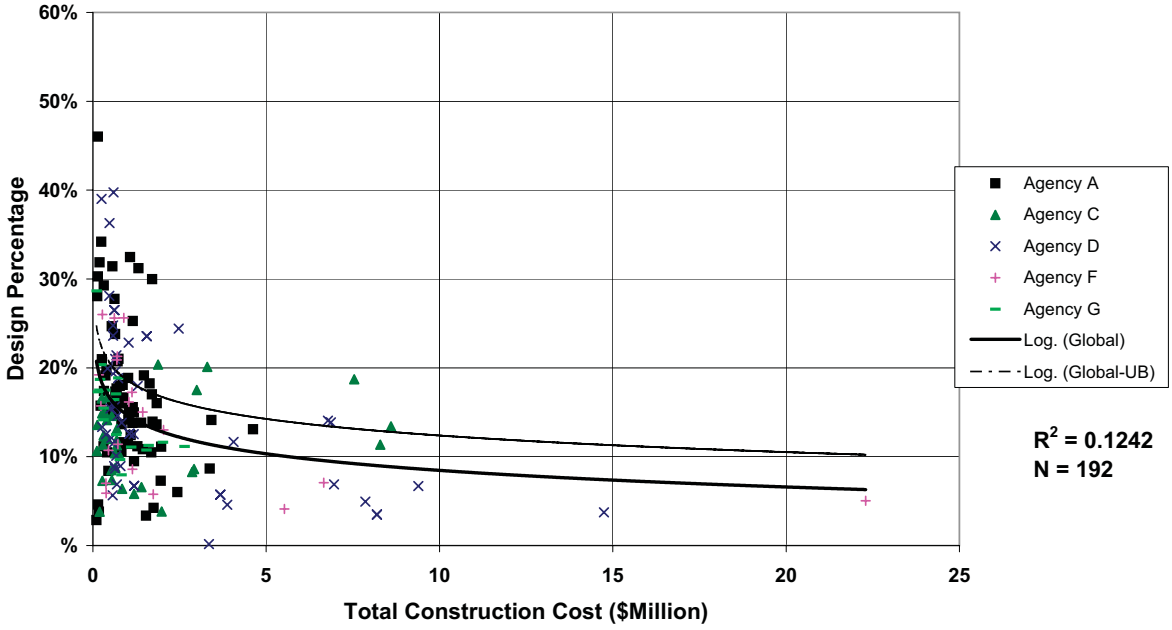
Design Percentage Versus Total Construction Cost



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

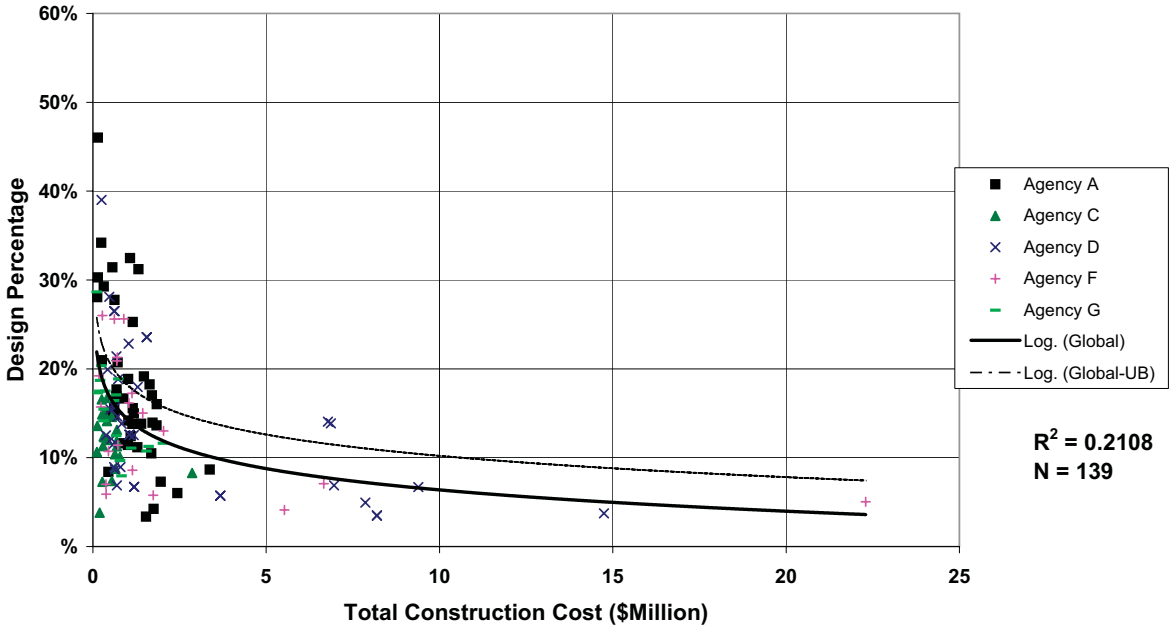
Pipe Systems - All Classification

Design Percentage Versus Total Construction Cost



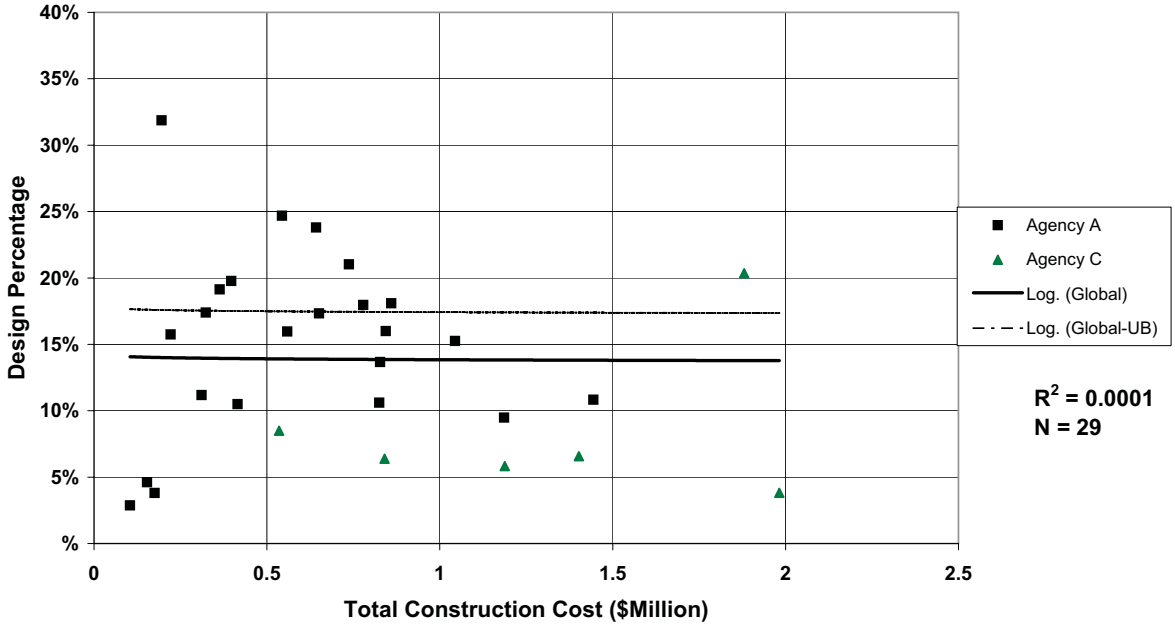
Pipe Systems - Gravity System (Storm Drains, Sewers)

Design Percentage Versus Total Construction Cost



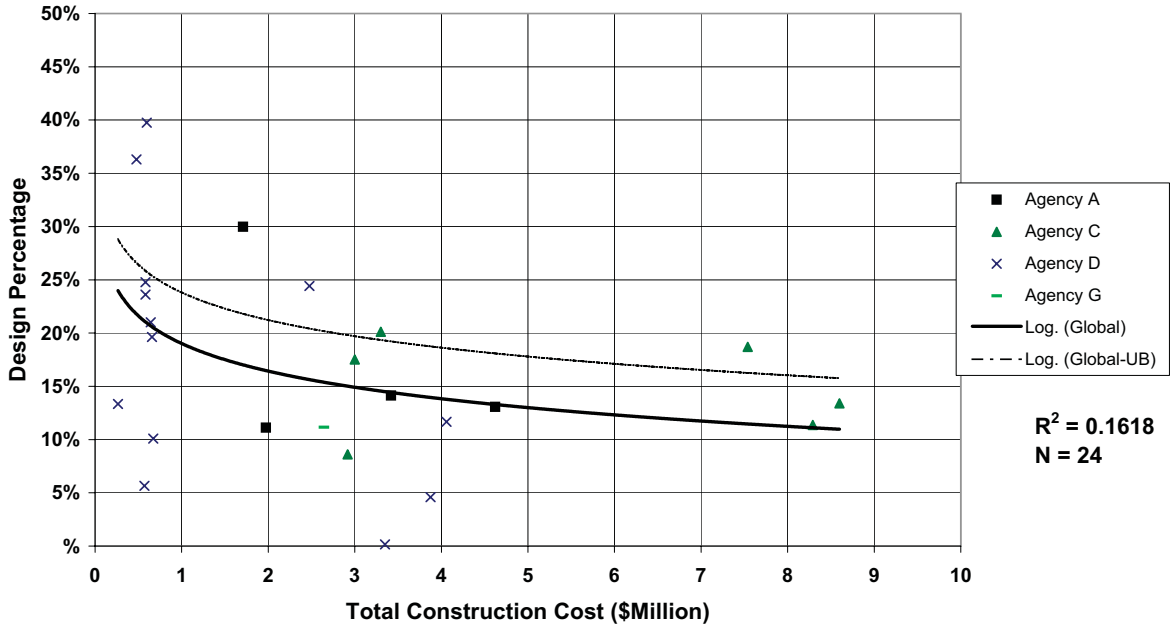
Pipe Systems - Pressure Systems

Design Percentage Versus Total Construction Cost



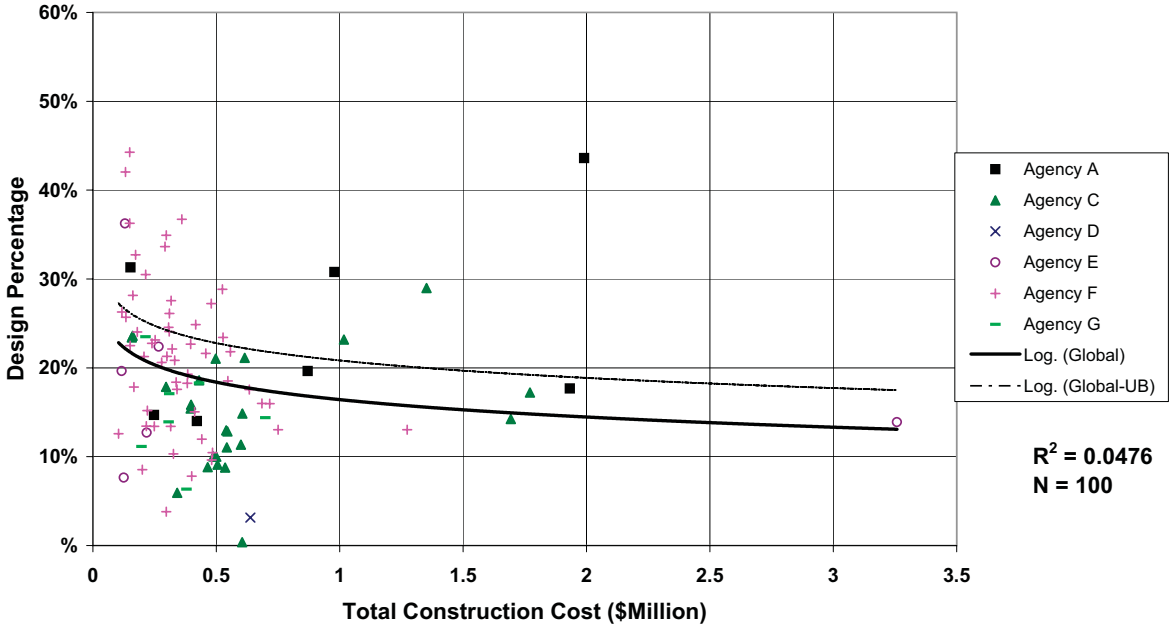
Pipe Systems - Pump Stations

Design Percentage Versus Total Construction Cost



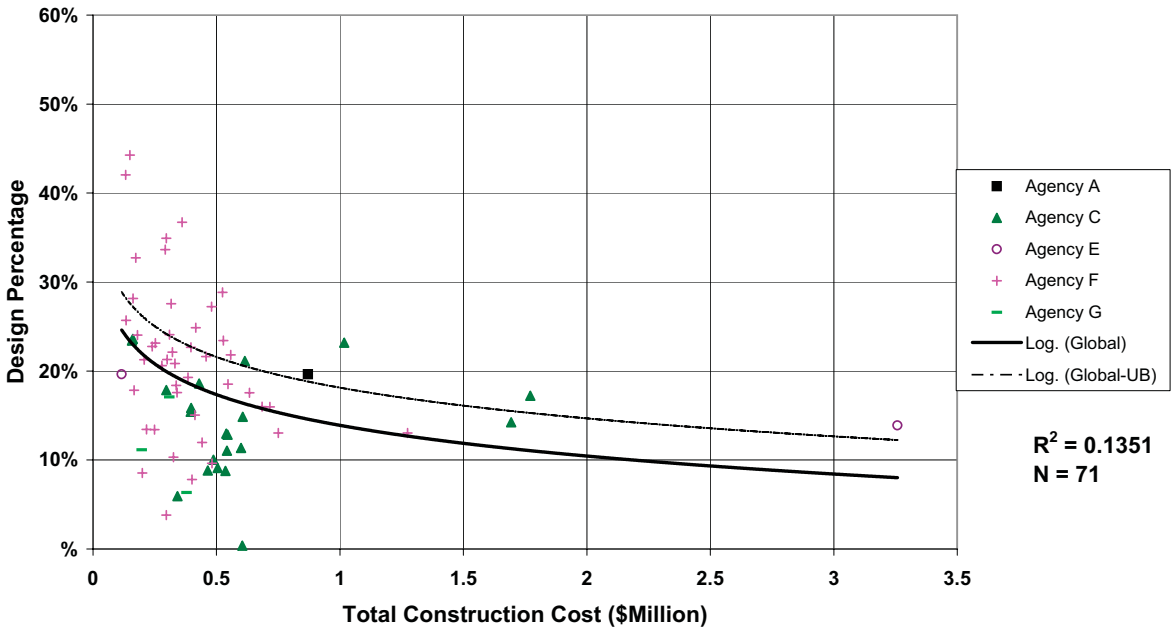
Parks - All Classification

Design Percentage Versus Total Construction Cost



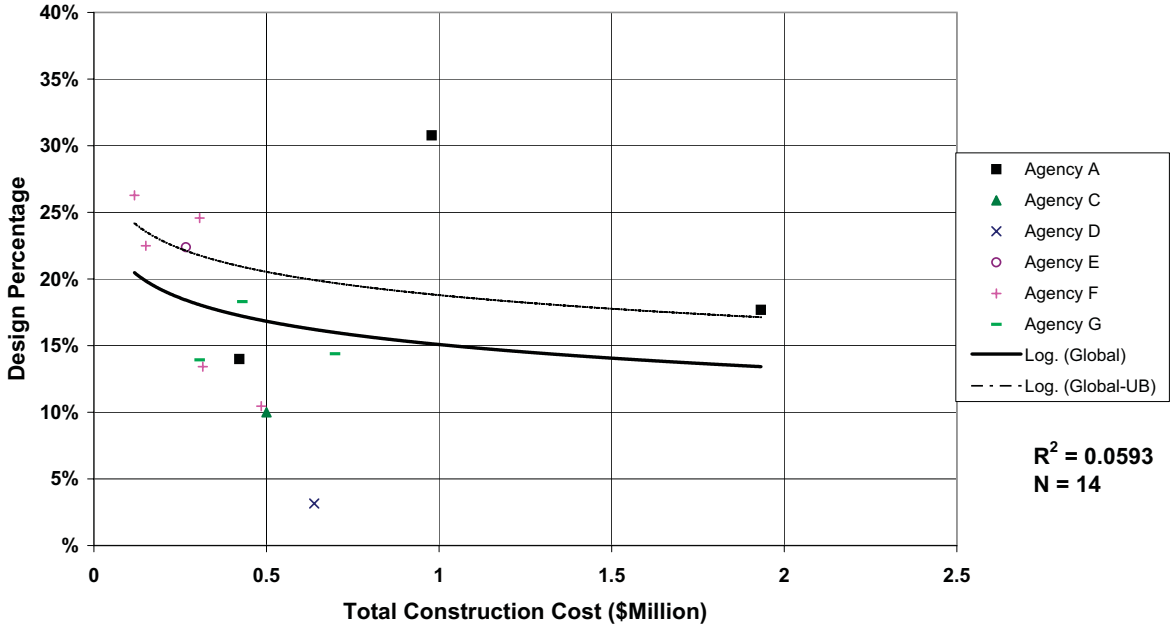
Parks - Playgrounds

Design Percentage Versus Total Construction Cost



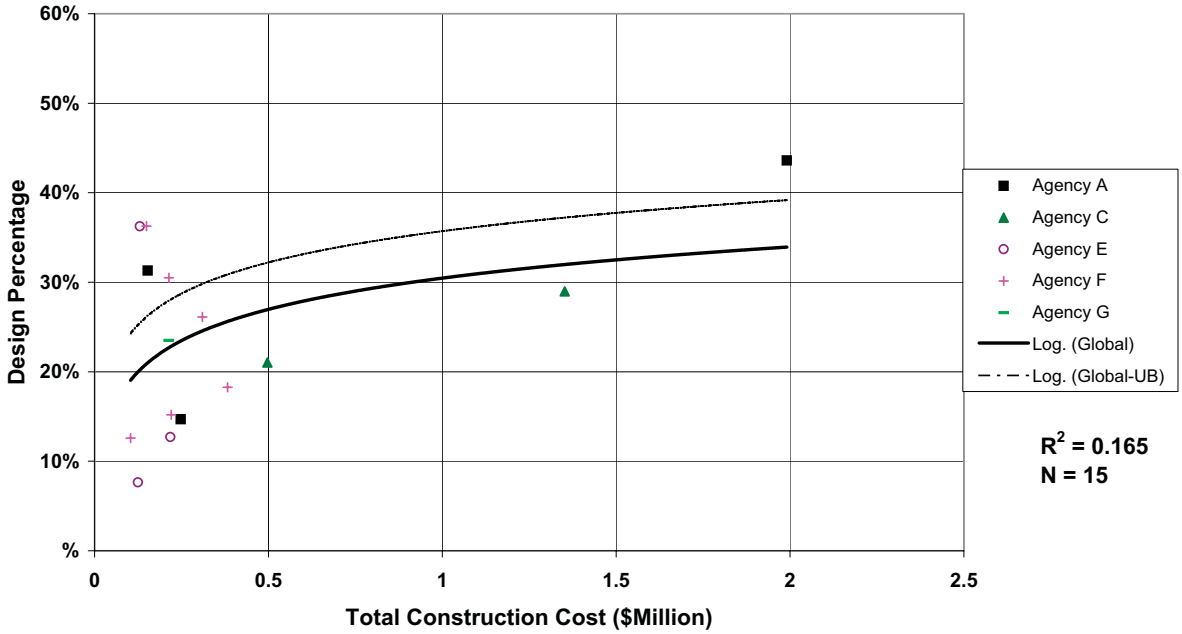
Parks - Sportfields

Design Percentage Versus Total Construction Cost



Parks - Restrooms

Design Percentage Versus Total Construction Cost



CURVES GROUP 2

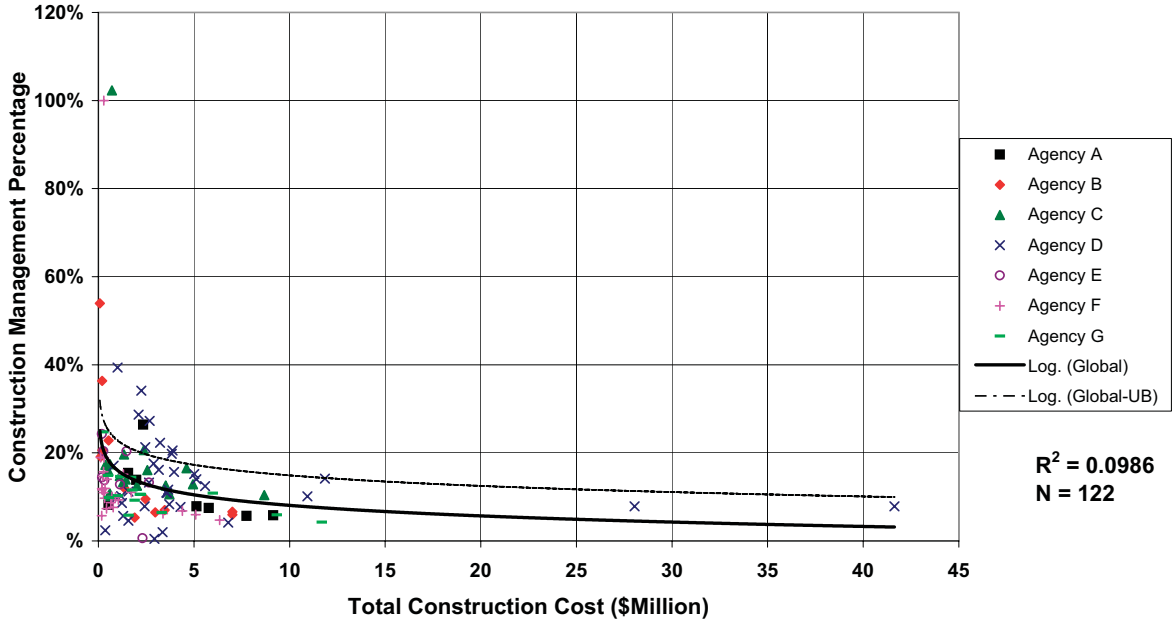
Construction Management Cost / Construction Cost

Versus

Total Construction Cost

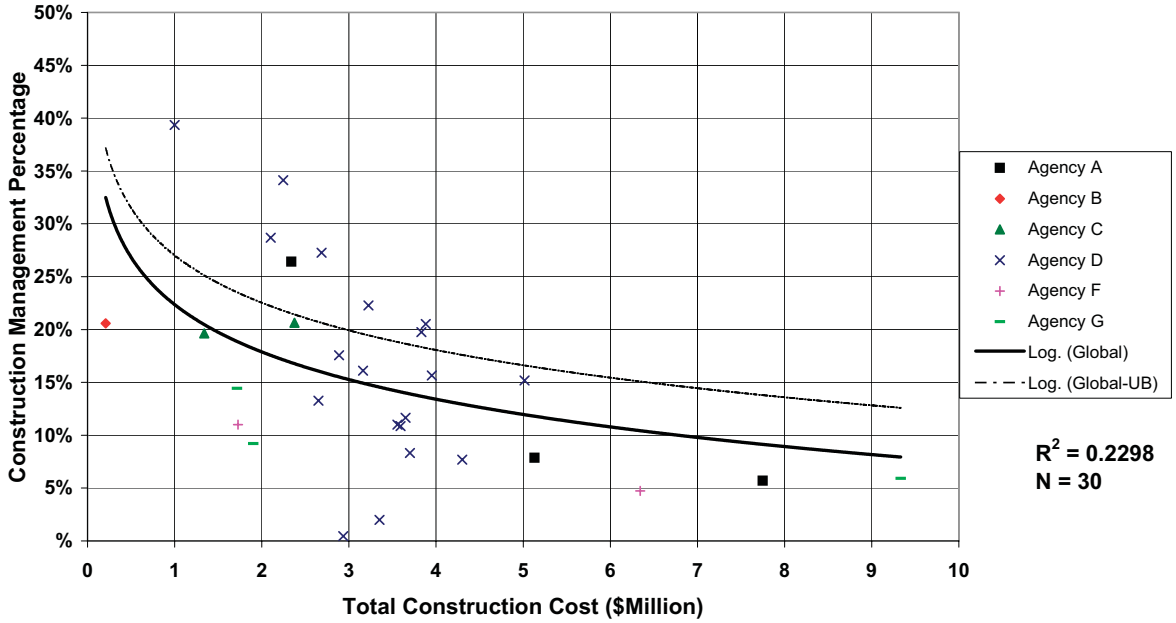
Municipal Facilities - All Classification

Construction Management Percentage Versus Total Construction Cost



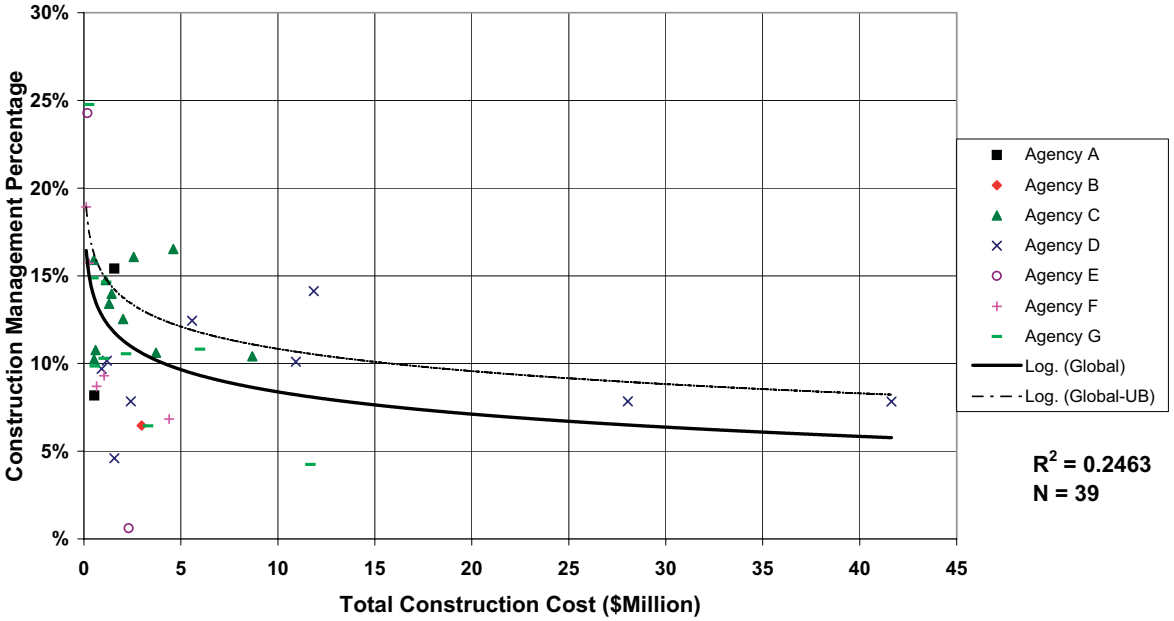
Municipal Facilities - Libraries

Construction Management Percentage Versus Total Construction Cost



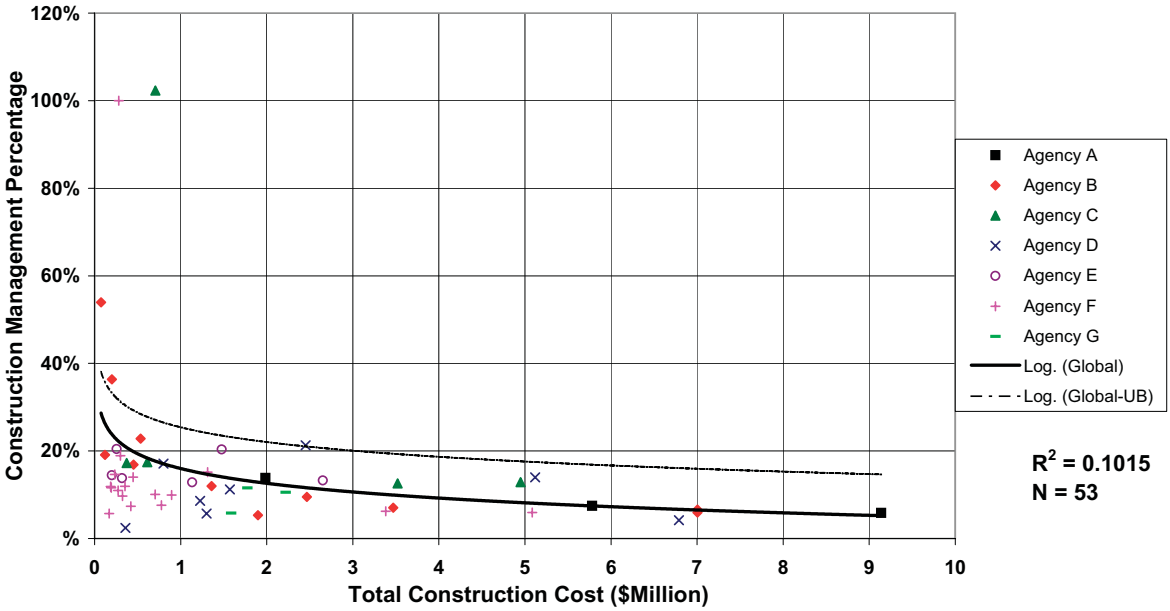
Municipal Facilities - Police / Fire Station

Construction Management Percentage Versus Total Construction Cost



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

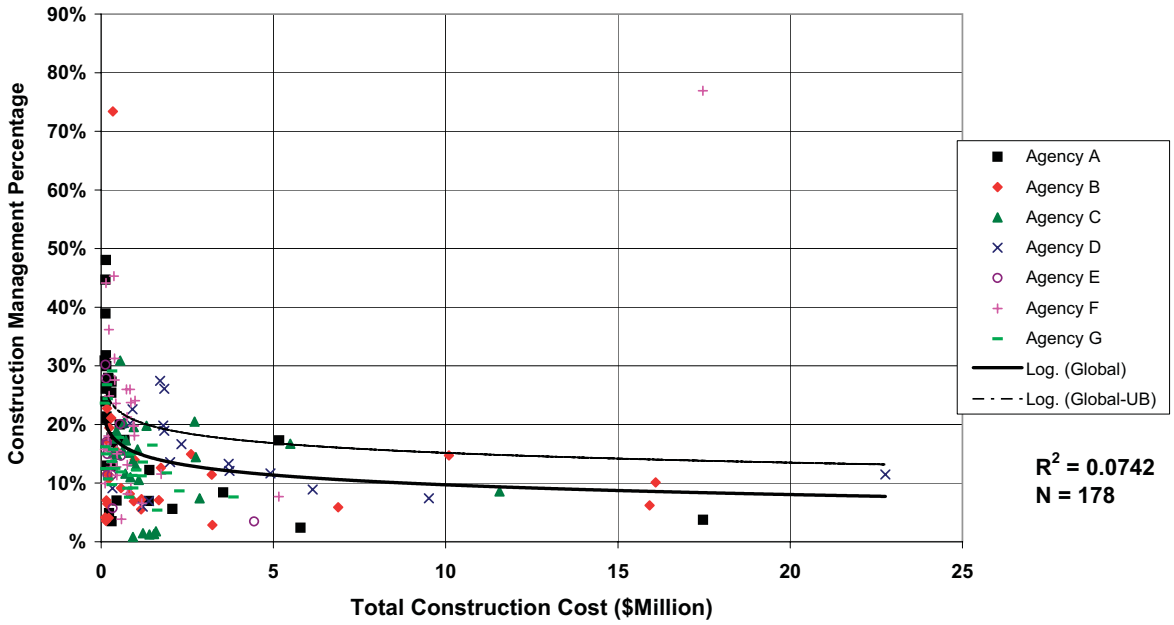
Construction Management Percentage Versus Total Construction Cost



* One Community Building … project had zero Total Construction Cost and was excluded from this graph

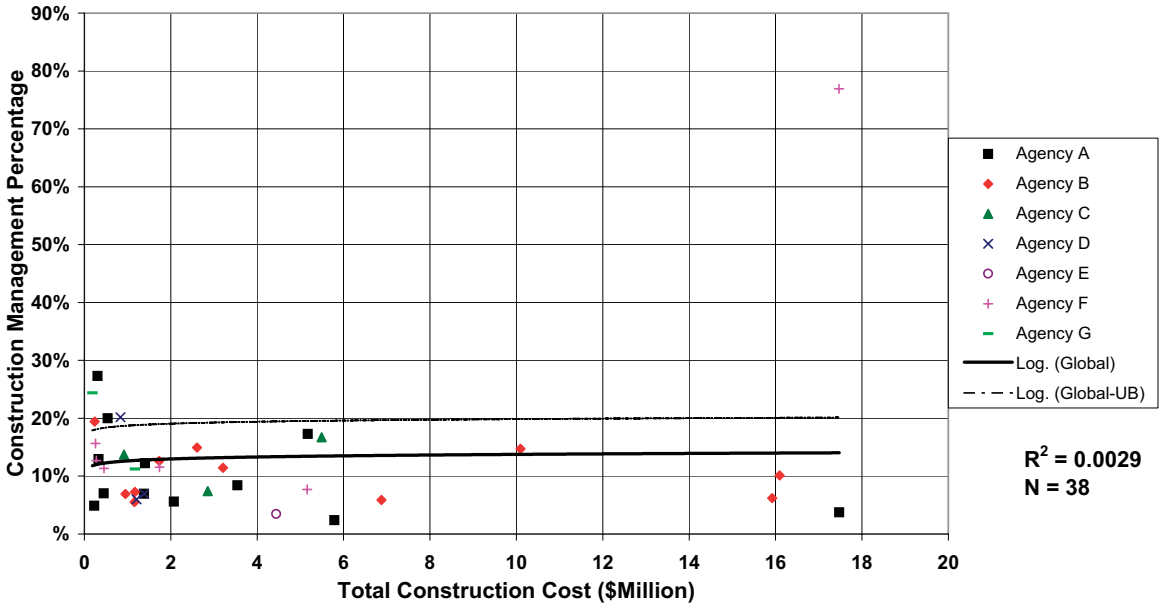
Streets - All Classification

Construction Management Percentage Versus Total Construction Cost



Streets - Widening / New / Grade Separation*

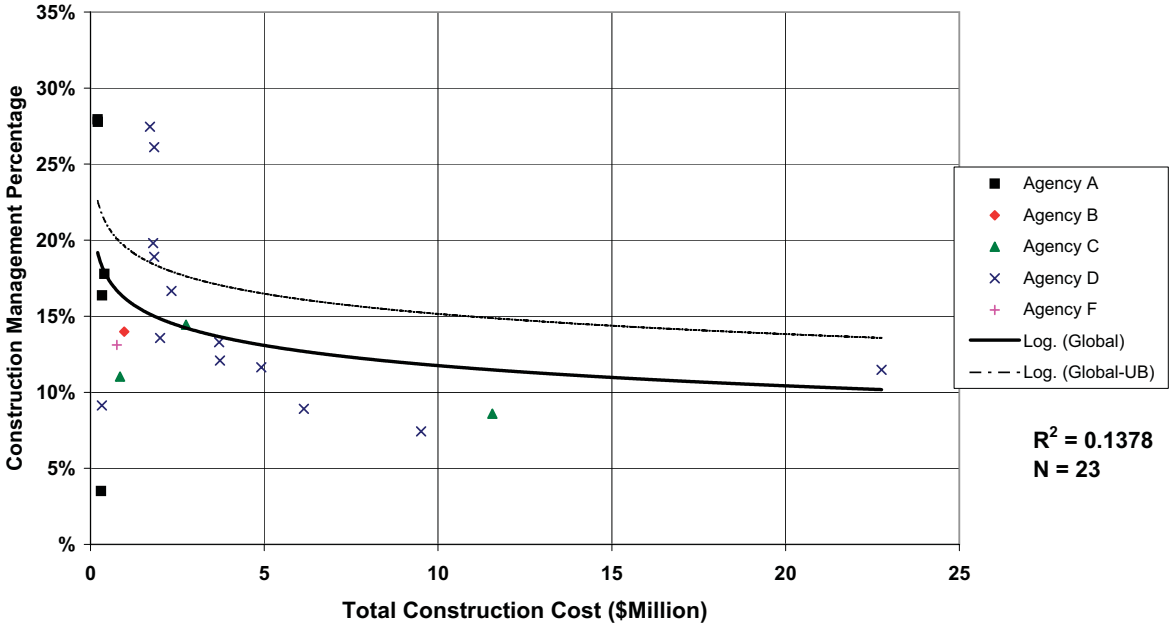
Construction Management Percentage Versus Total Construction Cost



* One Widening … project had zero Construction Management Cost and was excluded from this

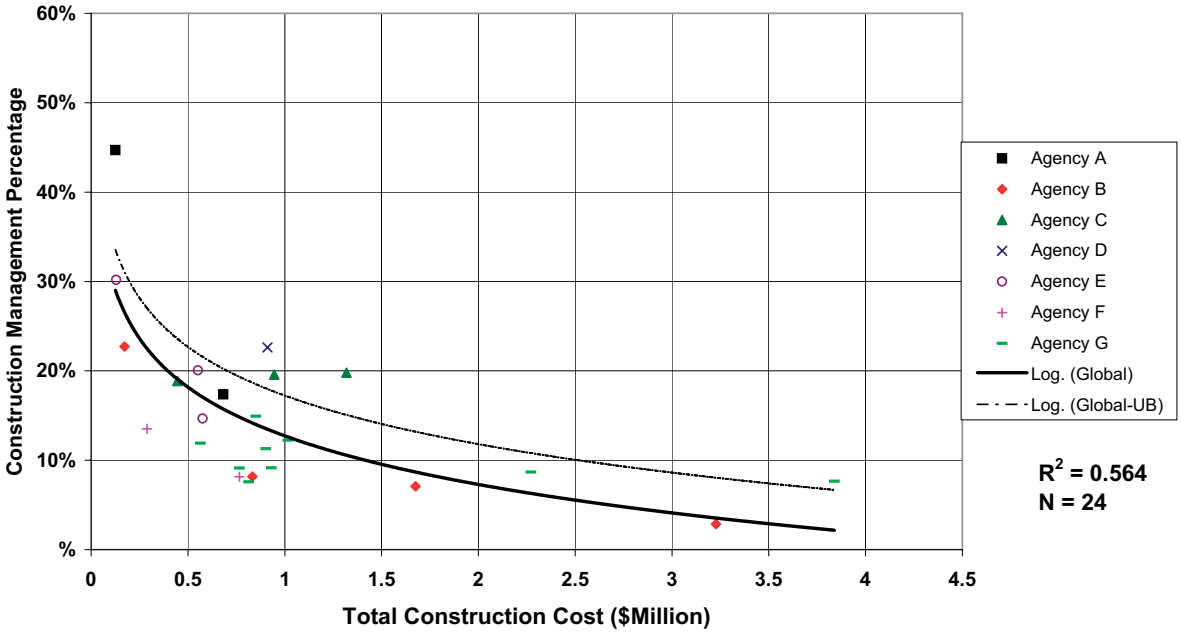
Streets - Bridges (Retrofit, New)

Construction Management Percentage Versus Total Construction Cost



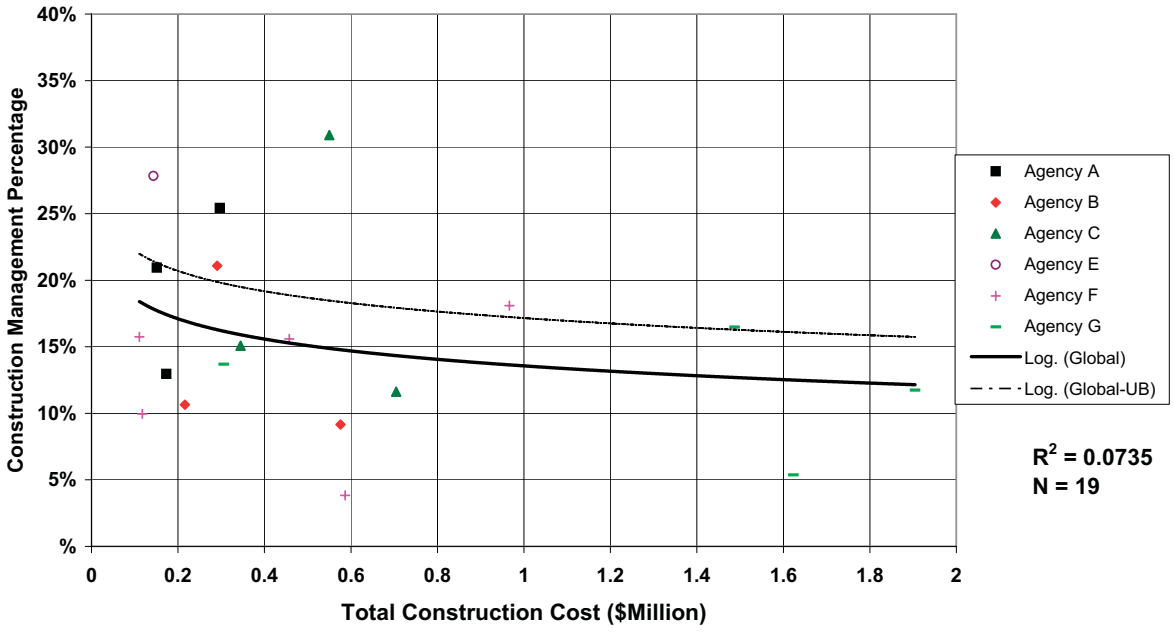
Streets - Reconstruction

Construction Management Percentage Versus Total Construction Cost



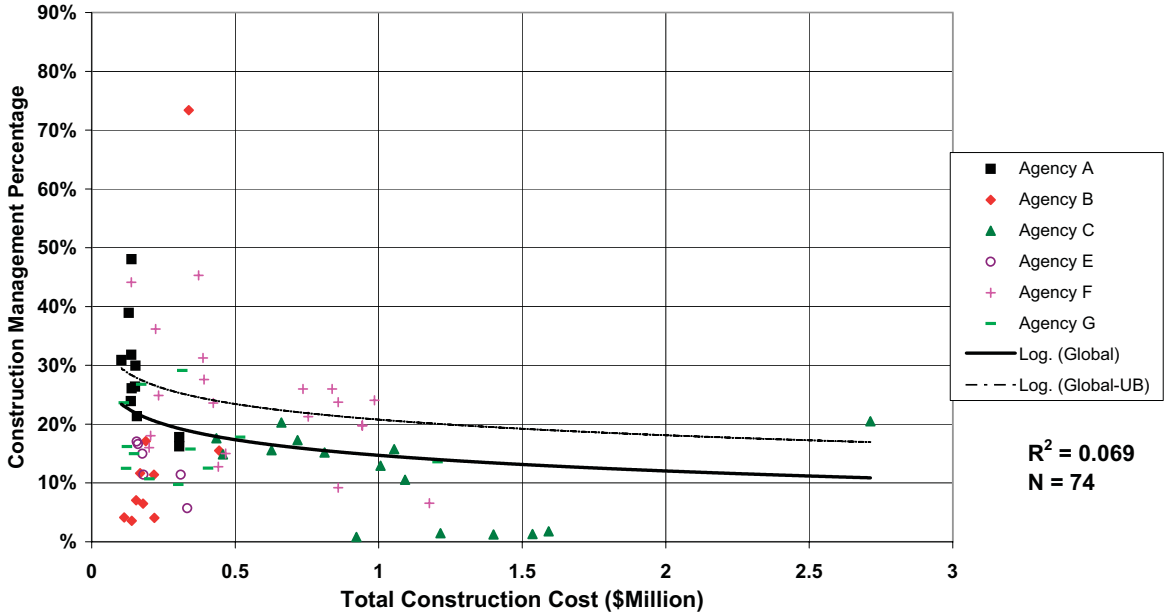
Streets - Bike / Pedestrian

Construction Management Percentage Versus Total Construction Cost



Streets - Signals *

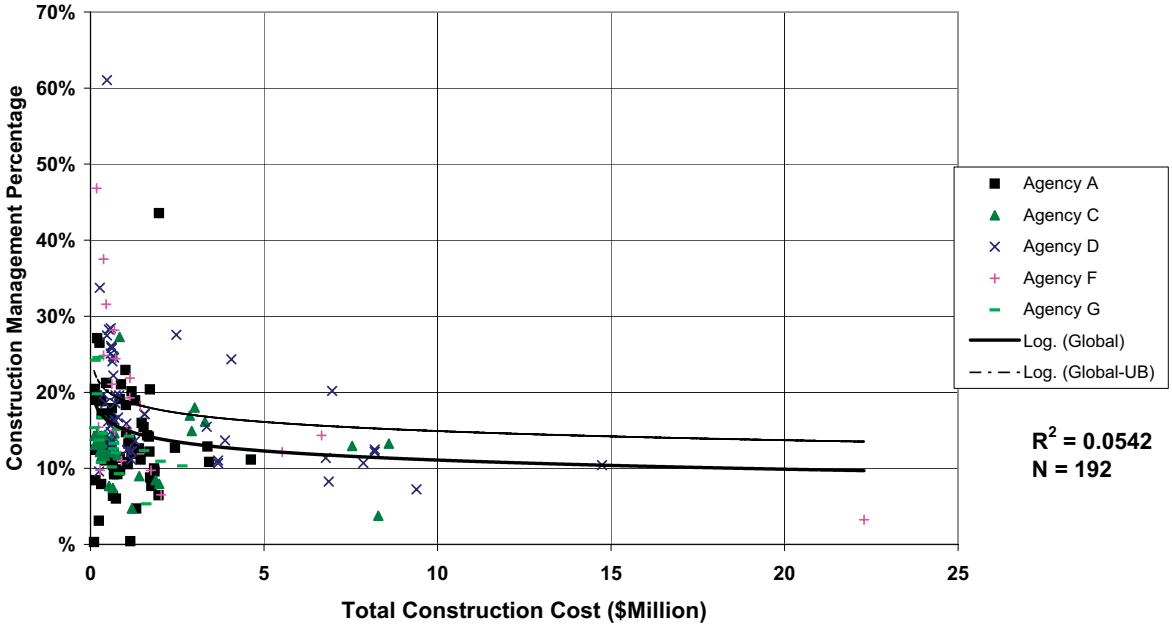
Construction Management Percentage Versus Total Construction Cost



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

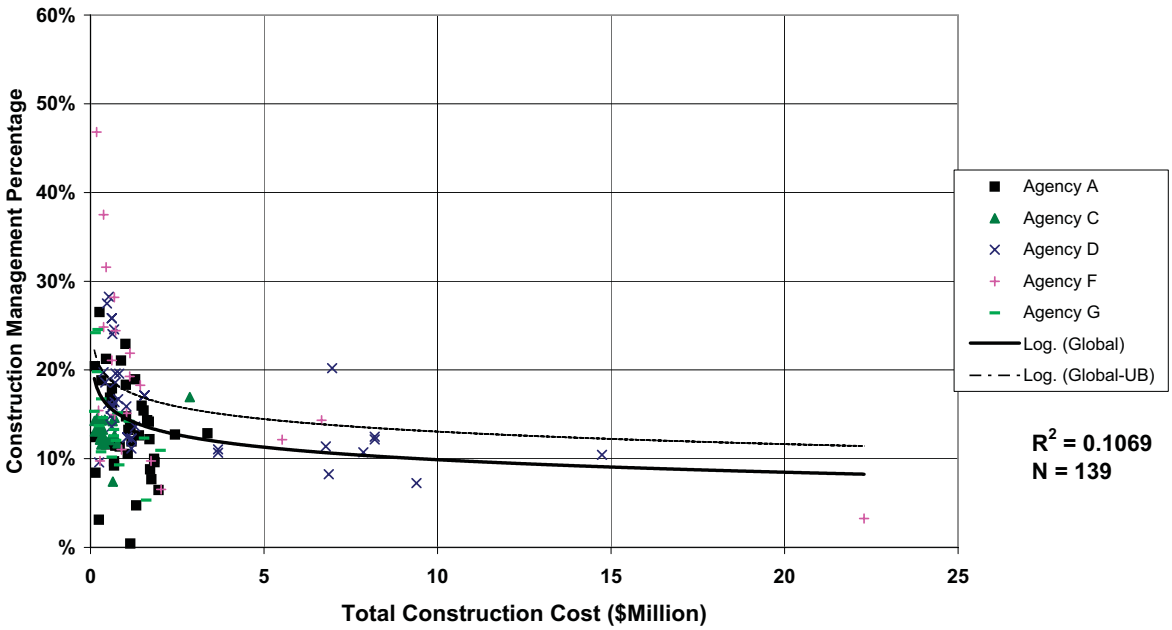
Pipe Systems - All Classification

Construction Management Percentage Versus Total Construction Cost



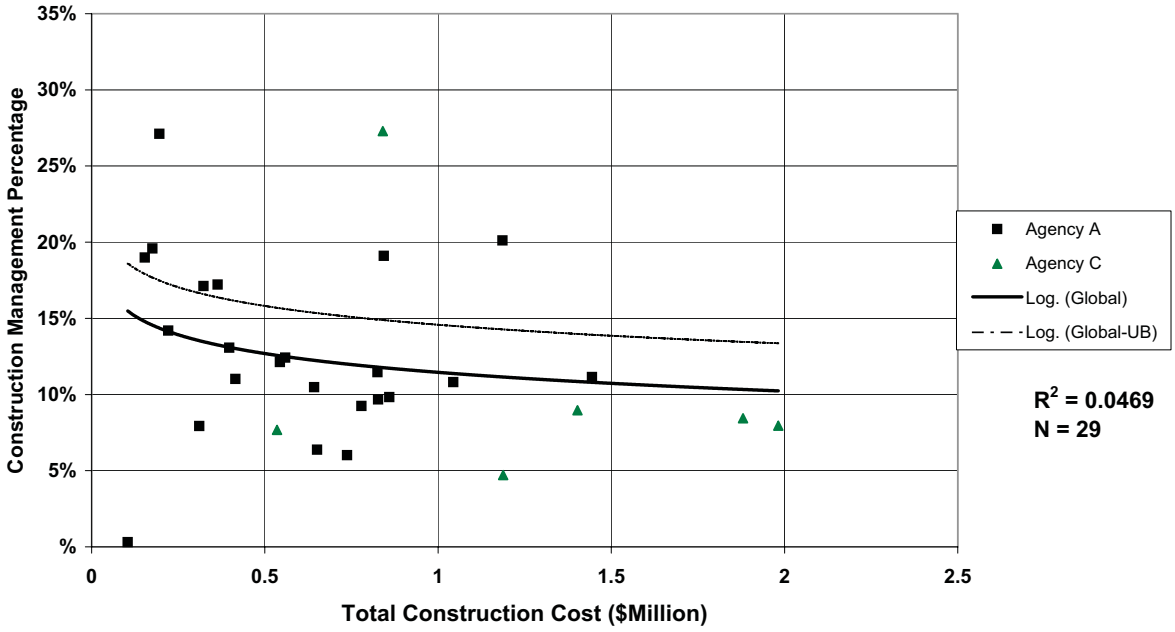
Pipe Systems - Gravity System (Storm Drains, Sewers)

Construction Management Percentage Versus Total Construction Cost



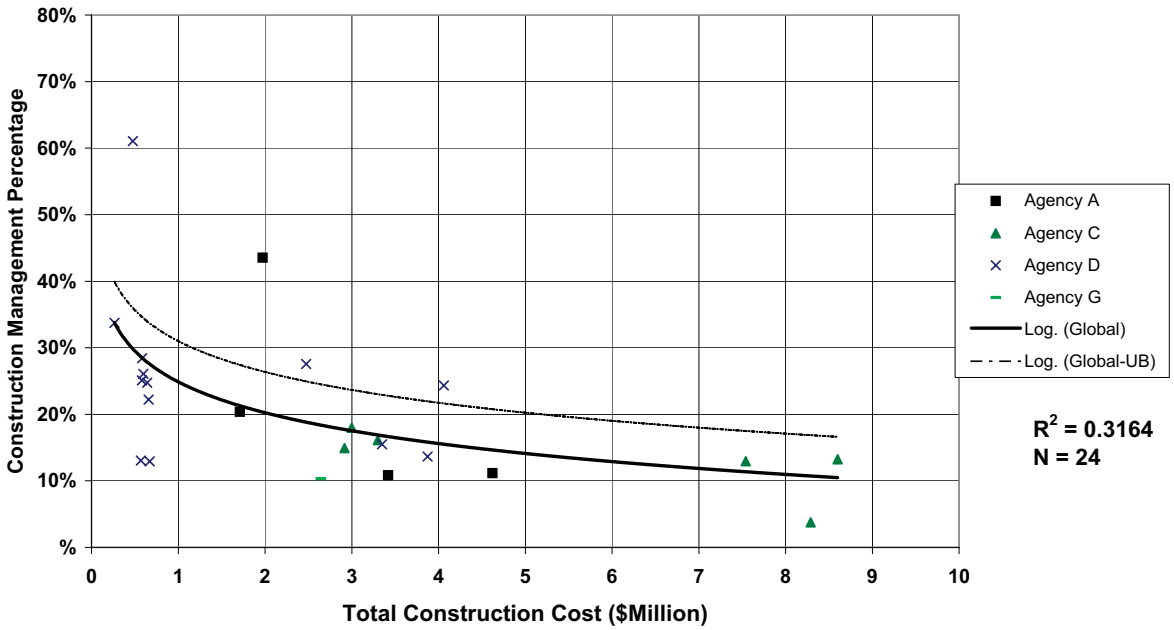
Pipe Systems - Pressure Systems

Construction Management Percentage Versus Total Construction Cost



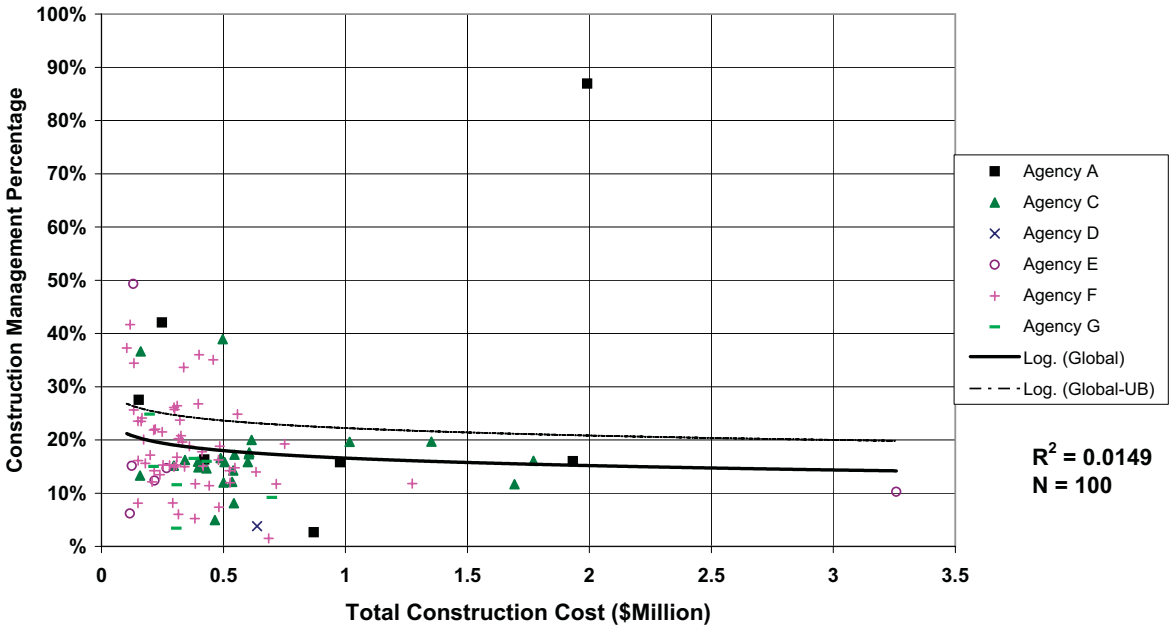
Pipe Systems - Pump Stations

Construction Management Percentage Versus Total Construction Cost



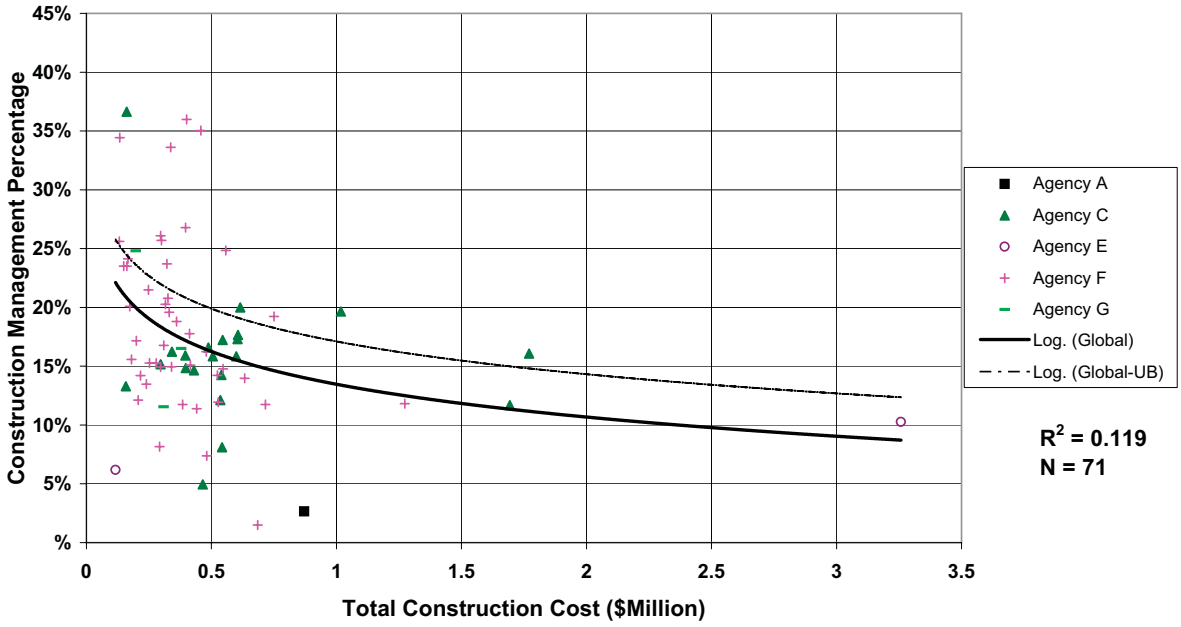
Parks - All Classification

Construction Management Percentage Versus Total Construction Cost



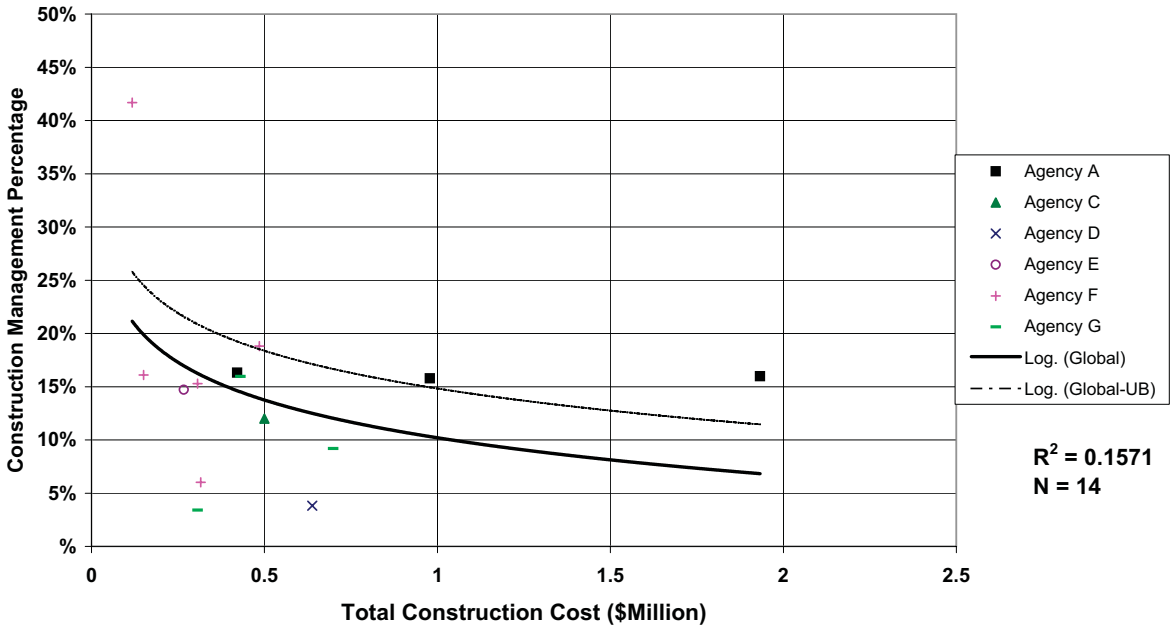
Parks - Playgrounds

Construction Management Percentage Versus Total Construction Cost



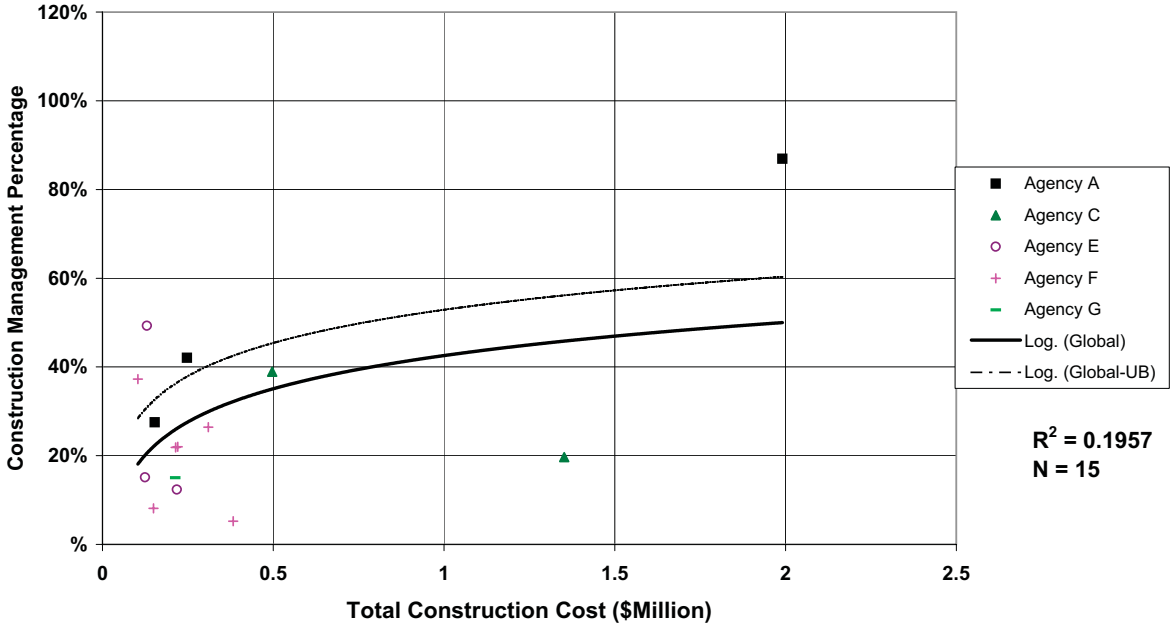
Parks - Sportfields

Construction Management Percentage Versus Total Construction Cost



Parks - Restrooms

Construction Management Percentage Versus Total Construction Cost



CURVES GROUP 3

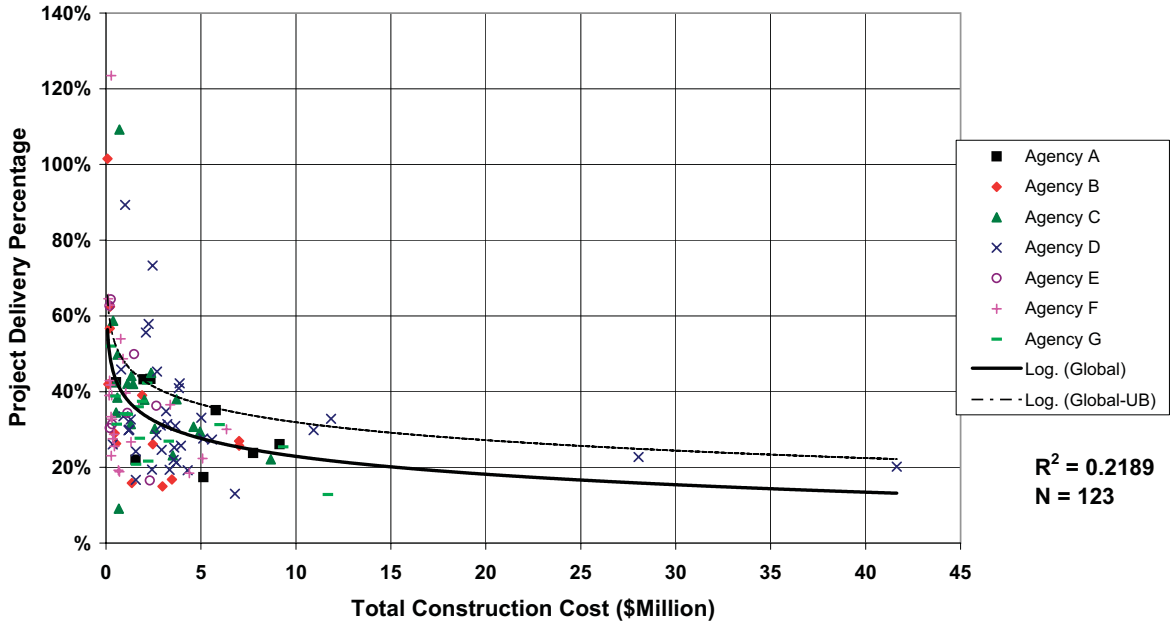
Delivery Cost / Construction Cost

Versus

Total Construction Cost

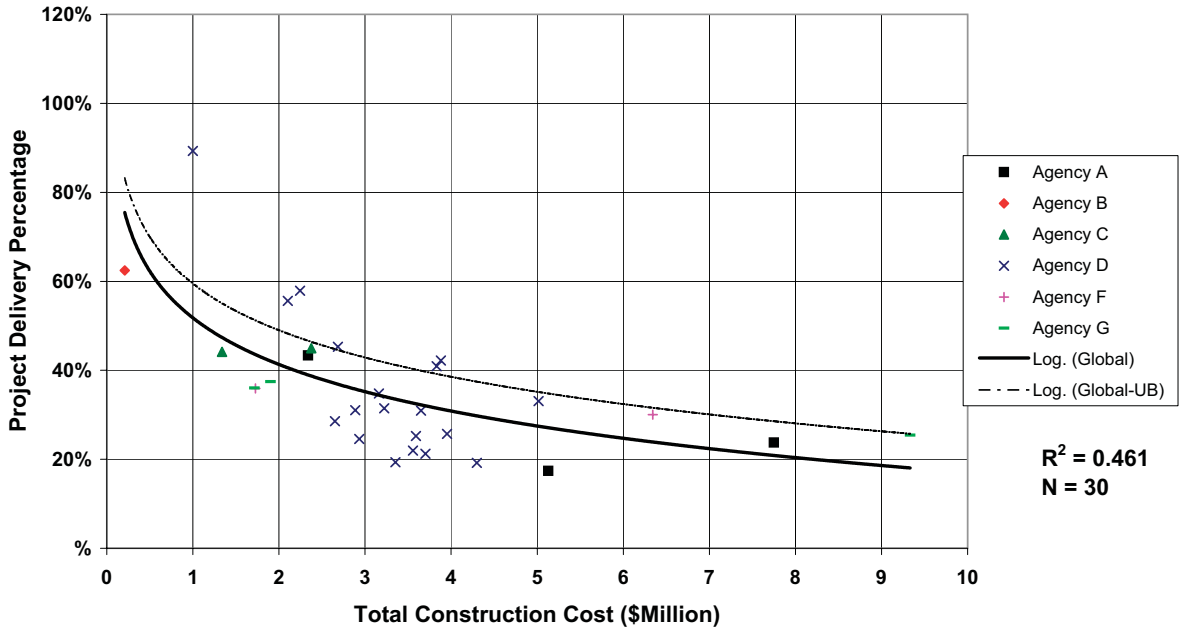
Municipal Facilities - All Classification

Project Delivery Percentage Versus Total Construction Cost



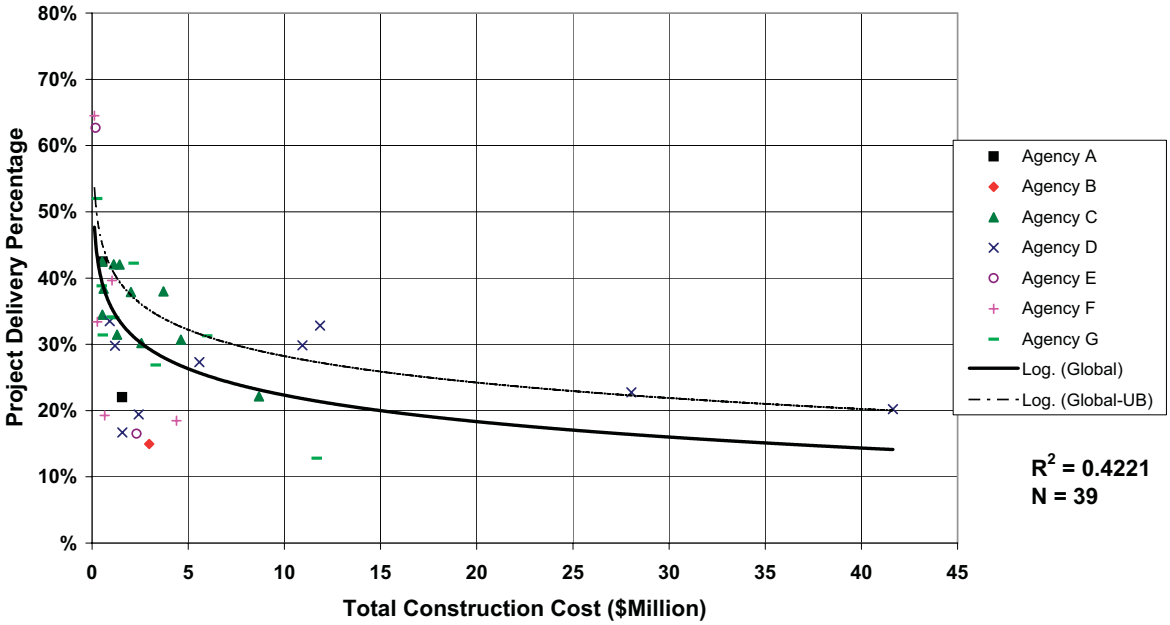
Municipal Facilities - Libraries

Project Delivery Percentage Versus Total Construction Cost



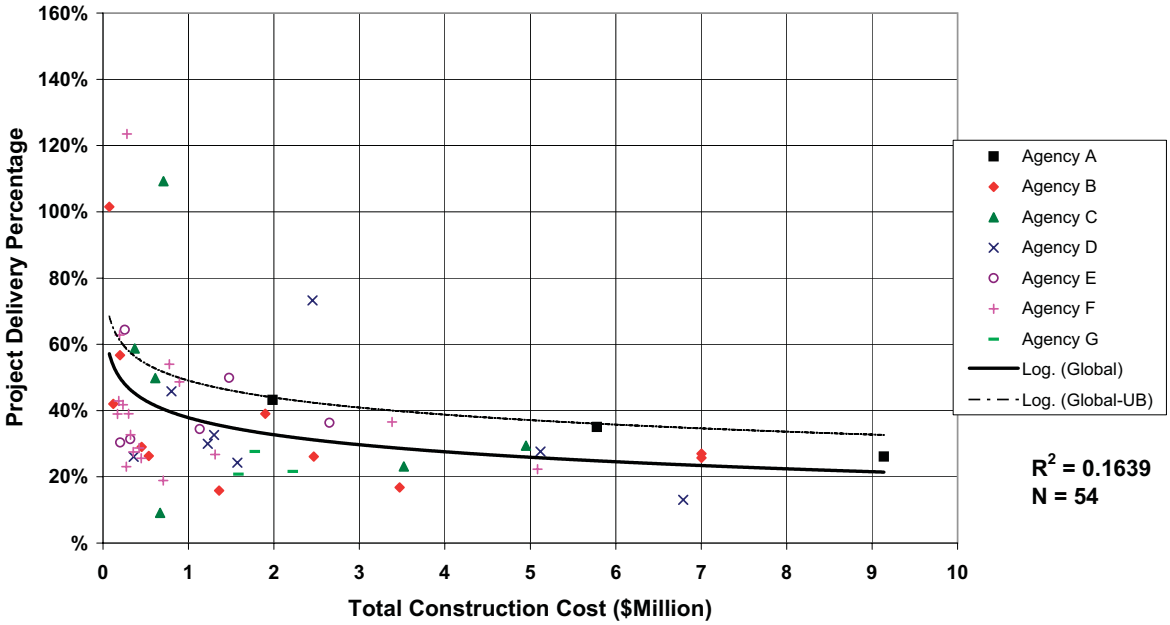
Municipal Facilities - Police / Fire Station

Project Delivery Percentage Versus Total Construction Cost



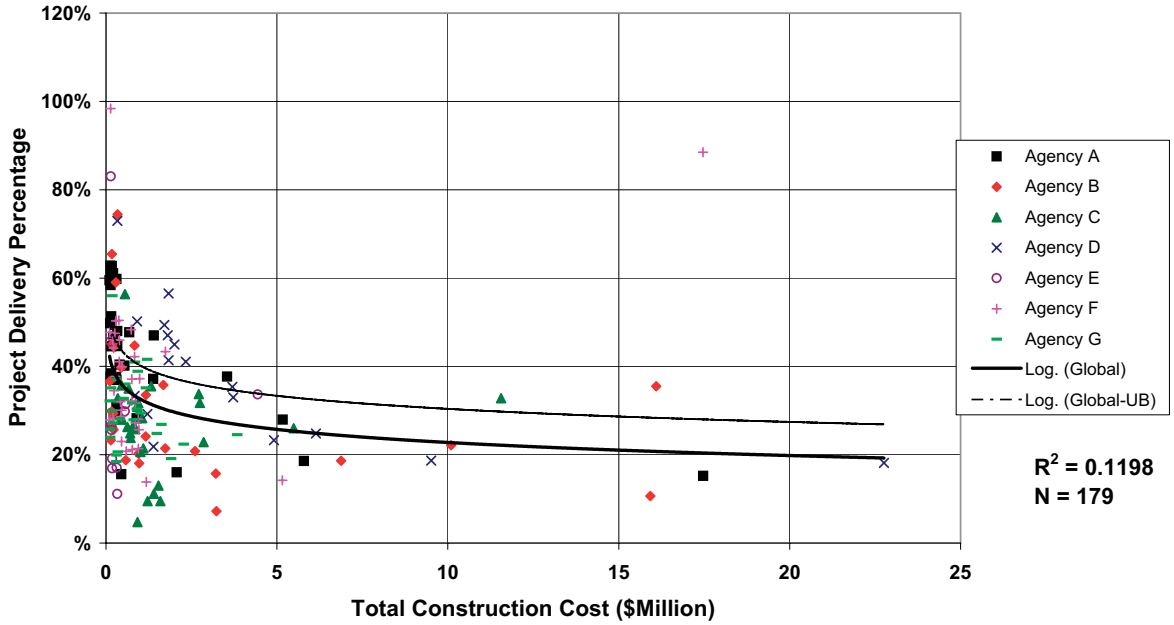
Municipal Facilities - Community Bldg./Rec. Center/CC/Gym

Project Delivery Percentage Versus Total Construction Cost



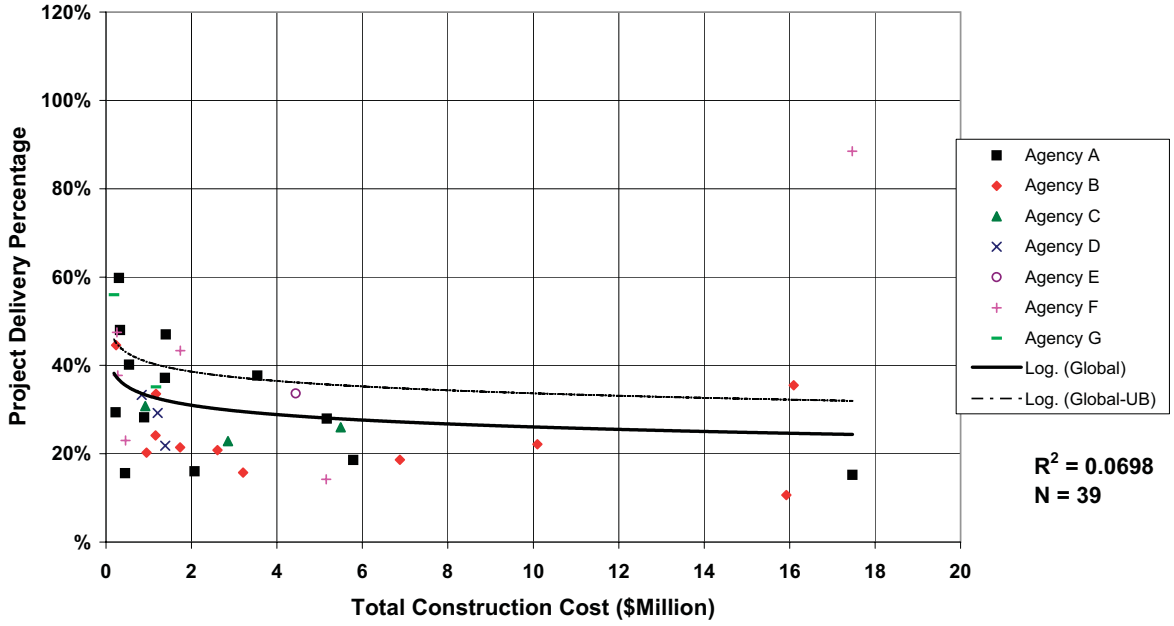
Streets - All Classification

Project Delivery Percentage Versus Total Construction Cost



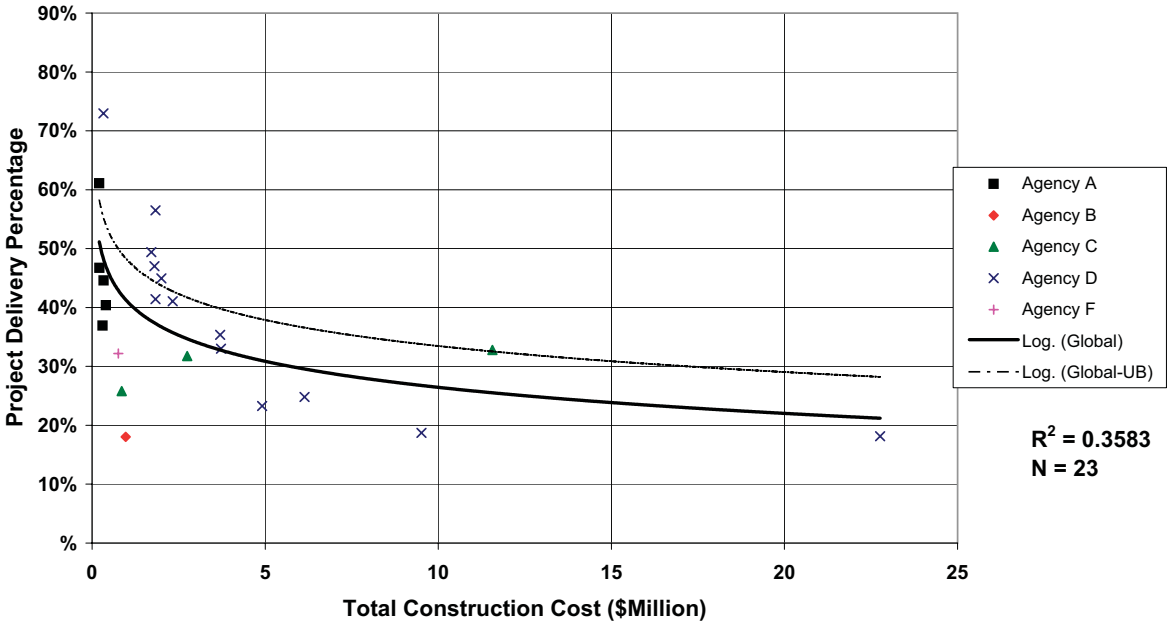
Streets - Widening / New / Grade Separation

Project Delivery Percentage Versus Total Construction Cost



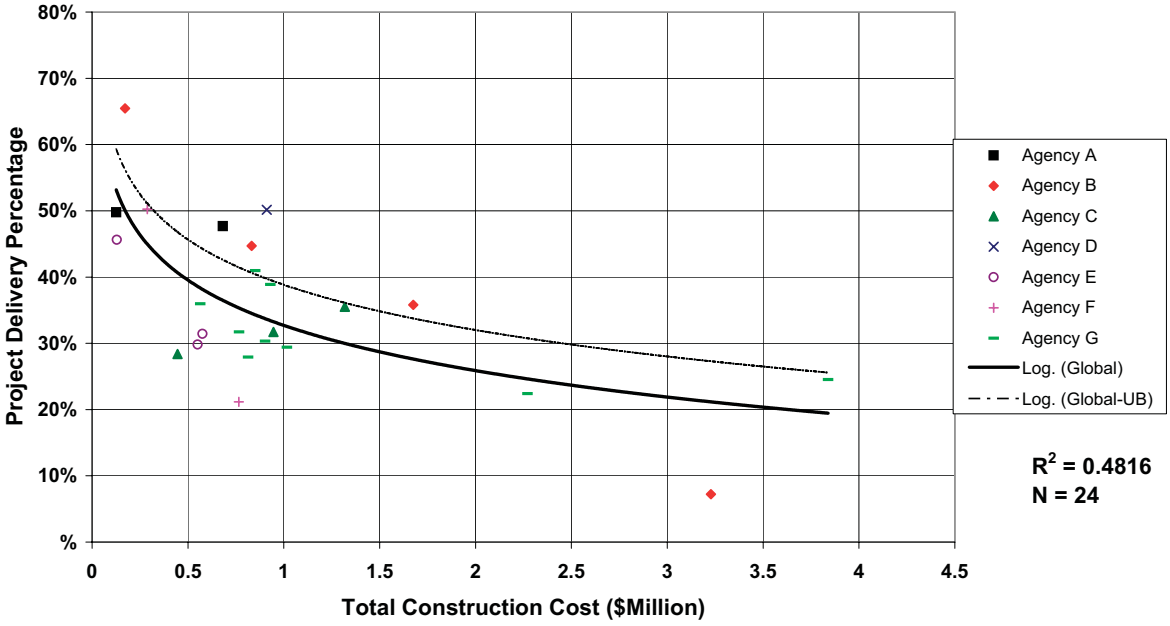
Streets - Bridges (Retrofit, New)

Project Delivery Percentage Versus Total Construction Cost



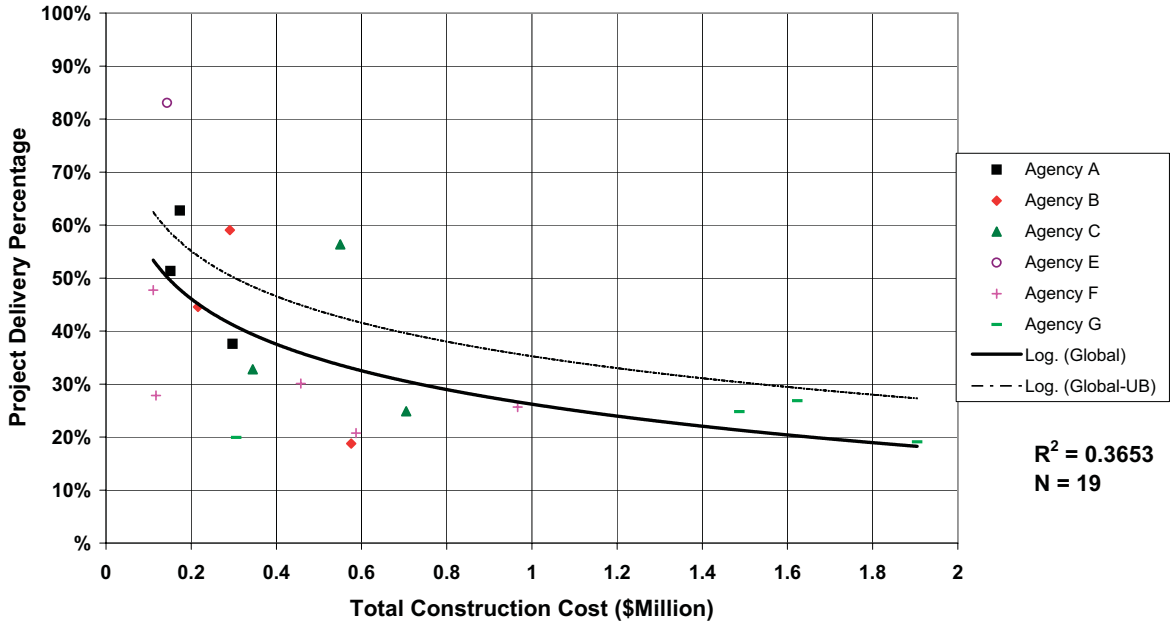
Streets - Reconstruction

Project Delivery Percentage Versus Total Construction Cost



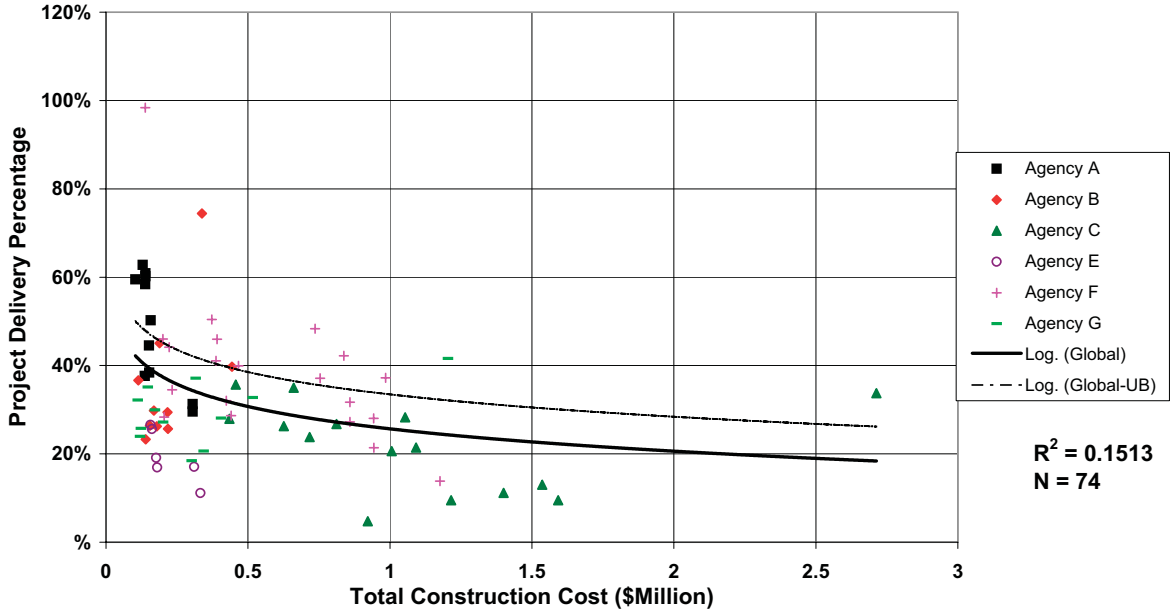
Streets - Bike / Pedestrian

Project Delivery Percentage Versus Total Construction Cost



Streets - Signals*

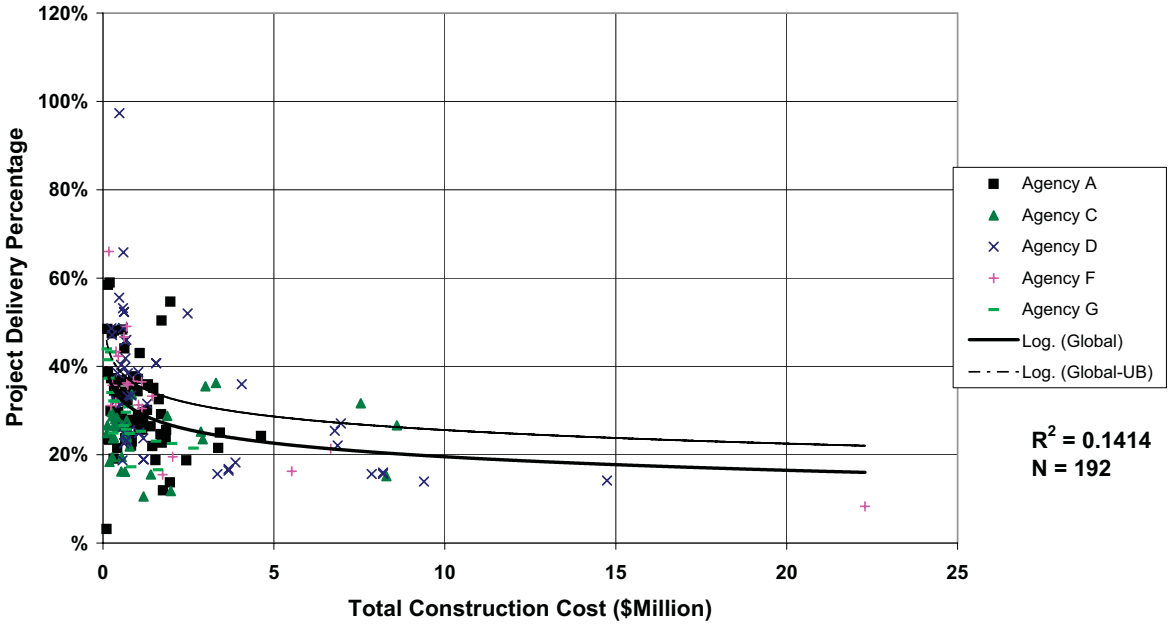
Project Delivery Percentage Versus Total Construction Cost



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

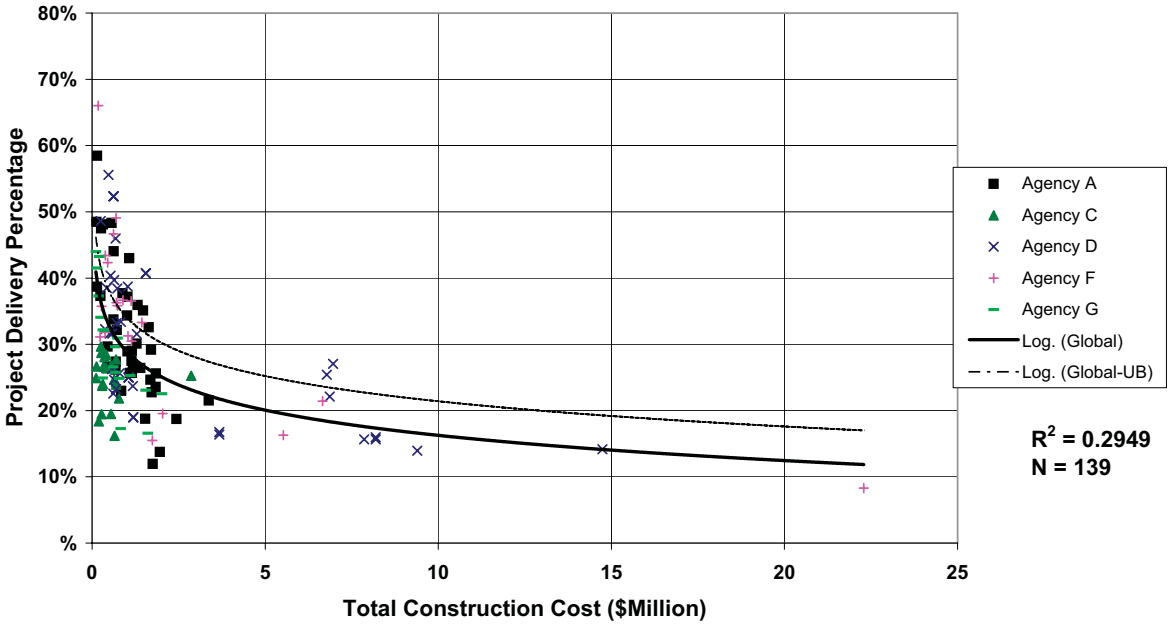
Pipe Systems - All Classification

Project Delivery Percentage Versus Total Construction Cost



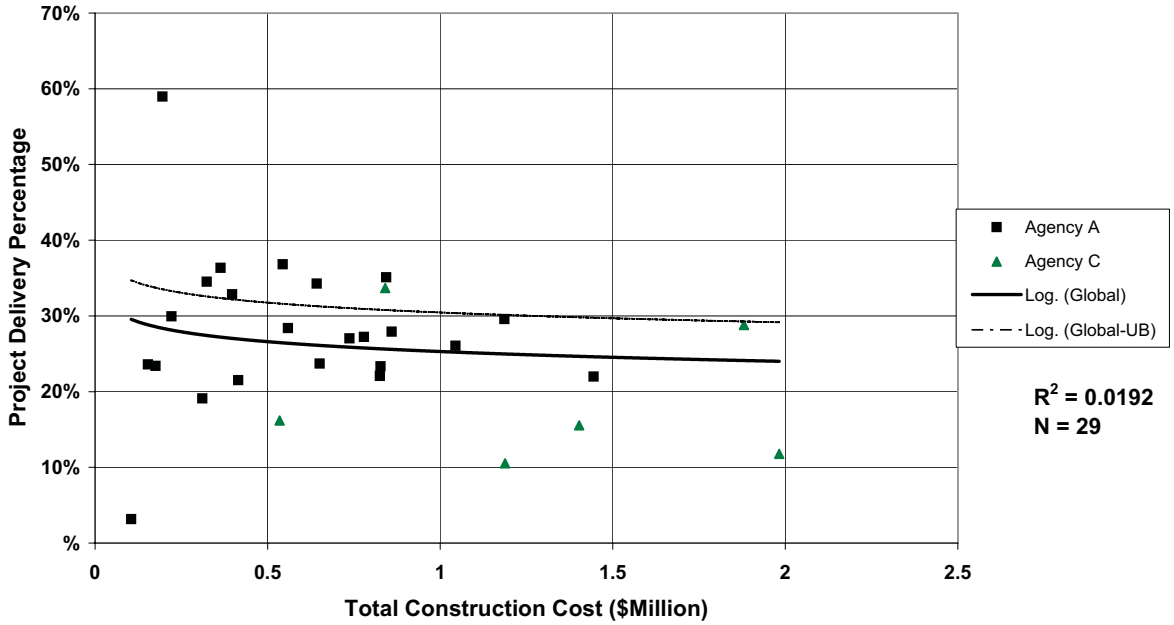
Pipe Systems - Gravity System (Storm Drains, Sewers)

Project Delivery Percentage Versus Total Construction Cost



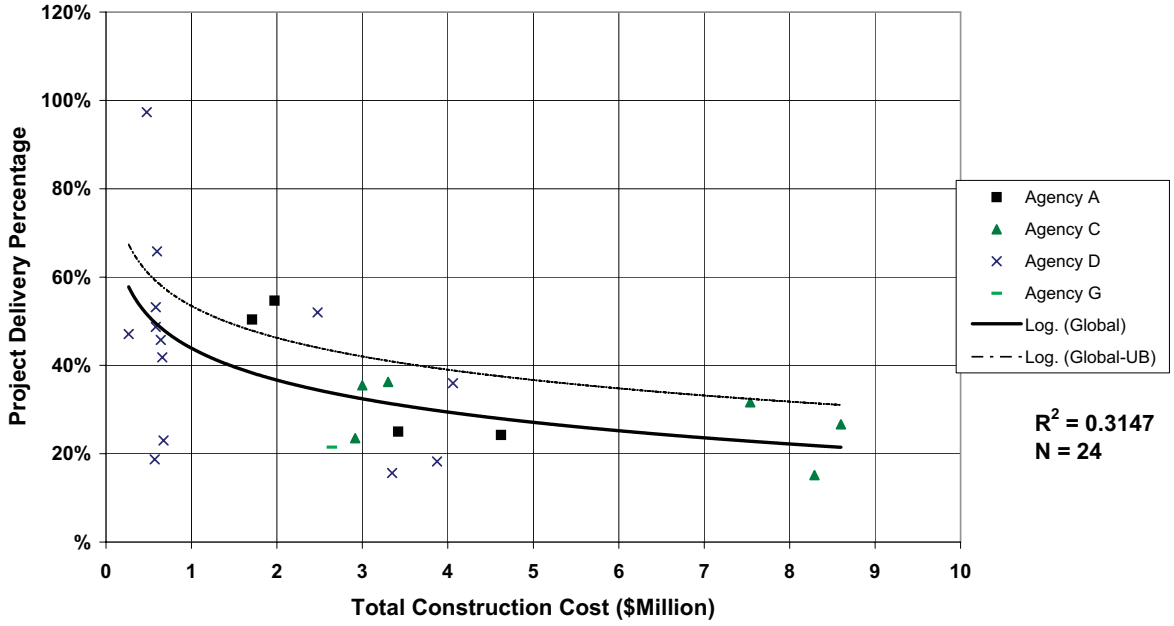
Pipe Systems - Pressure Systems

Project Delivery Percentage Versus Total Construction Cost



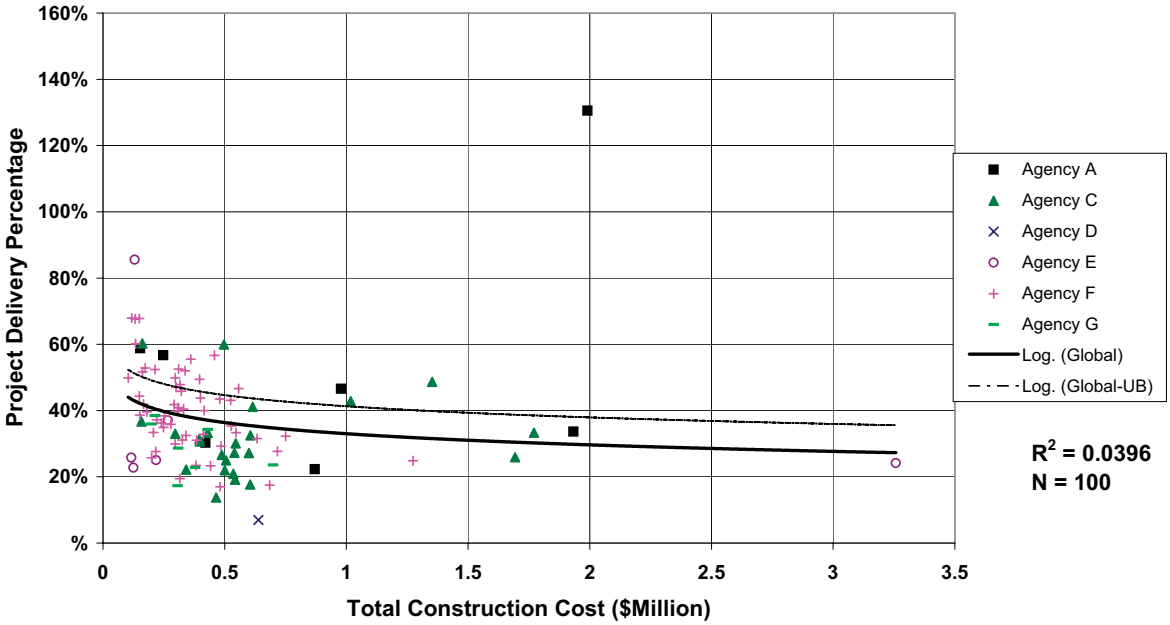
Pipe Systems - Pump Stations

Project Delivery Percentage Versus Total Construction Cost



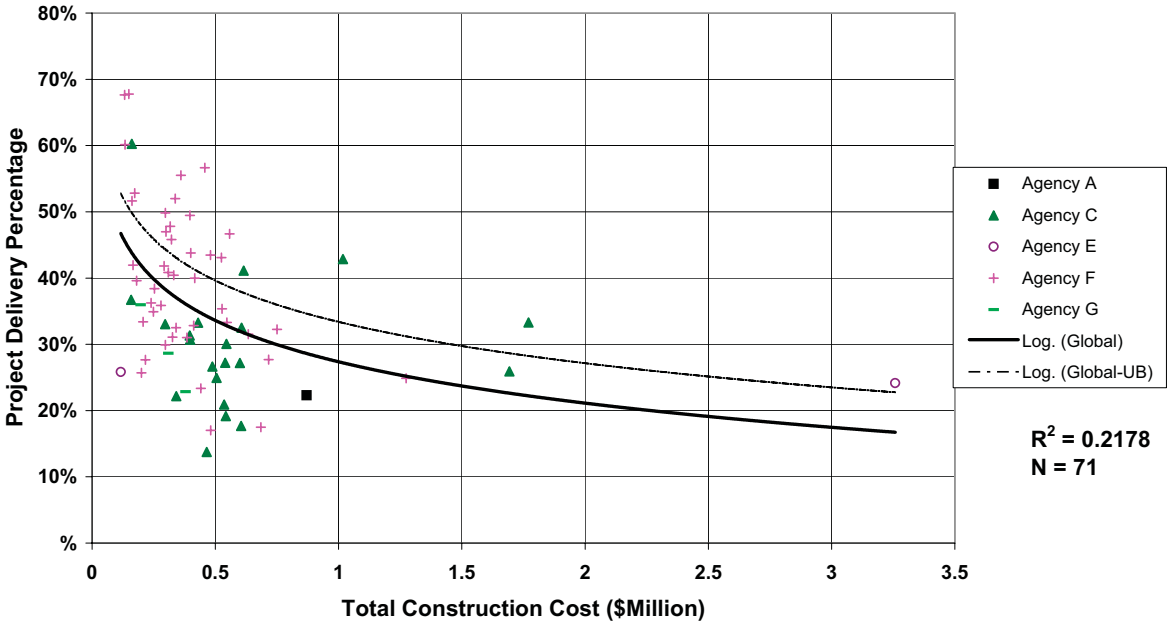
Parks - All Classification

Project Delivery Percentage Versus Total Construction Cost



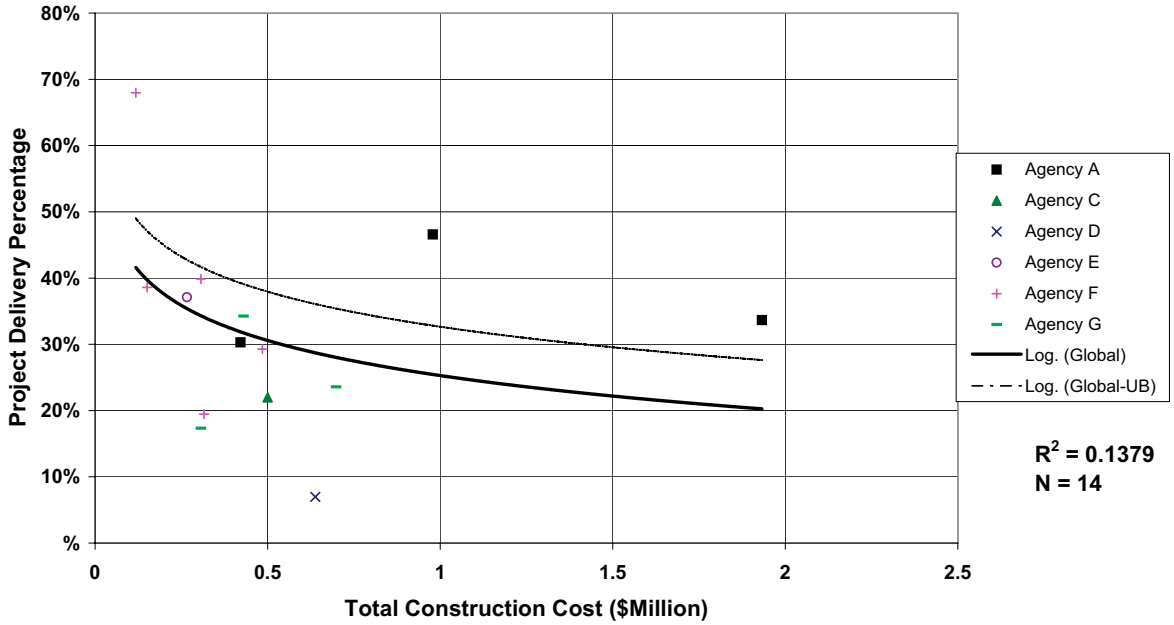
Parks - Playgrounds

Project Delivery Percentage Versus Total Construction Cost



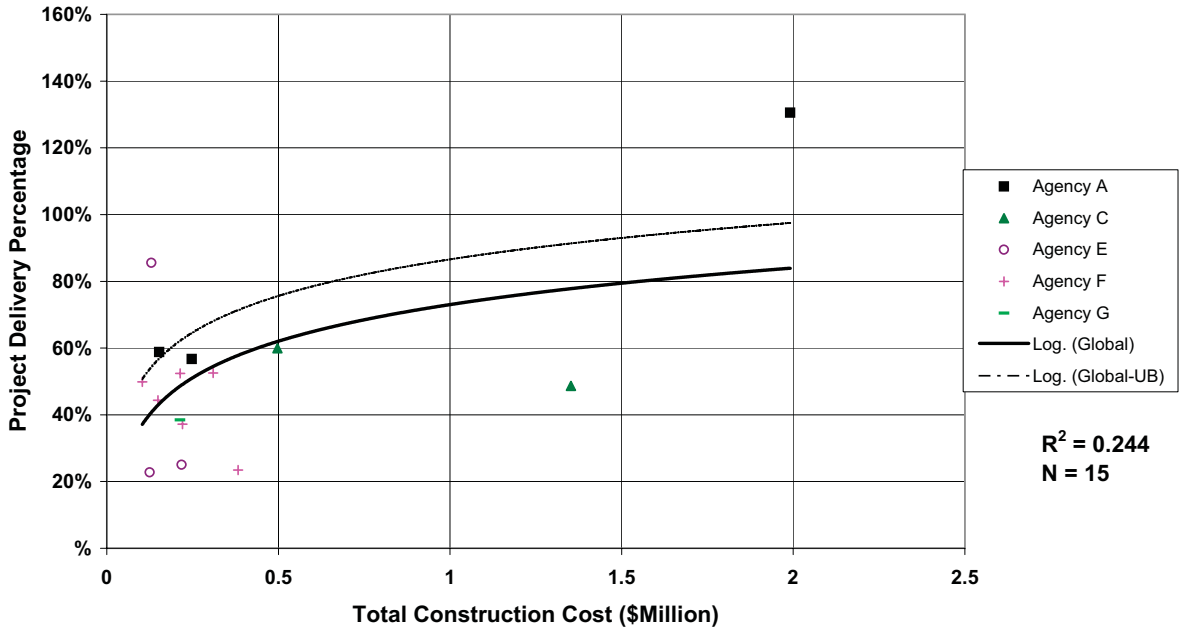
Parks - Sportfields

Project Delivery Percentage Versus Total Construction Cost



Parks - Restrooms

Project Delivery Percentage Versus Total Construction Cost



Performance Graphs R^2 Results

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

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

Appendix B

Outliers Identification








APPENDIX B Outliers Identification

Outliers, 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 thumb[2]:

> Point Distance from trend-line $\notin$ $[Q_1 - 1.5(Q_3 - Q_1), Q_3 + 1.5(Q_3 - Q_1)]$ => 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 [$\mu - 0.75\sigma$, $\mu + 0.75\sigma$] 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.

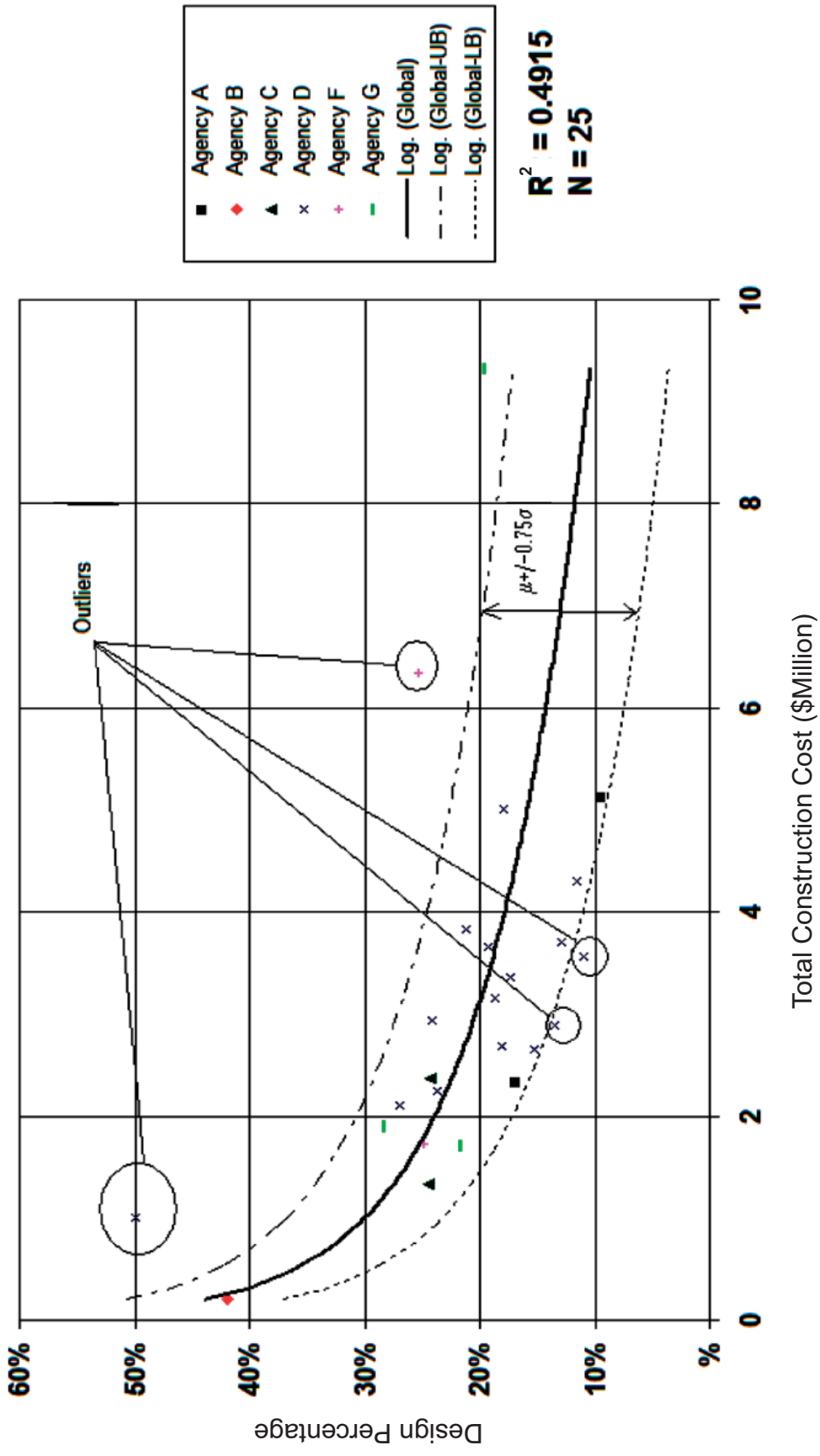


Figure C-1 Municipal Facilities - Libraries
Design Percentage Versus Total Construction Cost

Appendix C

Multi-Agency Benchmarking Database [Update 2004]








SEAL OF THE CITY AND COUNTY OF SAN FRANCISCO

Department of
PUBLIC WORKS
CITY OF SACRAMENTO

OAKLAND
PUBLIC WORKS AGENCY

CITY OF
SAN JOSE
CAPITAL OF SILICON VALLEY

CITY OF LOS ANGELES
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APPENDIX C 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

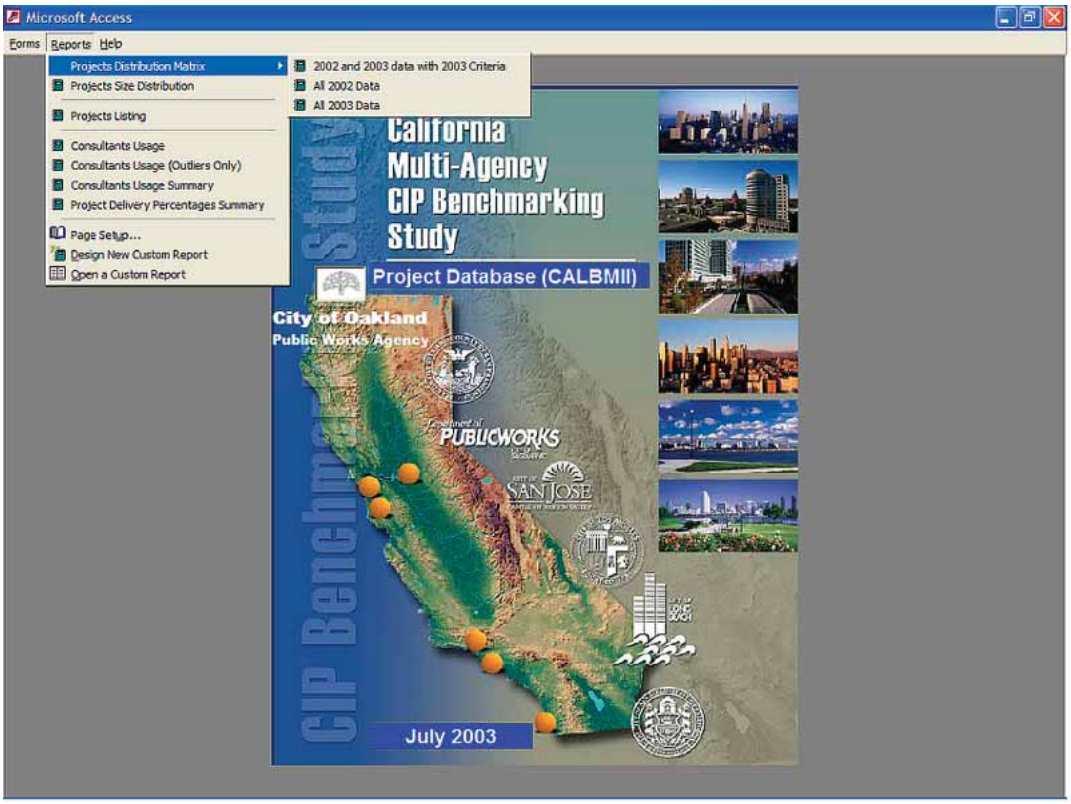


Figure C-2. Project Data Form

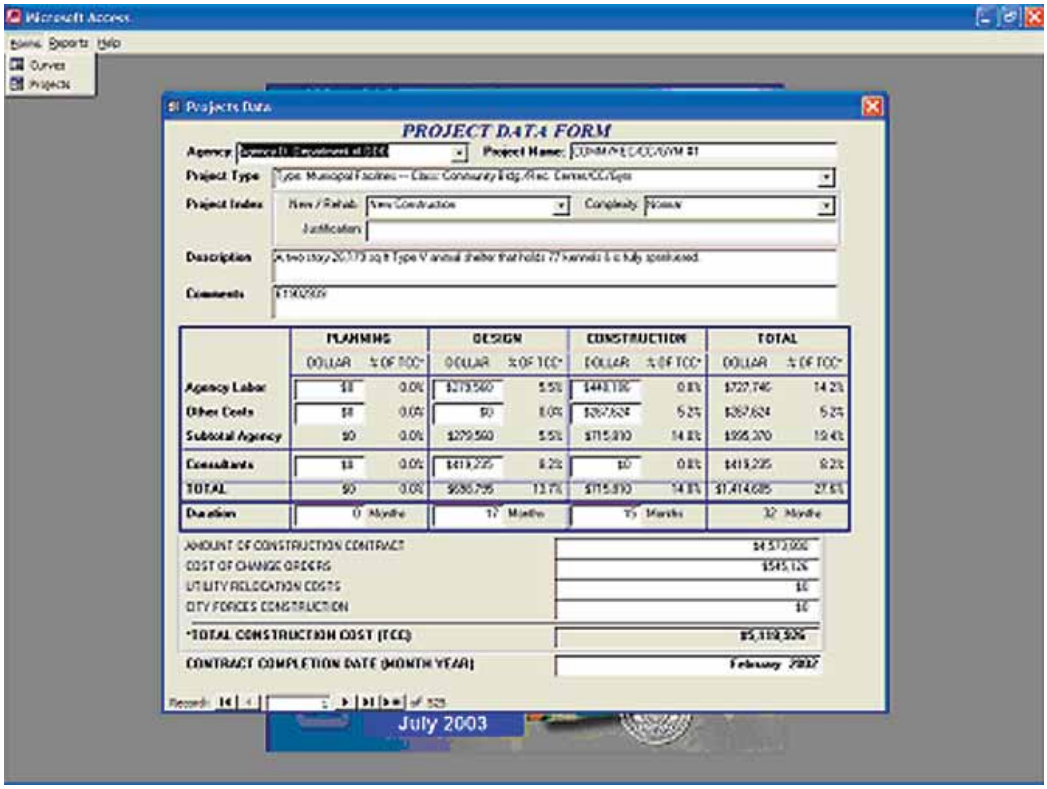


Figure C-3. Curves Form

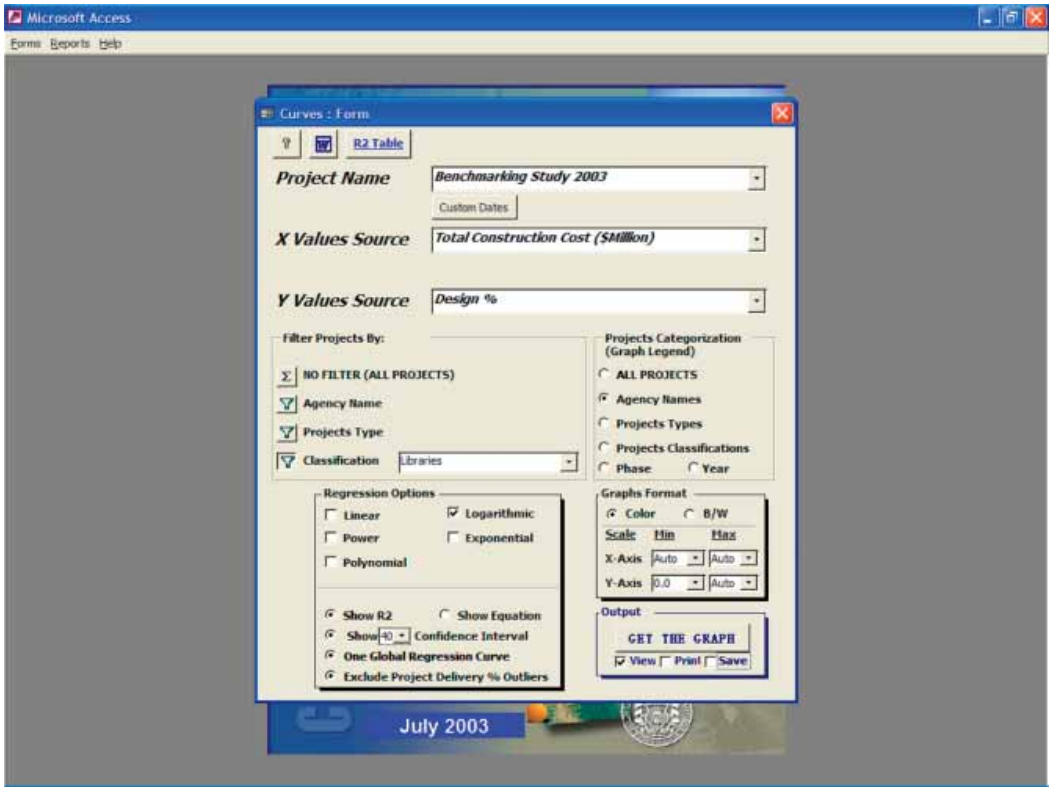
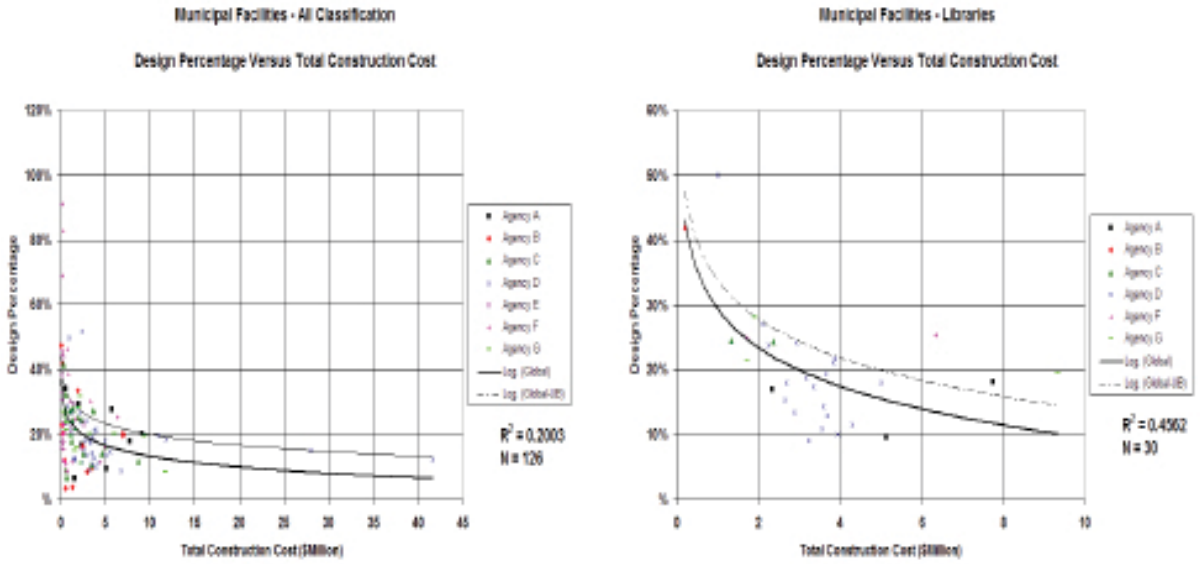


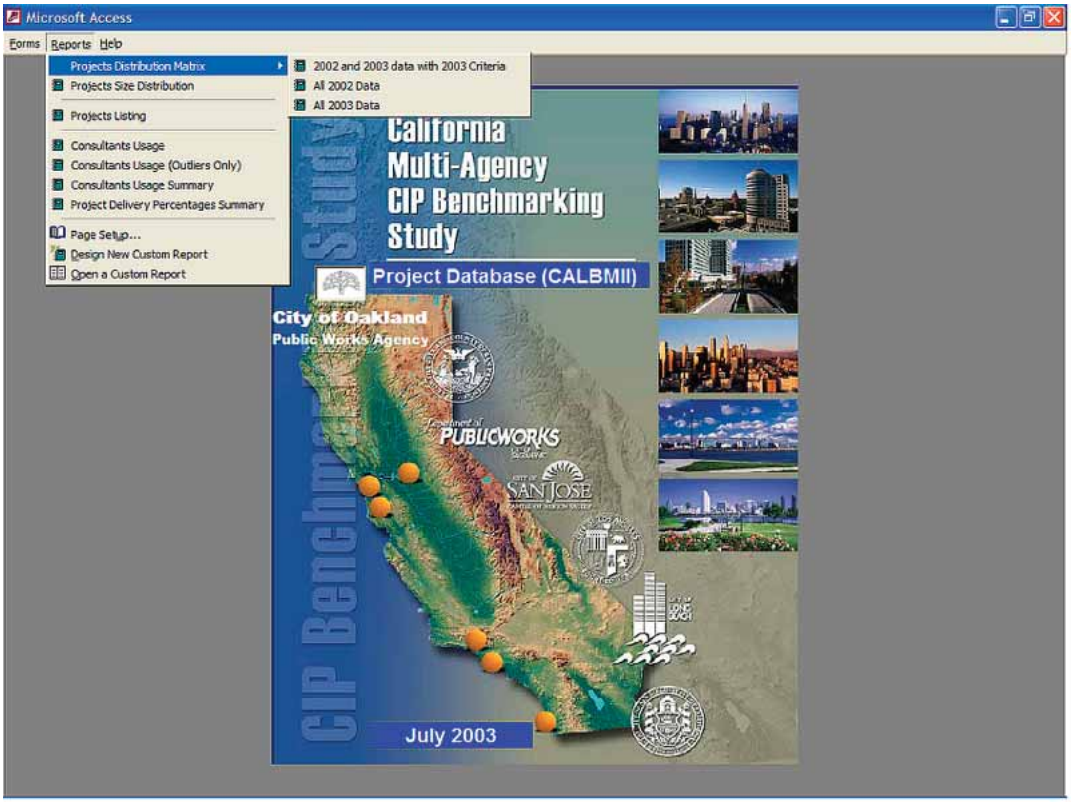
Figure C-4. Performance Model: Output of Figure C-3



- 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









Appendix D

Project Size Normalization

SEAL OF THE CITY AND COUNTY OF SAN FRANCISCO

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APPENDIX D 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
7. 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).

Project Size Normalization Impacts on the Number of Projects

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%

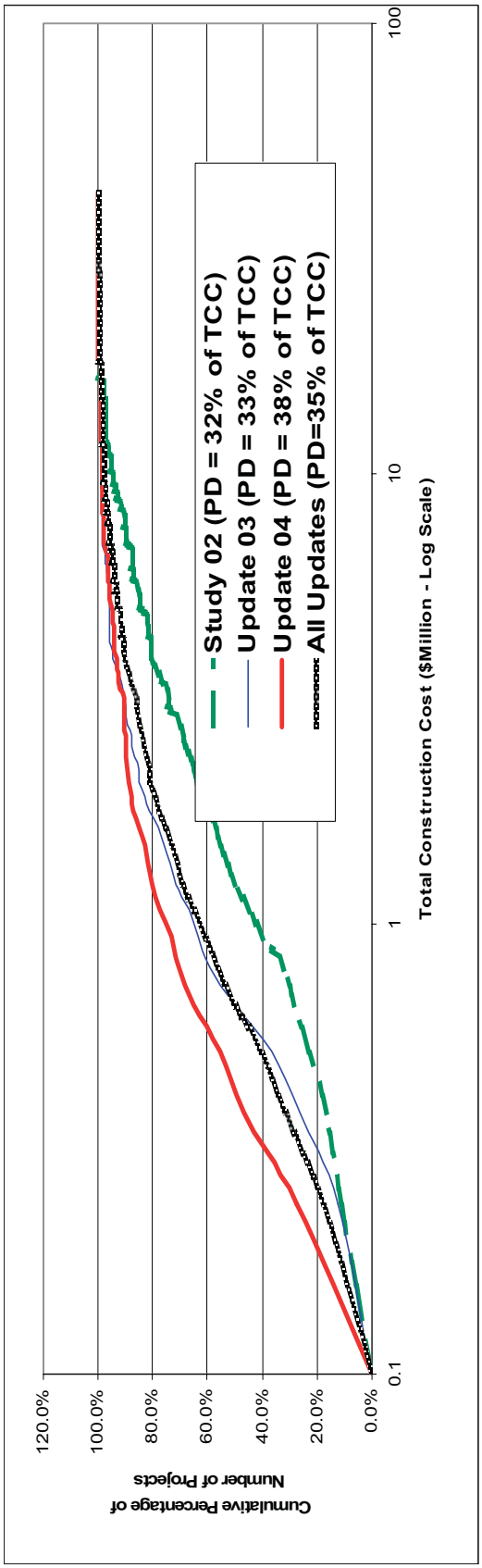

Figure D-1 — Original Project Size Distribution (Cumulative Histogram)

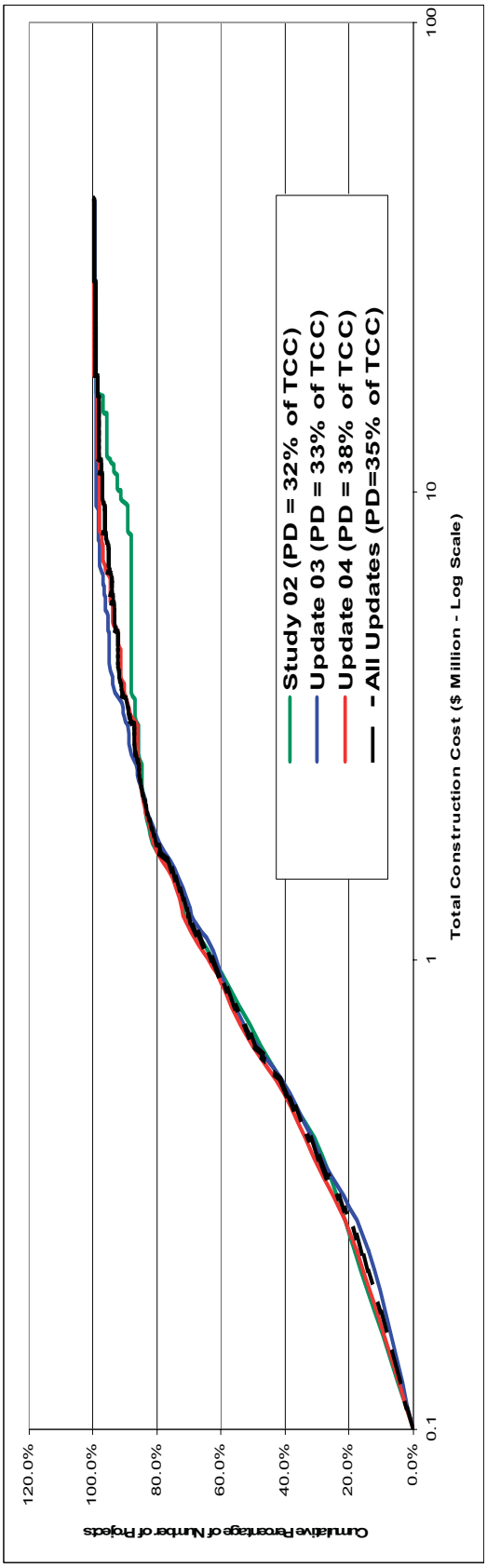

Figure D-2 — Final Project Size Distribution After Normalization (Cumulative Histogram)

Appendix E

Agencies Indirect Rate Factors








AGENCIES MULTIPLIERS / ADMIN ITEMS MATRIX (UPDATE 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%	NO
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							NO
Public Buildings & Parks/Field	27.70%	15.50%	12.00%	60.80%	4.00%	120.10%	
Transportation & Drainage Design/ Field	27.70%	14.70%	47.90%	31.80%	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%[2]	38.68%	75.85%	155.00%	NO
City of San Jose							
Department of Public Works	26.79%	25.00%	40.86%	13.00%	Included	148.00%	NO

(1) This value may be different from the Summation of the overhead values. The compounding formula is different for different Agencies.
(2) 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 Factor
	Update 2002	Update 2004	
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/ Bureau of Engineering
- City of Oakland, Public Works Agency
- 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

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