CIP Benchmarking Study

California Multi-Agency CIP Benchmarking Study

Annual Report - Update 2006








Department of PUBLIC WORKS
CITY OF SACRAMENTO

OAKLAND
PUBLIC WORKS AGENCY

CITY OF
SAN JOSE
CAPITAL OF SILICON VALLEY

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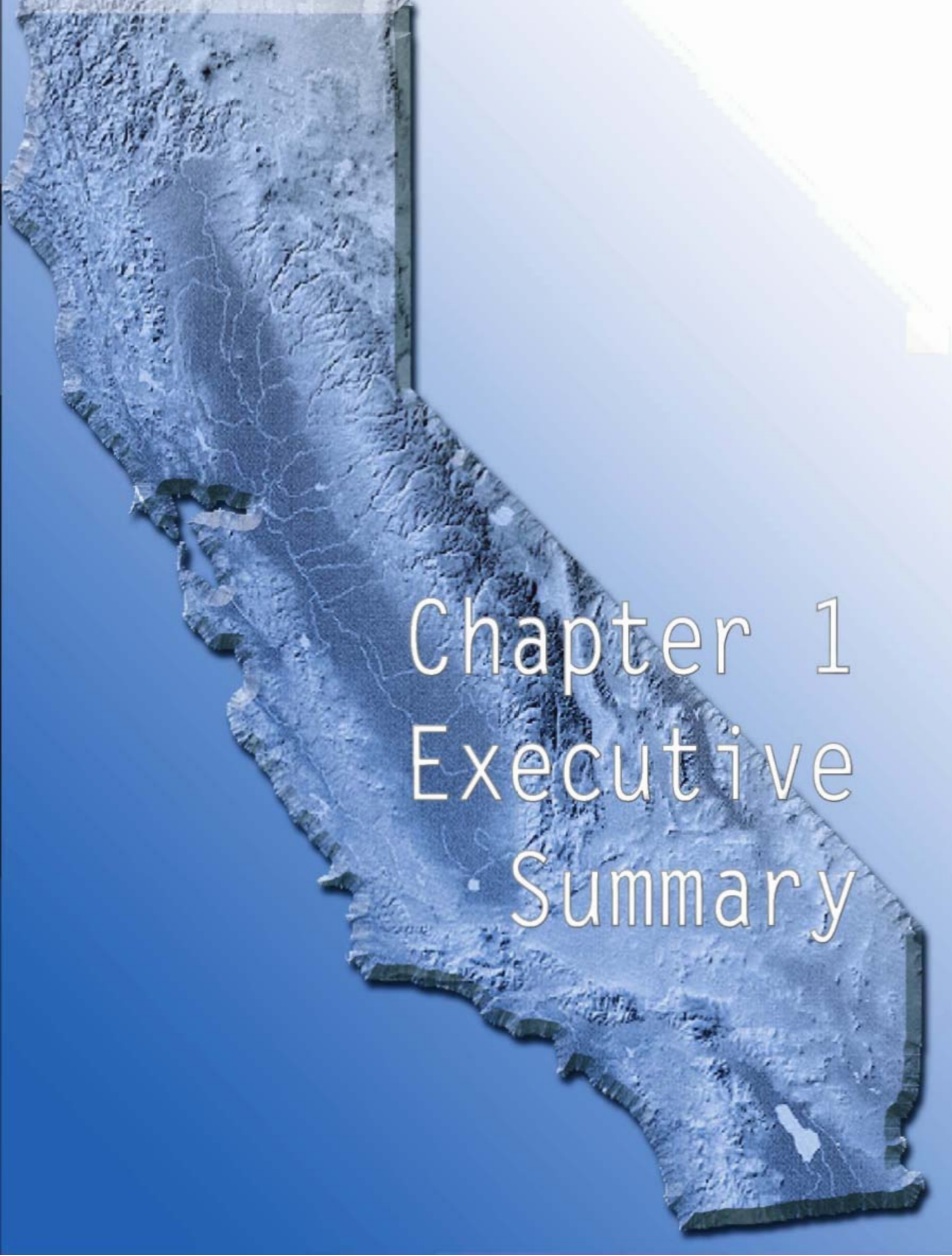

Chapter 1 Executive Summary

CIP Benchmarking Study

CHAPTER 1 Executive Summary

A. INTRODUCTION

Although it is highly effective for municipalities tasked with delivering Capital Improvement Projects to collaborate on their experiences and methods, it is also very rare that this actually occurs. Further, it is even more rare that such activities, once started, are continued uninterrupted for the purpose of effecting continuous positive improvement over a long period of time. This paradigm was challenged in 2002 when the first California Multi-Agency CIP Benchmarking Study (Study) was published. This Update 2006 marks 5 years of continuous collaboration between the participating Cities and represents an accomplishment unparalleled in the industry. Unlike many "single event" studies conducted in the past, this on-going study, involving all of the original participants, provides the benefit of actually experiencing the outcomes of the strategies it creates. The dynamic nature of this effort truly provides a basis for continuous improvement.

Since the participating Cities of Long Beach, Los Angeles, Oakland, Sacramento, San Diego, San Jose, and the City and County of San Francisco initiated these efforts, interest within the industry has been sparked. As a result, other benchmarking efforts, both large and small, have started to spring up in various parts of the country, such as municipalities in New York and Arizona, the Port of Long Beach, and large water utilities in the western United States. We applaud these efforts and look forward to a time when more agencies are sharing their best ideas for the benefit of all and owners can turn to one another to gather insight on how to best address the challenges they face.

In this fifth year of the Study, the *Update 2006* Project Team has pursued new and on-going endeavors:

- Continue to improve the quality of the performance data and the functionality of the database.
- Track the adoption of Best Management Practices (BMPs).
- Explore the issues involved in the actual implementation of BMPs (i.e., the process of moving from adoption to substantive implementation).
- Continue sharing challenges and solutions with one another through the on-line discussion forum.
- Perform special studies on topics of interest.

B. PERFORMANCE BENCHMARKING

Performance benchmarking involves collecting documented project costs and creating data models of the component costs of project delivery versus the total construction cost. Project delivery costs are defined as the sum of all agency, internal client, and consultant costs associated with project planning, design, bid, award, construction management, and closeout activities.

The *Update 2006* performance curves have been developed from data on projects completed on or after January 1, 2001. Outlier projects have been identified and eliminated. The remaining 650

projects used in the analyses were all delivered using the design-bid-build delivery method and each has a total construction cost of greater than $100,000.

I. Performance Data Analysis

The *Update 2006* performance data, shown in **Table 1-1**, indicate that for projects with completion dates in 2001 to 2004, project delivery costs increased, then stabilized between 2004 and 2005. This may be driven in part by improvements in cost data capture and reporting for the Study. Another driver may be the trend in average total construction cost, which decreased between 2001 and 2004 and increased in 2004 and 2005. Project delivery costs on larger projects are influenced by economies of scale. Agencies also report that as time goes on, it costs more to meet increasingly-stringent regulatory and municipal requirements. It is expected that as data collection methods and full BMP implementation improve, project delivery costs will begin to decline.

Project delivery performance and consultant usage by agency are also presented in **Table 1-2.**

Table 1-1 Project Delivery Costs by Project Completion Year (As % of Total Construction Cost)

Year	Design	Construction Management	Project Delivery (Total)
2001	16%	16%	32%
2002	17%	17%	34%
2003	19%	16%	35%
2004	24%	15%	39%
2005	22%	16%	38%
Average	20%	16%	36%

Table 1-2 Project Delivery Performance and Consultant Usage by Agency

AGENCY	DESIGN					CONSTRUCTION MANAGEMENT					PROJECT DELIVERY					TCC	
	In-House		Consultants			In-House		Consultants			In-House		Consultants				
	($M)	% of Design	($M)	% of Design	Total % of TCC	($M)	% of CM	($M)	% of CM	Total % of TCC	($M)	% of PD	($M)	% of PD	Total % of TCC	Average	Median
Agency A	$19.40	80%	$4.80	20%	23%	$18.20	98%	$0.40	2%	15%	$37.60	88%	$5.20	12%	37%	$1.20	$0.60
Agency B	$7.00	41%	$9.90	59%	16%	$8.10	58%	$5.90	42%	11%	$15.00	49%	$15.80	51%	27%	$1.10	$0.30
Agency C	$23.50	85%	$4.00	15%	16%	$20.70	96%	$0.80	4%	15%	$44.20	90%	$4.80	10%	32%	$1.60	$0.70
Agency D	$27.70	59%	$18.90	41%	18%	$42.00	91%	$4.00	9%	20%	$69.70	75%	$22.80	25%	37%	$2.60	$1.40
Agency E	$3.30	26%	$9.30	74%	21%	$5.90	71%	$2.40	29%	16%	$9.20	44%	$11.60	56%	37%	$1.90	$0.50
Agency F	$19.10	60%	$12.70	40%	21%	$18.60	91%	$1.80	9%	19%	$37.70	72%	$14.50	28%	40%	$1.20	$0.40
Agency G	$8.10	70%	$3.50	30%	20%	$6.80	99.50%	$0.04	0.50%	15%	$14.90	81%	$3.60	19%	35%	$1.20	$0.40
OVERALL	$108.10	63%	$63.10	37%	19%	$120.20	89%	$15.20	11%	16%	$228.30	74%	$78.30	26%	36%	$1.50	$0.60

Note:
In-House and Consultant costs are calculated as percentages of total agency Design, CM (Construction Management), and PD (Project Delivery) costs. TCC (Total Construction Cost) is the sum of construction contract award, change orders, utility relocation cost, and city forces construction cost. Design, CM (Construction Management), and PD (Project Delivery) costs as percentages of TCC are unweighted, arithmetic averages of projects by agency.

Performance curves produced for this Study are data regressions, demonstrating how close of a relationship exists between the dependent variable (y-axis) and the independent variable (x-axis). A best-fit logarithmic curve is calculated using the least-squares method in Excel®, and a R^2 value is displayed. The R^2 value, also called the coefficient of determination, is a value between 1 and 0, with a value approaching 0 indicating a poor model and a value approaching 1 indicating a close relationship. Please see **Chapter 3 Performance Benchmarking** for more detail.

P-values were also calculated for each regression, indicating the regression's suitability for predicting new values. The p-value indicates whether there are enough data points for the regression results to be statistically-significant. A statistically-significant model can be used to predict new values. For the purposes of this Study, a p-value below 0.10 was selected to indicate a statistically-significant result. Please see **Chapter 3 Performance Benchmarking** for more detail.

As indicated in **Table 1-3**, data were collected and analyzed at the level of four project types and fourteen project classifications. The performance models resulting from the analyses are summarized in **Table 1-3** and the performance curves are in **Appendix B**.

The table and best-fit curves provide an average of the data that can be used as a starting point for budgeting an entire program of projects. Caution and use of professional judgment is suggested if the best-fit curve is used to budget an individual project.

II. Special Studies

Special studies on consultant usage and change order rates were continued as part of *Update 2006*.

In the consultant usage special study, design performance was evaluated comparing projects where consultant usage (costs) exceeded one-fourth of the project delivery cost versus those for which there was no consultant usage.

The agencies agreed that there were no clear conclusions that could be drawn from the analyses due to low R^2 values and limited data. However, they observed that the design cost (as a percentage of total construction cost) for projects where consultant usage exceeded 25 percent of project delivery was not necessarily reduced compared to projects with no consultant usage.

The Project Team agreed that the driving reason to use consultants is generally not to achieve cost reduction, but to acquire specific expertise, to meet aggressive schedule demands, to meet short-term peaks in workloads, or to otherwise meet staffing needs that cannot be met through exclusive use of agency staff.

Change order data have been divided among three categories: Changed/Unforeseen Conditions, Changes to Bid Documents, and Client-Initiated Changes. Regression analyses were performed on change orders (as a percentage of total construction cost) versus total construction cost by each of the three categories as well as total change orders. The results were similar to those from the *Update 2005* analyses, with low resulting R^2 values.

Table 1-3 Summary of Performance Models

PROJECT TYPE Project Classification	Range of TCC	Count of Projects	Des. (% of TCC)	CM (% of TCC)	PD (% of TCC)
Municipal Facilities		**112**			
Libraries		**40**			
	$2M<TCC<$3.5M	14	25% to 18%	25% to 15%	50% to 33%
	$3.5M<TCC<$4M	16	24% to 17%	20% to 14%	44% to 31%
	$4M<TCC<$10M	10	23% to 14%	18% to 5%	41% to 19%
Police/Fire Station		**18**			
	$0.1M<TCC<$0.6M	6	36% to 26%	22% to 15%	58% to 41%
	$0.6M<TCC<$3M	6	32% to 22%	20% to 13%	52% to 35%
	$3M<TCC<$42M	6	28% to 15%	17% to 8%	45% to 23%
Community Bldg/Rec Ctr/ Child Care/Gym		**54**			
	$0.1M<TCC<$0.4M	20	31% to 23%	33% to 18%	64% to 41%
	$0.4M<TCC<$1.5M	19	30% to 21%	30% to 15%	60% to 36%
	$1.5M<TCC<$53M	15	28% to 20%	27% to 8%	55% to 28%
Streets		**188**			
Widening/New/Grade Separation		**24**			
	$0.1M<TCC<$0.6M	8	44% to 30%	21% to 14%	65% to 44%
	$0.6M<TCC<$5M	8	39% to 19%	20% to 10%	59% to 29%
	$5M<TCC<$18M	8	28% to 13%	16% to 8%	44% to 21%
Bridge		**9**			
	$0.1M<TCC<$0.3M	3	78% to 49%	26% to 19%	104% to 68%
	$0.3M<TCC<$2M	3	68% to 28%	25% to 16%	93% to 44%
	$2M<TCC<$12M	3	46% to 10%	22% to 13%	68% to 23%
Reconstruction		**38**			
	$0.1M<TCC<$0.6M	17	31% to 22%	22% to 16%	53% to 38%
	$0.6M<TCC<$1M	9	29% to 21%	21% to 16%	50% to 37%
	$1M<TCC<$12M	12	28% to 18%	20% to 12%	48% to 30%
Bike/Pedestrian/Streetscape		**43**			
	$0.1M<TCC<$0.3M	17	54% to 30%	24% to 17%	78% to 47%
	$0.3M<TCC<$0.6M	16	42% to 23%	23% to 16%	65% to 39%
	$0.6M<TCC<$2.2M	10	35% to 10%	22% to 15%	57% to 25%

Note: TCC = total construction cost. The project delivery percentages indicated are the ranges between the logarithmic regression curve and upper bound of the 50 percent confidence interval for the respective TCC values. Caution and review of the report text are urged in using this information. Refer to *Appendix B* for the corresponding regression curves, R^2 values, and N values for more details. Highlighted values indicate those for which R^2 values were particularly low, below 0.10.

Table 1-3 Summary of Performance Models (cont'd)

PROJECT TYPE Project Classification	Range of TCC	Count of Projects	Des. (% of TCC)	CM (% of TCC)	PD (% of TCC)
Signals		74			
	$0.1M<TCC<$0.2M	26	33% to 22%	26% to 17%	59% to 39%
	$0.2M<TCC<$0.5M	28	31% to 19%	24% to 15%	55% to 34%
	$0.5M<TCC<$3M	20	27% to 12%	22% to 11%	49% to 23%
Pipe Systems		**250**			
Gravity System		204			
	$0.1M<TCC<$0.5M	64	28% to 17%	23% to 18%	51% to 35%
	$0.5M<TCC<$1.1M	70	23% to 15%	22% to 16%	45% to 31%
	$1.1M<TCC<$23M	70	21% to 6%	21% to 13%	42% to 19%
Pressure Systems		29			
	$0.1M<TCC<$0.5M	11	18% to 13%	17% to 12%	35% to 25%
	$0.5M<TCC<$0.9M	12	18% to 13%	17% to 12%	35% to 25%
	$0.9M<TCC<$2M	6	18% to 13%	16% to 12%	34% to 25%
Pump Station		17			
	$0.1M<TCC<$0.7M	5	23% to 18%	30% to 21%	53% to 39%
	$0.7M<TCC<$3M	5	22% to 16%	28% to 17%	50% to 33%
	$3M<TCC<$22M	7	20% to 13%	24% to 12%	44% to 25%
Parks		**100**			
Playgrounds		73			
	$0.1M<TCC<$0.3M	22	36% to 23%	22% to 15%	58% to 38%
	$0.3M<TCC<$0.5M	27	32% to 22%	20% to 17%	52% to 39%
	$0.5M<TCC<$6M	24	28% to 17%	17% to 12%	45% to 29%
Sportfields		10			
	$0.1M<TCC<$0.3M	2	24% to 20%	15% to 19%	39% to 39%
	$0.3M<TCC<$0.7M	3	24% to 20%	15% to 19%	39% to 39%
	$0.7M<TCC<$2M	5	23% to 19%	16% to 20%	39% to 39%
Restrooms		17			
	$0.1M<TCC<$0.2M	6	19% to 29%	20% to 39%	39% to 68%
	$0.2M<TCC<$0.3M	5	21% to 30%	26% to 44%	47% to 74%
	$0.3M<TCC<$2M	6	23% to 38%	31% to 64%	54% to 102%

Note: TCC = total construction cost. The project delivery percentages indicated are the ranges between the logarithmic regression curve and upper bound of the 50 percent confidence interval for the respective TCC values. Caution and review of the report text are urged in using this information. Refer to *Appendix B* for the corresponding regression curves, R^2 values, and N values for more details. Highlighted values indicate those for which R^2 values were particularly low, below 0.10.

C. BEST MANAGEMENT PRACTICES

At the start of the Study, the agencies examined over 100 practices used in project delivery. They included practices in this Study that they did not already commonly use, but believed should be implemented as BMPs. Practices are added annually by the agencies to address specific challenges they encounter or reflect new learnings by the participants. Agency implementation of the selected practices has been and will continue to be tracked during the lifetime of the Study. Seven new BMPs were added to the list in *Update 2006.* These BMPs are believed to directly influence the cost of either design or construction management and, ultimately, efficient project delivery. The agencies have continued to pursue the full implementation of BMPs. As of *Update 2006*, the agencies have fully implemented more than 60 percent of all BMPs.

To support the linking of BMPs to performance improvements, BMP implementation has been tracked and project completion dates have been collected on the Performance Questionnaire. It is anticipated that the performance data will eventually demonstrate that as BMPs were implemented, project delivery costs were reduced. However, it is recognized that "processes" become effective "practices" only after a learning curve and full implementation on projects. Therefore, obtaining empirical evidence of this trend is expected to take several years.

Table 1-4 summarizes the BMPs that have been implemented by the participating agencies, as well as the priorities of those that are planned for implementation.

Table 1-4 Implementation of BMPs

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Planning	1.a.	Define capital projects well with respect to scope and budget including community and client approval at the end of the planning	✓	✓	✓	✓	✓	PI	PI	✓	✓	SC DU: Community involved after project is better-defined, typically at 30% design SD: Some Divisions only
	1.b.	Complete Feasibility Studies on projects prior to defining budget and scope	✓	✓	✓	✓	✓	PI	PI	✓	✓	LB: When applicable SC DU: Only on complex projects that require a Feasibility Study SD: Result of CIP Benchmarking SF: When applicable
Planning	1.d.	Utilize a Board/Council project prioritization system	✓	NI	2006	2007	✓	PI	2006	NI	NI	LA: Council allows Streets, Bridges and Stormwater programs a project priority system. SC DU: Getting closer to approved Asset Mgt system that would facilitate this BMP, but project drivers vary (permit requirements, projects in other departments, etc) SD: Result of CIP Benchmarking
	1.e.	Resource-load all CIP projects for design and construction	✓	PI: 2007	✓	2006	✓	PI	2006	NI	✓	LB: Software in development. SC DU: Estimate drafting only. SD: Result of CIP Benchmarking
	1.f.	Include a Master Schedule in the CIP that identifies start and finish dates for projects	✓	✓	✓	✓	✓	PI	PI	NI	✓	LB: Software in development. SC DU: Completion date only estimated, not determined by scheduling analyses.

Key:

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PI: Partially implemented
NI: No plans to implement at this time
TBD: To be determined
yyyy: Will be implemented in calendar year "yyyy"
* See Process Questionnaire in Appendix C of 2002 Report; year noted indicates this BMP was added later.

LA: Los Angeles;
LB: Long Beach
OK: Oakland
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DGS: Department of General Services,
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Table 1-4 Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Planning	1.i.	Show Projects on a Geographical Information System	✓	✓	PI	✓	✓	✓	✓	✓	✓	LB: Infrastructure only
Design	2.b.	Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start	✓	✓	✓	✓	✓	✓	PI	✓	✓	SC DU: General scope only for simple projects.
	2.f.	Define requirements for reliability, maintenance, and operation prior to design initiation	✓	✓	NI	2006	✓	NI	✓	✓	✓	SD: Some Divisions only
	2.i.	Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc.)	✓	✓	✓	✓	NI	✓	PI	✓	✓	SC DU: This is key to low delivery costs. Std special provisions are updated continuously for lessons learned, new requirements, changing technology, etc.

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Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Design	2.k. 2003	Train in-house staff to use Green Building Standards	✓	TBD	✓	✓	NI	✓	✓	✓	✓	This BMP is intended to improve client satisfaction (quality) and may not reduce project delivery cost directly. SF: When applicable
	2.l. 2004	Limit Scope Changes to early stages of design	✓	✓	✓	✓	✓	✓	✓	2006	✓	SC DU: Control and minimize, but difficult to eliminate, since clients and engineers come up with new/ better solutions.
	2.m. 2004	Require scope changes during design to be accompanied by Budget and Schedule approvals	✓	✓	PI	2007	✓	NI	✓	2006	2006	
	2.n. 2006	Implement a rotating RFQ process for contracting small projects to streamline the bidding and award process. (Include criteria for exemptions from formal Council approval.)	PI	✓	2007	PI	✓	NI	TBD	TBD	✓	SC DT: Maintains on-call consultant list for various engineering, traffic, landscape, architecture, and geotechnical services.

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Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Quality Assurance / Quality Control	3.I.a.	Develop and use a standardized Project Delivery Manual	✓	2007	2006	✓	2006	✓	PI: 2007	✓	✓	SC DU: Badly needs updating. SD: incorporated into PM training manual and std Primavera schedule template/descr. Details available as needed.
	3.II.b.	Perform a formal Value Engineering Study for projects larger than $1 million	✓	✓	NI	✓	✓	✓	✓	✓	✓	LA: For projects > $10M LB: As needed SC: As needed SF: As needed SJ: For projects > $5 million
	3.III.a.	Use a formal Quality Management System	✓	2006	NI	✓	✓	NI	✓	✓	2006	SD: Some Divisions only
	3.III.b	Perform and use post-project reviews to identify lessons learned	✓	TBD	✓	✓	✓	✓	✓	✓	✓	SC DU: For selected projects in one-on-one meetings with design and construction staff. Also includes feedback from client. Intended to promote candid

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Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
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	✓	✓	✓	NI	NI	✓	✓	✓	✓	SD: Individual CO < $200,000 SF: At Bureau level SJ: Individual CO < $100,000
	4.I.m.	Classify types of change orders	✓	✓	✓	✓	✓	✓	PI: 2006	✓	2006	LA: Draft Special Order prepared. SD: Only for scope changes.
	4.II.a.	Include a formal Dispute Resolution Procedure in all contract	✓	NI	✓	✓	✓	✓	✓	✓	✓	
	4.III.a.	Use a team building process for projects greater than $5 million	✓	✓	✓	✓	✓	✓	✓	✓	✓	LB: As-needed SD: As-needed SF: As-needed SJ: For projects > $10 M SC DU: As-needed
	4.IV.a.	Involve the Construction Management Team prior to completion of design	✓	✓	✓	2006	✓	✓	✓	✓	✓	SD: Some Divisions only

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Construction Management	4.V.a. 2003	Delegate authority below Council to make contract awards under $1	✓	✓	NI	NI	NI	NI	✓	✓	✓	
	4.V.b 2003	Establish a pre-qualification process for contractors on large, complex projects	✓	NI	✓	✓	NI	✓	✓	✓	✓	
	4.V.c 2003	Make bid documents available online	TBD	✓	TBD	✓	2006	2006	TBD	TBD	✓	LA: Not enough bids to make this useful. Resistance from smaller contractors who do not use the internet to conduct business. SD: Options being evaluated
Project Management	5.I.f.	Assign a client representative to every project	✓	✓	✓	✓	2006	✓	PI	✓	✓	SD: Only for large projects
	5.II.a	Provide formal training for Project Managers on a regular basis	✓	TBD	✓	✓	2006	NI	✓	✓	✓	LB: Program implementation put on hold due to budget cuts SD: Yearly PM academy, as funds allow SJ: Looking to improve program
	5.III.a.	Adopt and use a Project Control System on all projects	✓	✓	✓	✓	✓	NI	✓	✓	✓	SD: Project controls incorporated into Primavera schedule
	5.I.j 2003	Create in-house project management team for small projects	PI	NI	✓	✓	NI	NI	PI	NI	✓	SC DU: Not enough PMs to justify this. Don't want to restrict staff to small, less-rewarding projects. SD: Some Divisions only
	5.I.k 2004	Institutionalize Project Manager performance and accountability	✓	2006	PI	2006	✓	NI	NI	TBD	2006	SC DU: There is interest but no definite plan. SD: Only non-standardized goals
	5.III.e 2006	Implement a financial system that tracks expenditures by category, adequate to monitor project hard and soft costs during project delivery.	✓	2006	✓	PI	✓	2007	2007	✓	✓	LA: UPRS, Reports, Page 3 SC DT: Will complete automated report system by 2006. SC DU: Intend to utilize SC DT's software if it proves to function well with our PM Database.

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Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Project Management	5.III.f 2006	Implement a Work Breakdown Structure (WBS) to measure progress on project deliverables.	TBD	2006	2007	PI	PI	NI	✓	TBD	2006	SC DT: Working to/ Update: Provide Microsoft Project to all Project Managers and produce schedules with tasks/sub-task schedules
	5.III.g 2006	Monitor "earned value" versus budgeted and actual expenditures during project delivery.	TBD	2007	PI	TBD	PI 2007	NI	PI	TBD	2006	
	5.II.d 2006	Implement verification procedures to ensure that PM training includes agency policies, procedures, forms, and standards of practice (scheduling, budgeting, claims avoidance, risk analyses, etc.).	✓	TBD	2007	✓	2007	NI	TBD	TBD	2007	
	5.IV.a 2006	Bundle small projects whenever possible.	✓	NI	PI	✓	✓	✓	✓	✓	✓	

Key:

✔ : Implemented
PI: Partially implemented
NI: No plans to implement at this time
TBD: To be determined
yyyy: Will be implemented in calendar year "yyyy"
* See Process Questionnaire in Appendix C of 2002 Report; year noted indicates this BMP was added later.

LA: Los Angeles;
LB: Long Beach
OK: Oakland
SC: Sacramento
DGS: Department of General Services,
DT: Department of Transportation,
DU: Department of Utilities

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

Table 1-4 Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Consultant Selection and Use	6.c.	Include a standard consultant contract in the RFQ/RFP with a standard indemnification clause	✓	✓	✓	✓	✓	PI	✓	✓	✓	SD: Some Divisions only
	6.e.	Delegate authority to the Public Works Director/City Engineer to approve consultant contracts under $250,000 when a formal RFP selection process is used	NI	NI	NI	NI	NI	NI	✓	✓	2006	SC DU: Threshold is $100,000.
	6.g.	Implement and use a consultant rating system that identifies quality of consultant performance	✓	2006	✓	✓	NI	✓	✓	✓	✓	SC DU: Track performance for those selected for "support services." SJ: Need to incorporate more post-project review.
	6.m 2006	Implement as-needed, rotating, or on-call contracts for design and construction management work that allow work to be authorized on a task order basis to expedite the delivery of smaller projects.	✓	2006	✓	2006	✓	✓	✓	✓	✓	

Key:

✔ : Implemented
PI: Partially implemented
NI: No plans to implement at this time
TBD: To be determined
yyyy: Will be implemented in calendar year "yyyy"
* See Process Questionnaire in Appendix C of 2002 Report; year noted indicates this BMP was added later.

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SD: San Diego
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SJ: San Jose

As indicated above, a continuing objective of this Study is to eventually link the implementation of BMPs to incremental improvements in project delivery performance. To do so, the point at which a practice is fully implemented and impacting project delivery costs must be verified and defined.

To this end, each agency was asked to complete a survey on two recently- completed projects. They were to describe the document used or produced during the delivery of the project that could serve to verify that the BMP has been applied. The exercise was successful in that the agencies were able to document BMP implementation at a given point in time on specific projects.

The study team remains optimistic that these types of exercises will facilitate credible linking of BMP implementation to changes in performance in the future. At the same time, they acknowledge that successful linking may take several years to achieve.

D. ONLINE DISCUSSION FORUM

Among the primary benefits accruing to the participating agencies during this ongoing Study has been the opportunity to discuss the challenges of public works project delivery with their peers. These successful open forum communications included online discussions of over thirty topics that influence project delivery efficiency. The following discussion topics are summarized in **Chapter 5 Online Discussion Forum.**

- Change Orders and Contingency Encumbrance
- Scheduling and Cost Estimating Staff
- Street Light Technology Survey
- Small Business Performance Bonds
- Increasing the Number of Construction Bids
- Utilities Relocation
- Pavement Design

An archive of the full discussion forum is posted confidentially on the Study website for access by the participants.

E. CONCLUSIONS

I. Performance Benchmarking

The distribution of projects contributed by any given agency to the database is driven by the needs of its community. These needs change over time. Because of this, agencies do not contribute data equally to the various classifications. If the distribution of projects becomes more uniform among all classifications for each agency, the reliability of the models will be improved.

After five years of data collection, the performance benchmarking effort in *Update 2006* showed that the performance models are driven by a large number of relatively small projects (below $1M in total construction cost). Thus there continue to be data gaps to be filled to improve the usefulness of results from the data regressions. The models can be improved for medium-sized and larger-sized projects if more data are collected for total construction cost values above $1M. However, it is not clear if this is practical for the agencies given the actual types and sizes of projects they deliver, as discussed above.

In any event, the process of collecting the requested data benefits the agencies in that they are able to verify that this data is accessible and correct. Additionally, going through data collection allows agencies to identify and implement improvements to their project delivery cost accounting systems and processes. The descriptive

results of the R^2 statistic also allow the agencies to better-understand the amount of scatter in the project delivery costs, even if the p-values indicate that most regressions can be used with caution and professional judgement for budgeting purposes.

Monitoring and correcting the data collection procedures by the participating agencies is important to improve confidence in the data and obtain consistent results from the analyses. This has been and will continue to be an important part of the study for several years.

Additional conclusions from performance benchmarking are presented here:

- Generally, the relative cost of design, construction management, and overall project delivery decreases total construction cost increases. This is consistent with what is intuitively expected due to economies of scale in project delivery.

- Median total construction cost values of projects in the Study are stable on projects completed between 2001 and 2005. Average total construction costs decreased between 2001 and 2004 and increased between 2004 and 2005.

- Project delivery costs as a percentage of total construction cost increased on projects completed between 2001 and 2004.

The increase in project delivery costs may be because:

- Project delivery costs as a percentage of total construction cost tend to be higher on smaller projects than larger ones. Thus, some of the increase in project delivery costs may be explained by the decreasing average total construction cost of projects over the same period in the dataset.

- Agencies also report that as time goes on, it costs more to meet increasingly-stringent regulatory and municipal requirements.

- Better data tracking and collection may have also resulted in higher reported project delivery costs.

It is expected that as the improvements in data collection methods and full BMP implementation improve, project delivery costs will begin to decline.

Other conclusions include:

- Change orders may be limited in practice by the project's contingency budget, frequently 10 percent of total construction cost. The special study on change orders also showed that change orders due to unforeseen and changed conditions averaged 5 percent of total construction cost; those due to changes in bid documents averaged 3 percent; and those due to changes in scope averaged 2 percent.

- When consultant usage exceeded 25 percent of project delivery cost, the design cost as a percentage of total construction cost was not necessarily reduced compared to projects with no consultant usage.

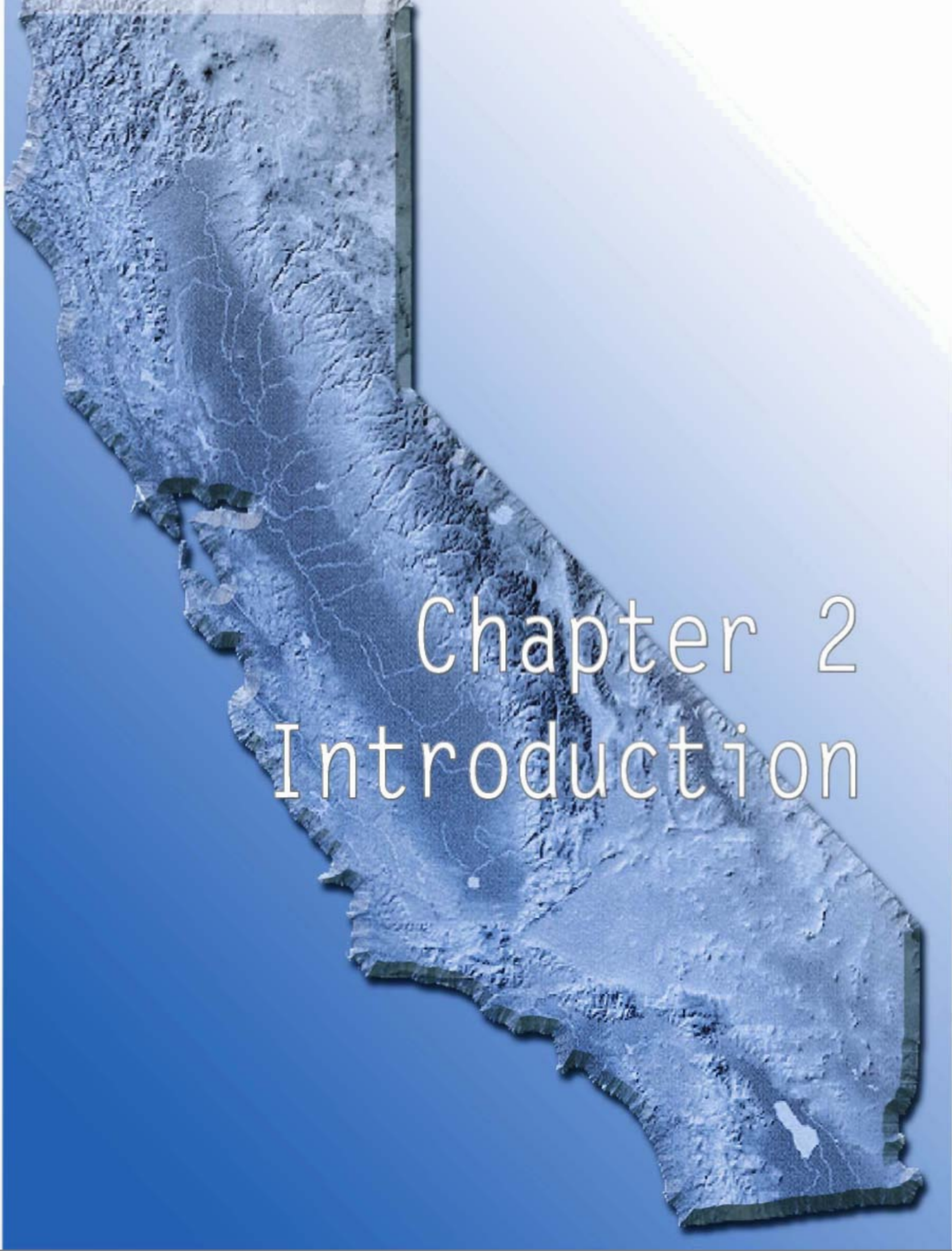
- The increase in design costs associated with using consultants may be justified in many cases where consultants offer specialized technical expertise, the projects are complex, there is an aggressive project schedule, there are peak workload demands that can't easily be met using in-house staff, or there are other resource limitations on in-house staff.

II. Best Management Practices

The agencies have continued to increase the full implementation of BMPs. As of *Update 2006*, the agencies have fully implemented more than 60 percent of all BMPs. A sampling of implementation on projects indicated that agency BMP implementation status reporting generally appears accurate. However, there is some variability and latitude regarding what constitutes BMP "implementation". To enhance the potential of linking practices to performance in future Studies, better BMP implementation documentation may be useful.

III. Online Discussion Forum

The agencies have noted throughout the life of the Study that a key benefit of participation is the open exchange of ideas with regard to project delivery processes. Tracking the implementation of BMPs, identifying new BMPs, and sharing and developing strategies to address issues they face are important steps towards improving project delivery performance. To that end, the participants will continue sharing information through the Online Discussion Forum and during the quarterly meetings, and presenting the more interesting results to the public through the Study reports.



Chapter 2
Introduction

CIP Benchmarking Study

CHAPTER 2

Introduction

Although it is highly effective for municipalities tasked with delivering Capital Improvement Projects to collaborate on their experiences and methods, it is also very rare that this actually occurs. Further, it is even more rare that such activities, once started, are continued uninterrupted for the purpose of effecting continuous positive improvement over a long period of time. This paradigm was challenged in 2002 when the first California Multi-Agency *CIP Benchmarking Study* (Study) was published. This *Update 2006* marks 5 years of continuous collaboration between the participating Cities and represents an accomplishment unparalleled in the industry. Unlike many "single event" studies conducted in the past, this on-going study, involving all of the original participants, provides the benefit of actually experiencing the outcomes of the strategies it creates. The dynamic nature of this effort truly provides a basis for continuous improvement.

Since the participating Cities of Long Beach, Los Angeles, Oakland, Sacramento, San Diego, San Jose, and the City and County of San Francisco first initiated these efforts, interest within the industry has been sparked. As a result, other benchmarking efforts, both large and small, have started to spring up in various parts of the country, such as municipalities in New York and Arizona, the Port of Long Beach, and large water utilities in the western United States. We applaud these efforts and look forward to a time when more agencies are sharing their best ideas for the benefit of all and owners can turn to one another to gather insight on how to best address the challenges they face.

In this fifth year of the Study, the *Update 2006* Project Team has pursued a number of new and on-going endeavors:

- Continue to improve the quality of the performance data and the functionality of the database.
- Track the adoption of Best Management Practices (BMPs).
- Explore the issue of what is involved with the actual implementation of BMPs (i.e., the movement from adoption to proven implementation).
- Continue sharing information with one another through the on-line discussion forum.
- Perform special studies on the topic of interest.

A. BACKGROUND

In October 2001, the City of Los Angeles, Department of Public Works, Bureau of Engineering initiated the Study with several of the largest cities in California. These cities joined together to form the Project Team for the Study. After working together for five years, this team agrees that they benefit from collaborating and pooling their project delivery knowledge and experience.

The Study initially involved six agencies, with a seventh (City of Oakland) joining the team in 2003. The participating agencies currently include:

- 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 and Capital Projects Department
- City and County of San Francisco, Department of Public Works - Bureau of Engineering, Bureau of Architecture, and Bureau of Construction Management
- City of San Jose, Department of Public Works - City Manager's Office

Table 2-1 summarizes some of the general characteristics of the participating agencies and/or of specific departments. The number of their full-time employees (including non-technical staff) involved in capital project delivery ranges from 100 to 900, and their CIP budgets for the next 3 fiscal years range from $250 million to $2 billion.

Table 2-1 Agencies' Overall Information

Information	Population	Area (sq. mi.)	Website	Government Form
Long Beach	499,166	50	http://www.longbeach.gov	Council-Manager-Charter
Los Angeles	3,912,200	472	http://eng.lacity.org	Mayor-Council
Oakland	399,484	66.25	http://www.oaklandpw.com and www.oaklandnet.com	Mayor-Council-Administrator
Sacramento	452,959	98	http://www.cityofsacramento.org	Council-Manager
Dept. of General Services				
Dept. of Transportation				
Dept. of Utilities				
San Diego	1,277,168	342	http://www.sandiego.gov	Mayor-Council
San Francisco	801,377	46.7	http://www.sfdpw.com	Mayor-Board of Supervisors (11 members)
San Jose	953,679	178	http://www.sanjoseca.gov	Mayor-Council-Manager

In 2002, upon initiation of the Study, it was agreed that published data provided by Study participants should remain anonymous in order to create a positive, non-competitive team environment, conducive to meeting the Study's goals. Therefore, no projects are identified by name in this document or in the project database and agencies are referred to by an alias (such as "Agency A") when anonymity is appropriate.

B. BENEFITS OF PARTICIPATION

The participating agencies have been very supportive of the Study efforts over the years. The Study is possible only because the agencies believe they are benefiting from their continued participation. The agencies have expressed the benefits they experience in a variety of ways, including the following:

- The City and County of San Francisco indicates that "We've learned how well we've performed in comparison with other agencies in the delivery of capital projects. We've shared best management practices that improved the effectiveness and efficiency of our work. Because of the relationships and bond that we've developed in working together over the years, help from one another is only a click of a computer or a phone call away. This inter-agency support network has been invaluable."

- Participation in the statewide benchmarking process has provided the City of Long Beach with unique and valuable insight as to how project delivery varies from agency to agency, both in terms of non-construction related costs and methodology. The process has also challenged the City of Long Beach to fully understand its own processes and costs, and to re-evaluate those areas that do not meet the standards being set by the other agencies participating in this study. Project cost accounting has become more timely and accurate due to the City of Long Beach's participation. In addition, based on the experiences and practices shared by the other participants, the City of Long Beach has implemented BMPs that were found to improve project delivery.

- The City of Oakland says the study has helped it network with peer agencies effectively and efficiently. According to the City of Oakland, "We are now part of a larger Public Works family in California that enables us to draw on our peers' expertise and knowledge to establish best management practices and improve the delivery of capital projects in the City of Oakland."

- The City of San Jose has benefited by having ready access to the BMPs of the largest cities in California. This has assisted their decision-making process regarding policy and procedural improvements, including the recent delegation by City Council of increased authority to the Director for award of construction contracts up to $1 million.

- According to the City of Los Angeles: "Every management book talks about taking time for strategic planning. This Study has become a valuable tool to meet with the Project Team four times a year and focus on process improvements for the Los Angeles Bureau of Engineering. In addition, over 100 project managers have raised their level of performance in updating the Uniform Project Reporting

System (UPRS). As a consequence, the UPRS becomes a more valuable resource for both Management and the Project Managers and enables us to fully utilize the UPRS in the data gathering process for the California Multi-Agency Benchmarking Study."

- The City of Sacramento, Department of Utilities indicates that participation has been beneficial by exposing staff to project management concepts that are new to its team, such as resource loading schedules. The Study has also led to a re-examination of processes and procedures that have fallen out of use, such as use of post-project reviews. Some of these BMPs have been reinstated in the project close-out process. By regularly re-visiting the various BMPs under consideration by the Project Team, the Department of Utilities can bring concepts back to its management team that have been tested and proven effective by similar agencies. Learning about software in use by other agencies for extracting financial data into a database has been particularly useful.

- Participation in the California Multi-Agency Benchmarking Study has set the City of Sacramento Department of Transportation "on a fast track to improving its project delivery systems. There is a tremendous sense of accomplishment knowing that we have implemented the vast majority of the study's recommended best management practices and in participating with our peers to develop new ones. We continue to rely on both the Study BMPs and the online discussions to develop our own Project Delivery Manual which formalizes our project delivery policies and standards. And this year, we are challenging our employees in our Funding and Project Development, Design, and Construction Management sections to develop new training plans and internal performance standards. The BMPs and performance benchmarking will be invaluable tools in our efforts to accomplish our goals."

- The City of San Diego says that "The benefit of networking with the 7 largest cities in California and sharing not only how we do business, but exploring ways to improve upon it, has been invaluable."

C. STUDY FOCUS

In this year's Study, special attention was given to defining and building consensus on a number of new BMPs that the Project Team agreed to begin implementing. The BMPs were all developed with the belief they will improve the efficiency of capital project delivery.

During each quarterly Project Team meeting, time was set aside to discuss the challenges the participants encounter in the capital project delivery process and to brainstorm ways to effectively address those challenges. The Project Team evaluated the list of BMPs from *Update 2005* and agreed that additional BMPs were desired. New BMPs were then developed and added to the implementation list. Recognizing that adoption of a BMP in policy is not enough to achieve performance improvement, the Project Team gained consensus towards what "implementation" means and how it can be demonstrated.

A sampling of implementation on projects indi-

cated that agency BMP implementation status reporting generally appears accurate. To enhance the potential of linking practices to performance in the future, better BMP implementation documentation will be useful.

Please see **Chapter 4 Best Management Practices** for more detail on the results of this effort.

D. STUDY GOALS

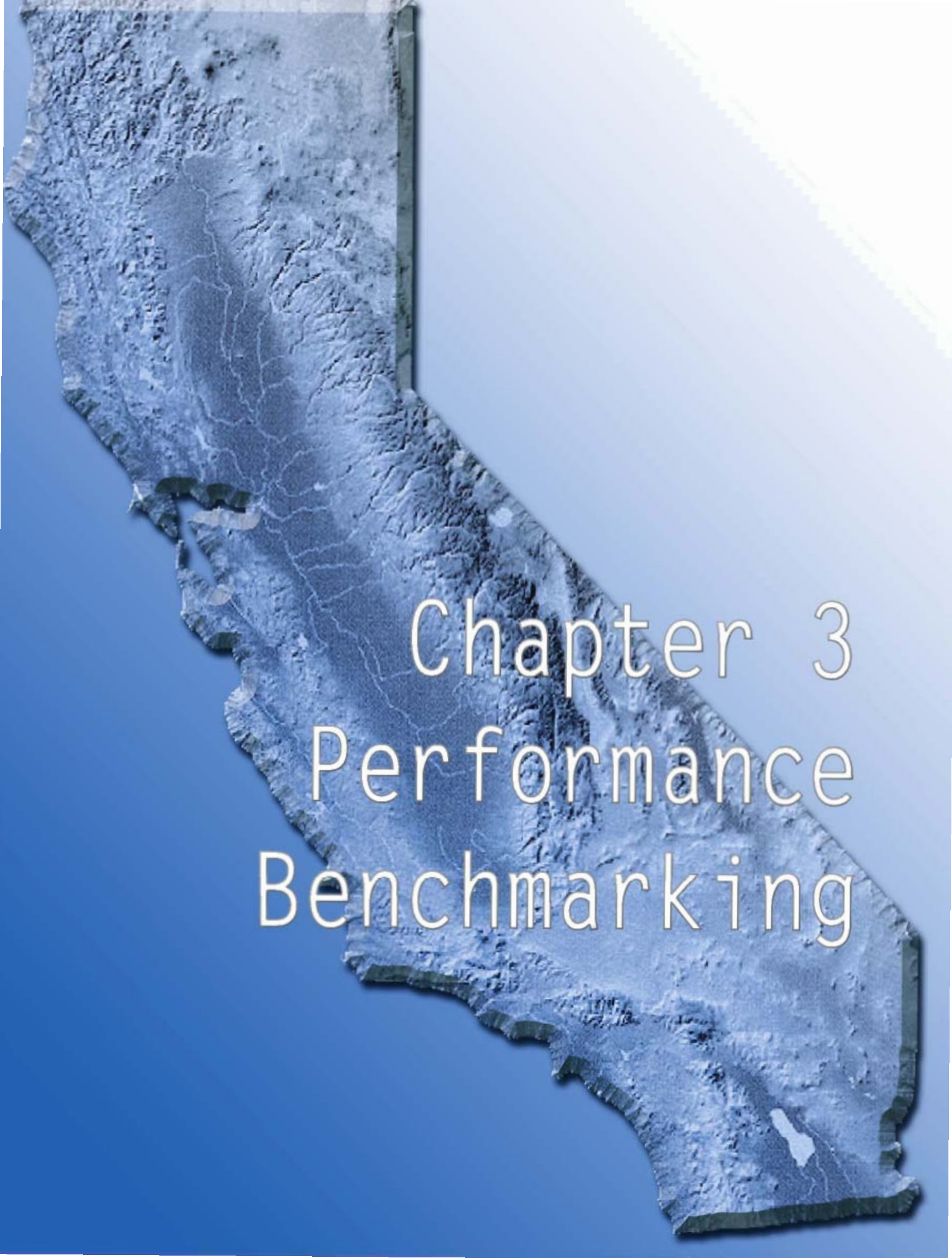
The Study Methodology is described in detail in the first study report (published in 2002) and modifications to it have been documented in subsequent Study reports. In *Update 2006*, the agencies made progress on several goals:

1. **Improve the quality of the performance data and the functionality of the database.** The agencies continued their efforts to capture complete project delivery costs and increase the number of projects in the database. Performance curves were developed for projects falling into 14 classifications among 4 project types. Regressions were done for design, construction management, and overall project delivery costs as a function of total construction cost (TCC). The Performance Questionnaire was modified to acquire data on the number of bids received. Agencies verified or corrected randomly-selected project data, and made presentations on their data collection process. A statistical outlier analysis was also performed.

2. **Improve the data collection process.** The agencies continued to demonstrate a commitment to providing consistent, accurate cost data to the Study by presenting a detailed account of how they complete Performance Questionnaires. The group discussed points of confusion, arrived at consensus on definitions, and reaffirmed previously-established definitions.

3. **Identify and implement BMPs for performance improvement.** The Project Team continued to discuss common challenges and share ideas for addressing those challenges during the quarterly meetings as well as in the online discussion forum. New BMPs were adopted by the Project Team for implementation and added to the implementation list. The Study Team continued to track the implementation of BMPs in order to link these practices to capital project performance improvement over time. In addition, this year each agency reported upon BMP implementation for two randomly-selected projects. The purpose of the exercise was to clarify what it means to "implement" a BMP.

4. **Perform special studies on topics of interest**. This year's special studies were on consultant usage and change order rates. This year's consultant usage analyses were an expansion of the analyses performed in *Update 2005*. The change order special study attempted to identify differences in the change order rates among defined change order categories and trends in change order rates.



Chapter 3
Performance Benchmarking

CIP Benchmarking Study

CHAPTER 3 Performace Benchmarking

Performance benchmarking involves collecting documented project costs and plotting the component costs of project delivery against the TCC. All of the actual project costs are collected by the agencies using a Performance Questionnaire created in Microsoft Excel®. Data is then compiled from the questionnaire in Excel® using a Visual Basic for Applications (VBA) code and transferred into the database, where the data is reviewed and vetted. A copy of the current Performance Questionnaire can be found in **Appendix A**.

A. STUDY CRITERIA

The following criteria applied to *Update 2006* performance benchmarking analyses:

- **Total Construction Costs** – TCC is the sum of the awarded construction contract, net change orders, utility relocation, and construction by agency forces. TCC does not include land acquisition, environmental monitoring and mitigation, design, or construction management costs. All projects included in the analyses have a TCC exceeding $100,000.

- **Completion Date** – Projects included in the Study analyses were completed on or after January 1, 2001. Projects with earlier completion dates were kept in the database, but excluded from the analyses.

- **Outlier Elimination** – Statistical outliers were identified using the statistical method described in the *Update 2004* report. The total project delivery cost of each project in the database was evaluated against all other projects in the same classification. Potential outliers were then excluded from the analyses only if the respective agency confirmed that the project delivery process was not representative of the procedures normally used to deliver projects. Projects confirmed as outliers by the agencies were kept in the database, but excluded from the analyses.

- **Project Delivery Method** – All projects in this Study were delivered through the traditional Design-Bid-Build delivery method. Projects delivered using other methods are not included in this Study at this time.

- **Change Order Classification** – In order to support meaningful change order analyses, the Project Team agreed to report change order costs divided into classifications. The following classifications were selected:

1. Changed/Unforeseen Conditions
2. Changes to Bid Documents
3. Client-Initiated Changes

- **Proj ect Classifications** – Streetscape projects that required customized designs were added to the Streets project type and were with the existing Bike/Pedestrian project classification. The project types and classifications are shown in **Table 3-1**.

Table 3-1 Project Types and Classifications

Project Types	Classifications
Municipal Facilities	▪ Libraries ▪ Police and Fire Stations ▪ Community Centers, Recreation Centers, Child Care Facilities, Gymnasiums
Streets	▪ Widening, New, and Grade Separation ▪ Bridges ▪ Reconstruction ▪ Bike Ways, Pedestrian Ways, and Streetscapes ▪ Signals
Pipe Systems	▪ Gravity Systems ▪ Pressure Systems ▪ Pump Stations
Parks	▪ Playgrounds ▪ Sportfields ▪ Restrooms

The Performance Questionnaire was also modified for the Project Team to indicate the number of bids received and to indicate whether the project included a LEED-certified building. This was done to support future special studies on those subjects. The questionnaire was also modified to include a calculation of the Total Project Cost (the sum of TCC and Project Delivery Cost) for the Project Team's information.

B. DATA COLLECTION AND CONFIRMATION

The agencies are commited to providing accurate, complete project delivery cost data to support the development of performance models. Project delivery costs are defined as the sum of all agency, internal client, and consultant costs associated with project planning, design, bid, award, construction management, and closeout activities. Examples of specific activities included in project delivery are presented in **Table 3-2**.

Each agency prepared a presentation describing how it completes the project delivery cost data portion of the Perfomance Questionnaire. The presentations were shared with the Project Team during a quarterly workshop. The goal of these presentations was to confirm that the agencies were completing the questionnaires with comparable, complete, and accurate values. The agencies have found that preparing the presentation and discussing the methods used help clarify points of confusion or inconsistency, and allow the Project Team an opportunity to build consensus towards further refining definitions.

Each agency was also asked to verify data for 5 randomly-selected projects that were submitted in previous Study phases. The confirmations were collected, the required corrections made, and the results of the confirmation were shared with the agencies. Because the number of projects corrected is a small proportion of the entire database, the overall impact of the revisions upon the analyses was inconsequential. This exercise did, however, reaffirm the need to continue improving the data collection and reporting process on all reported project data.

C. PERFORMANCE DATABASE

Table 3-3 summarizes the number of projects included in the database and in the analyses. The database now contains 974 projects in total.

Following the application of the study criteria described above, 650 projects fit the Study criteria and were included in the analyses.

The participating agencies decided to use fully-burdened costs for project delivery tasks because agencies' overhead multipliers were similar. They also agreed that land acquisition costs should be excluded from the total construction cost calculation.

Table 3-2 Project Cost Categories

Category and Phase	Description
1) Design Costs:	The design phase (and associated costs) begins with the initial concept, includes planning as well as design, and ends with the issuance of a construction notice-to-proceed. Design costs consist of direct labor costs, other direct agency costs such as art fees and permits, and consultant services cost associated with planning and design. Design may include the following:
Pre-Design	• Complete schematic design documents • Review and develop scope • Evaluate schedule and budget • Review alternative approaches to design and construction • Obtain owner approval to proceed • Attend hearings and proceedings in connection with the project • Prepare feasibility studies • Prepare comparative studies of sites, buildings, or locations • Provide submissions for governmental approvals • Provide services related to future facilities, systems, or equipment • Provide services as related to the investigation of existing conditions of site or buildings or to prepare as-built drawings • Develop life cycle costs • Complete environmental documentation and clearances • Manage right-of-way procurement process • Monitor and control project costs
Design	• Complete design development documents including outline specifications • Evaluate budget and schedule against updated construction cost estimate • Complete design and specifications • Develop bid documents and forms including contracts • Complete permit applications • Coordinate agency reviews of documents • Review substitutions of materials and equipment • Prepare additive or deductive alternate documentation • Coordinate geotechnical, hazardous material, acoustic or other specialty design requirements • Provide interior design services • Monitor and control project costs

Table 3-2 Project Cost Categories (cont'd)

Category and Phase	Description
Bid and Award	• Prepare advertisement for bids • Perform prequalification of bidders • Manage the pre-bid conference • Perform the bid evaluations • Prepare the recommendation for award • Obtain approval of contract award from Board/Council • Prepare the notice to proceed • Monitor and control project costs
2) Construction Management Costs:	All the costs associated with the management of the construction of the project, including closeout costs, are included in this category. Construction management costs consist of direct labor, other agency costs, and consultant usage. Construction management may include the following:
Construction	• Hold pre-construction conference • Review and approve schedule and schedule updates • Perform on-site management • Review shop drawings, samples, and submittals • Perform testing and inspection • Process payment requests • Review, and negotiate change orders • Prepare monthly reports to owner and agencies • Respond to requests for information • Develop and implement a project communications plan • Perform document control • Manage claims • Perform final inspections and develop/track punch list
Closeout Phase	• Commission facilities and equipment • Train maintenance and operation personnel • Document and track warranty and guarantee information • Plan move-in • File notices (occupancy, completion, etc.) • Check and file as-built documents • Monitor and control project costs
3) Total Delivery Costs:	This is the total cost of delivering a capital improvement project. It is also the sum of the design cost and construction management costs indicated above.

Table 3-2 Project Cost Categories (cont'd)

Category and Phase	Description
4) Change Order Cost:	Please see the *Update 2005* Report for details as the following types of change orders: • Changed/Unforeseen Conditions • Changes to Bid Documents • Client-Initiated Changes
5) Construction Cost:	This is the direct construction cost, including all change orders during the construction phase (from the issuance of Notice to Proceed to Notice of Acceptance). The following costs are associated with construction and are included in the total construction cost: • Direct actual construction • Total amount of positive change orders throughout construction • Fixtures, furnishing, and equipment (FFE) • Utilities relocation • Work performed by the agency's staff and other agencies' staff

Table 3-3 Growth of Database

Study Phase[1]	Submitted	Deleted		Increase	Excluded		Net
	(a) Total	(b) TCC <$100K	(d) Non-Repre-sentative	(d)=(a)-(b)-(c)	(e) Project Completion Date <2001	(g) Outliers	Projects in Analyses (h)= (d)-(e)-(f)-(g)
I	237	25	41	171	121	7	43
II	285	0	31	254	86	23	145
III	262	0	13	249	4	45	200
IV	170	17	34	119	0	25	94
V	182	0	12	181	0	13	168
Total	**1,136**	**42**	**120**	**974**	**211**	**113**	**650**

Note:
[1] Study Phase indicates action taken on the count of projects corresponding to Study Years I = 2002, II = 2003, III = 2004, IV = 2005, and V = 2006.
[2] One design-build project removed from database.

There are 4 project types (Municipal Facilities, Streets, Pipe Systems, and Parks) and 14 project classifications included in this Study. **Table 3-4** summarizes the distribution of projects included in the *Update 2006* analyses.

The number of projects in the database for Municipal Facilities, Streets, and Parks showed slight net decreases from *Update 2005*, due to the outlier analyses and shift in project completion date criterion. The number of Pipe Systems projects increased the most, indicating that municipalities are continuing to focus on building these types of critical infrastructure in the face of growing populations and aging infrastructure.

In "Statistical Analyses of Construction Cost Data" (Dessouky & Associates, 2002), it was recommended that a minimum data set of 1,000 projects, distributed evenly among classifications, ranges of TCC, and agencies is necessary to achieve statistically-significant results. (Please see the *Study 2002* report Appendix B.) The agencies acknowledged that it is vital to the success of the Study to continue increasing the size of the data set as much as possible, thereby increasing the confidence, consistency, and reliability of results.

Table 3-4 Projects Distribution Matrix

Agency	Long Beach	Los Angeles	Oakland	Sacramento	San Diego	San Francisco	San Jose	Total
Municipal Facilities	**8**	**40**	**9**	**14**	**3**	**13**	**25**	**112**
Libraries	0	32	1	0	3	1	3	40
Police/Fire Station	3	2	2	2	0	6	3	18
Comm./Rec. Center/ Child Care/Gym	5	6	6	12	0	6	19	54
Streets	**13**	**7**	**33**	**30**	**48**	**22**	**35**	**188**
Widening/ New/Grade Separation	1	1	1	3	9	2	7	24
Bridges	0	4	0	0	4	1	0	9
Reconstruction	8	2	10	4	4	6	4	38
Bike/Pedestrian/ Streetscape	2	0	12	9	9	4	7	43
Signals	2	0	10	14	22	9	17	74
Pipe Systems	**2**	**69**	**17**	**25**	**70**	**44**	**23**	**250**
Gravity System	2	63	17	21	46	33	22	204
Pressure Systems	0	0	0	1	21	7	0	29
Pump Stations	0	6	0	3	3	4	1	17
Parks	**6**	**2**	**8**	**1**	**6**	**14**	**63**	**100**
Playgrounds	2	0	7	0	0	12	52	73
Sportfields	1	2	0	1	3	0	3	10
Restrooms	3	0	1	0	3	2	8	17
Total	**29**	**118**	**67**	**71**	**127**	**93**	**146**	**650**

Note: Count is of projects included in *Update 2006* analyses.

D. OVERHEAD RATES

Based upon the results of an evaluation performed in the *Update 2004,* the Study Team agreed that normalization of the cost data for differences in overhead rates was not necessary at this time. Please see the *Update 2004* report for more details on the overhead rate analyses and **Appendix C** Indirect Rates of this report for a summary of overhead rates.

E. PERFORMANCE DATA ANALYSES

Table 3-5 summarizes characteristics of the 650 projects included in the analyses by project completion year and shows trends in the average TCC values, median TCC values, design costs, construction management costs, and overall project delivery costs.

Table 3-6 summarizes the average cost of design, construction management, and project delivery costs by agency for projects included in the analyses. Project delivery information comparing the use of in-house staff versus consultants, is also included.

Table 3-5 Project Count and Project Delivery by Completion Year

Project Completion Date	Count by Project Type					Project Delivery Data				
	Municipal Facilities	Streets	Pipes	Parks	Total	Average TCC ($M)	Median TCC ($M)	Design Cost (% of TCC)	Construction Management Cost (% of TCC)	Project Delivery Cost (% of TCC)
2001	17	9	51	10	87	$1.70	$0.60	16%	16%	32%
2002	32	48	73	10	163	$1.70	$0.80	17%	17%	34%
2003	27	49	50	47	173	$1.40	$0.50	19%	16%	35%
2004	19	42	24	21	106	$1.00	$0.60	24%	15%	39%
2005	16	40	52	12	120	$1.60	$0.50	22%	16%	38%
Total	**111**	**188**	**250**	**100**	**649**	**$0.00**	**$0.60**	**20%**	**16%**	**36%**

Note:
One project in the *Update 2006* analyses with a project completion date in 2006 is not included in this table.

Table 3-6 Project Delivery Performance and Consultant Usage by Agency

AGENCY	DESIGN					CONSTRUCTION MANAGEMENT					PROJECT DELIVERY					TCC	
	In-House		Consultants			In-House		Consultants			In-House		Consultants				
	($M)	% of Design	($M)	% of Design	Total % of TCC	($M)	% of CM	($M)	% of CM	Total % of TCC	($M)	% of PD	($M)	% of PD	Total % of TCC	Average	Median
Agency A	$19.40	80%	$4.80	20%	23%	$18.20	98%	$0.40	2%	15%	$37.60	88%	$5.20	12%	37%	$1.20	$0.60
Agency B	$7.00	41%	$9.90	59%	16%	$8.10	58%	$5.90	42%	11%	$15.00	49%	$15.80	51%	27%	$1.10	$0.30
Agency C	$23.50	85%	$4.00	15%	16%	$20.70	96%	$0.80	4%	15%	$44.20	90%	$4.80	10%	32%	$1.60	$0.70
Agency D	$27.70	59%	$18.90	41%	18%	$42.00	91%	$4.00	9%	20%	$69.70	75%	$22.80	25%	37%	$2.60	$1.40
Agency E	$3.30	26%	$9.30	74%	21%	$5.90	71%	$2.40	29%	16%	$9.20	44%	$11.60	56%	37%	$1.90	$0.50
Agency F	$19.10	60%	$12.70	40%	21%	$18.60	91%	$1.80	9%	19%	$37.70	72%	$14.50	28%	40%	$1.20	$0.40
Agency G	$8.10	70%	$3.50	30%	20%	$6.80	99.50%	$0.04	0.50%	15%	$14.90	81%	$3.60	19%	35%	$1.20	$0.40
OVERALL	$108.10	63%	$63.10	37%	19%	$120.20	89%	$15.20	11%	16%	$228.30	74%	$78.30	26%	36%	$1.50	$0.60

Notes:
1 In-House and Consultant costs are calculated as percentages of total agency Design, CM (Construction Management), and PD (Project Delivery) costs.
2 TCC (Total Construction Cost) is the sum of construction contract award, change orders, utility relocation cost, and city forces construction cost.
3 Design, CM (Construction Management), and PD (Project Delivery) costs as percentages of TCC are unweighted, arithmetic averages of projects by agency.

Between project completion dates from 2001 to 2005, **Table 3-5** shows that the median TCC of projects in the Study are about $0.5 to 0.6M, well below the average TCC in each case. (Only one project with a completion date in 2006 was submitted.) This skew indicates that more projects have a TCC below the average than above the average. As larger projects are completed and submitted to the Study, the gap between the median TCC and average TCC should close.

The *Update 2006* performance data, shown in **Table 3-5**, indicate that for projects with completion dates in 2001 to 2004, relative project delivery costs increased, and stabilized between 2004 and 2005. This may be driven in part by improvements in cost data capture and reporting for the Study. Another driver may be the trend in average total construction cost, which decreased between 2001 and 2004, and increased in 2004 and 2005. Project delivery costs on larger projects are influenced by economies of scale. It is expected that as data collection methods and full BMP implementation improve, project delivery costs will begin to decline.

I. DEFINITIONS

Performance curves produced for this Study are regressions of data, demonstrating how close of a relationship exists between the dependent variable (y-axis) and the independent variable (x-axis). For instance, a regression curve of design cost as a percentage of TCC versus TCC would be prepared to evaluate how much of the variability in design cost is due to the TCC value.

The regression trendline provides a running average of project delivery cost for each TCC that can be used as a starting point for budgeting an entire program of projects. Caution and use of professional judgment is required if using the regression trendline to budget an individual project.

Confidence Interval

The upper bound of the 50 percent confidence interval is displayed on each of the regression curves. The upper and lower bounds of the confidence interval indicates the level of certainty in a data set, and how likely it is that a random sample from the data set will fall within the interval. The wider the distance between the upper and lower bounds of a confidence interval, the less certainty in the model and greater the need to collect more data before drawing conclusions from the data set.

Coefficient of Determination

A best-fit logarithmic curve is calculated using the least-squares method in Excel®, and a R^2 value is displayed. The R^2 value, also called the coefficient of determination, is a value between 1 and 0, with a value approaching 0 indicating a poor model and a value approaching 1 indicating a high dependence of the y-value statistic on the x-value statistic.

Project performance data were analyzed using the custom database application at both the Project Type level and the Project Classification level. The database application was used to select data and generate regression curves for the Study.

Statistical Significance

To evaluate the statistical significance of the result obtained, the regression analyses included a calculation of p-values. Whereas the R^2 value is a descriptive statistic (i.e., describes the current set of data), the p-value is a predictive statistic. It indicates whether there are enough data points to arrive at statistically-significant results and could be used to predict new values. The selection of a desirable p-value is subjective, though 0.10 or 0.05 is usually used as the maximum desirable value. For the purposes of this Study, a critical p-value of 0.10 was selected. Thus, any result where $p \leq 0.10$ indicates a statistically-significant

result. There is no difference between a p-value slightly below 0.10 as one that is far below 0.10. Both results are considered to have equal statistical significance.

For regressions resulting in a p-value above 0.10, additional projects should be added to the database to improve the result. Please see the *Study 2002* report for additional detail on the connection between the number of projects and p-values.

For each of the regressions, the R^2 value and p-value should be considered separately. A high R^2 value does not mean the result is statistically-significant, and vice-versa.

II. RESULTS

The results of the regression analyses are presented in **Table 3-7** and **Appendix B** . The ranges of design, construction management, and project delivery costs as percentages of TCC shown are for the best-fit logarithmic trendline (i.e., performance model), not the range of corresponding data.

The shape of most of the best-fit curves is consistent with what is intuitively expected. The dependent variable (i.e., design, construction management, or project delivery) has higher average values and greater scatter at the low values of TCC. This decrease in both average value and variability as TCC increases, exhibits an inverse relationship.

Because the R^2 values and, in many cases, the number of relevant data points are relatively low, the reader is cautioned that this table is to be used as a reference and not for prediction of performance. Readers are urged to review the curves in **Appendix B** in conjunction with using this table.

Table 3-7 Summary of Performance Models

PROJECT TYPE / Project Classification	Range of TCC	Count of Projects	Des. (% of TCC)	CM (% of TCC)	PD (% of TCC)
Municipal Facilities		**112**			
Libraries		**40**			
	$2M<TCC<$3.5M	14	25% to 18%	25% to 15%	50% to 33%
	$3.5M<TCC<$4M	16	24% to 17%	20% to 14%	44% to 31%
	$4M<TCC<$10M	10	23% to 14%	18% to 5%	41% to 19%
Police/Fire Station		**18**			
	$0.1M<TCC<$0.6M	6	36% to 26%	22% to 15%	58% to 41%
	$0.6M<TCC<$3M	6	32% to 22%	20% to 13%	52% to 35%
	$3M<TCC<$42M	6	28% to 15%	17% to 8%	45% to 23%
Community Bldg/Rec Ctr/ Child Care/Gym		**54**			
	$0.1M<TCC<$0.4M	20	31% to 23%	33% to 18%	64% to 41%
	$0.4M<TCC<$1.5M	19	30% to 21%	30% to 15%	60% to 36%
	$1.5M<TCC<$53M	15	28% to 20%	27% to 8%	55% to 28%
Streets		**188**			
Widening/New/Grade Separation		**24**			
	$0.1M<TCC<$0.6M	8	44% to 30%	21% to 14%	65% to 44%
	$0.6M<TCC<$5M	8	39% to 19%	20% to 10%	59% to 29%
	$5M<TCC<$18M	8	28% to 13%	16% to 8%	44% to 21%
Bridge		**9**			
	$0.1M<TCC<$0.3M	3	78% to 49%	26% to 19%	104% to 68%
	$0.3M<TCC<$2M	3	68% to 28%	25% to 16%	93% to 44%
	$2M<TCC<$12M	3	46% to 10%	22% to 13%	68% to 23%
Reconstruction		**38**			
	$0.1M<TCC<$0.6M	17	31% to 22%	22% to 16%	53% to 38%
	$0.6M<TCC<$1M	9	29% to 21%	21% to 16%	50% to 37%
	$1M<TCC<$12M	12	28% to 18%	20% to 12%	48% to 30%
Bike/Pedestrian/Streetscape		**43**			
	$0.1M<TCC<$0.3M	17	54% to 30%	24% to 17%	78% to 47%
	$0.3M<TCC<$0.6M	16	42% to 23%	23% to 16%	65% to 39%
	$0.6M<TCC<$2.2M	10	35% to 10%	22% to 15%	57% to 25%

Note: TCC = total construction cost. The project delivery percentages indicated are the ranges between the logarithmic regression curve and upper bound of the 50 percent confidence interval for the respective TCC values. Caution and review of the report text are urged in using this information. Refer to *Appendix B* for the corresponding regression curves, R^2 values, and N values for more details. Highlighted values indicate those for which R^2 values were particularly low, below 0.10.

Table 3-7 Summary of Performance Models (cont'd)

PROJECT TYPE Project Classification	Range of TCC	Count of Projects	Des. (% of TCC)	CM (% of TCC)	PD (% of TCC)
Signals		**74**			
	$0.1M<TCC<$0.2M	26	33% to 22%	26% to 17%	59% to 39%
	$0.2M<TCC<$0.5M	28	31% to 19%	24% to 15%	55% to 34%
	$0.5M<TCC<$3M	20	27% to 12%	22% to 11%	49% to 23%
Pipe Systems		**250**			
Gravity System		**204**			
	$0.1M<TCC<$0.5M	64	28% to 17%	23% to 18%	51% to 35%
	$0.5M<TCC<$1.1M	70	23% to 15%	22% to 16%	45% to 31%
	$1.1M<TCC<$23M	70	21% to 6%	21% to 13%	42% to 19%
Pressure Systems		**29**			
	$0.1M<TCC<$0.5M	11	18% to 13%	17% to 12%	35% to 25%
	$0.5M<TCC<$0.9M	12	18% to 13%	17% to 12%	35% to 25%
	$0.9M<TCC<$2M	6	18% to 13%	16% to 12%	34% to 25%
Pump Station		**17**			
	$0.1M<TCC<$0.7M	5	23% to 18%	30% to 21%	53% to 39%
	$0.7M<TCC<$3M	5	22% to 16%	28% to 17%	50% to 33%
	$3M<TCC<$22M	7	20% to 13%	24% to 12%	44% to 25%
Parks		**100**			
Playgrounds		**73**			
	$0.1M<TCC<$0.3M	22	36% to 23%	22% to 15%	58% to 38%
	$0.3M<TCC<$0.5M	27	32% to 22%	20% to 17%	52% to 39%
	$0.5M<TCC<$6M	24	28% to 17%	17% to 12%	45% to 29%
Sportfields		**10**			
	$0.1M<TCC<$0.3M	2	24% to 20%	15% to 19%	39% to 39%
	$0.3M<TCC<$0.7M	3	24% to 20%	15% to 19%	39% to 39%
	$0.7M<TCC<$2M	5	23% to 19%	16% to 20%	39% to 39%
Restrooms		**17**			
	$0.1M<TCC<$0.2M	6	19% to 29%	20% to 39%	39% to 68%
	$0.2M<TCC<$0.3M	5	21% to 30%	26% to 44%	47% to 74%
	$0.3M<TCC<$2M	6	23% to 38%	31% to 64%	54% to 102%

Note: TCC = total construction cost. The project delivery percentages indicated are the ranges between the logarithmic regression curve and upper bound of the 50 percent confidence interval for the respective TCC values. Caution and review of the report text are urged in using this information. Refer to *Appendix B* for the corresponding regression curves, R^2 values, and N values for more details. Highlighted values indicate those for which R^2 values were particularly low, below 0.10.

Unlike the other regressions, regressions for the Restrooms classification showed a direct (as opposed to an inverse) relationship between the dependent variable and TCC. That is, as the TCC increased, the design, construction management, and project delivery cost trendline sloped upwards. The agencies noted in *Update 2005* that more expensive restrooms tend to require more complex features and elaborate architectural design elements, explaining some of the trend. Also, the relatively low number of data points overall and clustering of nearly all data points in the range of less than $500,000 TCC may contribute to the trend. One data point that is relatively high in both project delivery percentage and TCC skews the best-fit curve to a positive slope. Without that data point included, the best-fit curve is relatively flat. This point is not an outlier, so it is included in the regression analysis.

A larger portion of confirmed outliers would be expected in the *Update 2006* analyses, since re-evaluation of outliers was performed on the whole database. However, only 113 of 974 total projects were confirmed as outliers, still roughly 11 percent of the total projects. As a result, the outlier analyses did not lead to significant improvement (increase) in R^2 values. In fact, in many cases R^2 values were decreased. The results of the analyses show that the R^2 values for the data are improving in some cases with continued additions of data to the database and repetition of the outlier analyses.

The agencies theorized that one of the reasons R^2 values varied significantly by project type and classification is that there are differences in how different types of projects are delivered. Pipe and Municipal Facilities projects, for instance, were probably better-defined at the beginning of a project and thus allow for the design effort to be more focused. This would lead to more consistent performance and therefore higher R^2 values. They also observed that Construction Management exhibited higher variability in relative cost than Design for the same project types and classifications. This is probably due to the stronger influence of project-specific factors on the Construction Management costs than on Design costs.

The results of statistical significance tests indicate that additional data points are required for most of the performance models. A table summarizing the calculated p-values is included in Appendix B. Additional data points for models with p-values above 0.10 should improve (reduce) the p-value. For those models with p-values>0.10, the model should not be used alone to predict delivery costs for individual projects.

Increasing the size of the project database will continue to be a challenge since the Study criteria for project completion date rolls forward with each Study phase. In addition, the agencies also struggle to identify as many projects as possible that meet the rest of the Study criteria. The Project Team will identify and evaluate ways to address this issue as the Study continues in future phases.

F. SPECIAL STUDY: CHANGE ORDERS

Although the study has collected change order data for several years, *Update 2006* is the second year that change order data was analyzed. For *Update 2006,* it was decided that agencies would report their change order data on the Performance Questionnaire utilizing three categories as defined in guidance contained in *Update 2005* for future years. These categories are:

1. Changed/Unforeseen Conditions
2. Changes to Bid Documents
3. Client-Initiated Changes

Previously, agencies also reported change orders

into a fourth category termed "Credit Change Orders". Starting in *Update 2006*, all credit change orders were reported in one of the three categories listed above. Additionally, "Credit Change Order" data collected in previous years was also redistributed into one of these three categories. Data from 43 projects was reclassified in this fashion.

As part of this shift, the Study Team raised the question of whether it was fair to consider credit changes at all and whether only positive cost change orders should be considered. This inquiry was made because the credits served to decrease the TCC, while costs associated with designing these features and executing the change orders during construction were incurred, thus resulting in a seemingly higher level of delivery cost as a percentage of TCC. However, review of the data revealed that these credits had a very small impact upon TCC and thus a small impact upon delivery cost as a percentage of TCC.

The Study Team also considered the case where credit change orders were used to adjust unused construction allowances included in a base bid, such as those for permitting or extended unit costs. In these cases, design costs would still be incurred in designing facilities, construction management costs would increase to execute the credit change order, and the TCC would be reduced. Selected projects for one agency were reviewed in detail and it was found that only a few, small change orders were issued for this purpose, again having little impact on delivery cost as a percentage of TCC.

Upon further investigation it was determined that the agencies had been reporting change orders for all categories on a net basis (i.e., summation of all positive and negative change orders). Therefore, it was decided that including credit change orders in the other three categories was consistent with the overall database composition, and that reporting net change orders was consistent with current agency practice.

Analyses were conducted of change order as a percentage of TCC versus TCC. Individual regressions were produced for each of the three categories, as well as all three categories combined. In each instance, the project sample size represented a combination of all project types. The results of the regression analyses are presented in **Figure 3-1** to **Figure 3-4**.

The results were similar to those from the *Update 2005* analyses. The resultant R^2 values were very low. Also, there is more data scatter associated with smaller projects than with larger ones.

Among project included in the *Update 2006* analyses, change orders averaged 10 percent of TCC with 5 percent associated with unforeseen and changed conditions, 3 percent with changes in bid documents, and 2 percent resulting from changes in scope. Although these figures may not be entirely predictive relative to any given project, they may be of use when considering a portfolio of projects or program.

The *Update 2006* analyses showed that change orders averaged 10 percent in the data set. It is postulated that this is because 10 percent is a common amount for change order contingencies. This result is similar to what was seen in *Update 2005*. When this contingency is exceeded, the agencies must often go to their Boards or Councils for approval to increase the existing contract or establish an entirely new contract. This encourages agencies and their contractors to work within allotted limits. In addition, if a new contract is established to pay for additional change orders, it is probable that the cost is no longer linked to the original project.

Figure 3-1 Total Change Orders vs. TCC
(All Project Types)

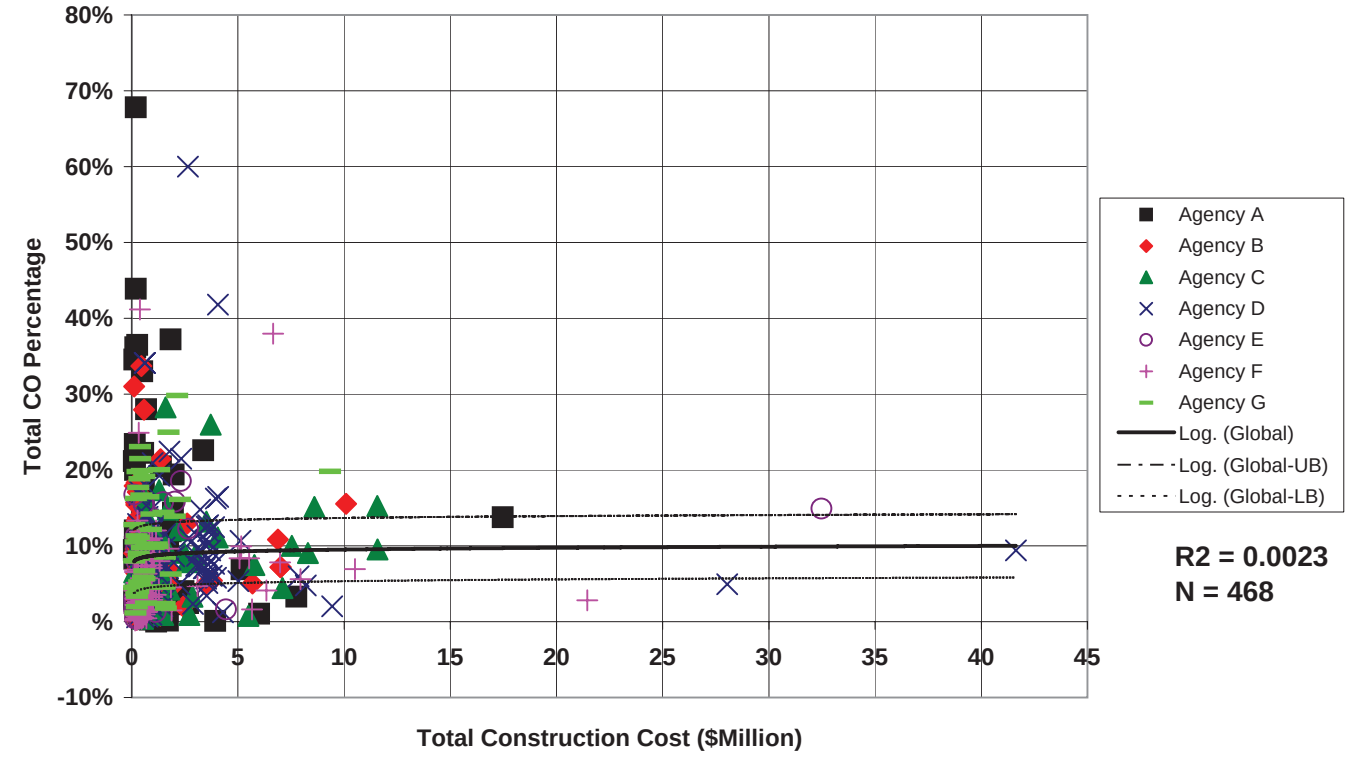


Figure 3-2 Changed Conditions Change Orders vs. TCC
(All Project Types)

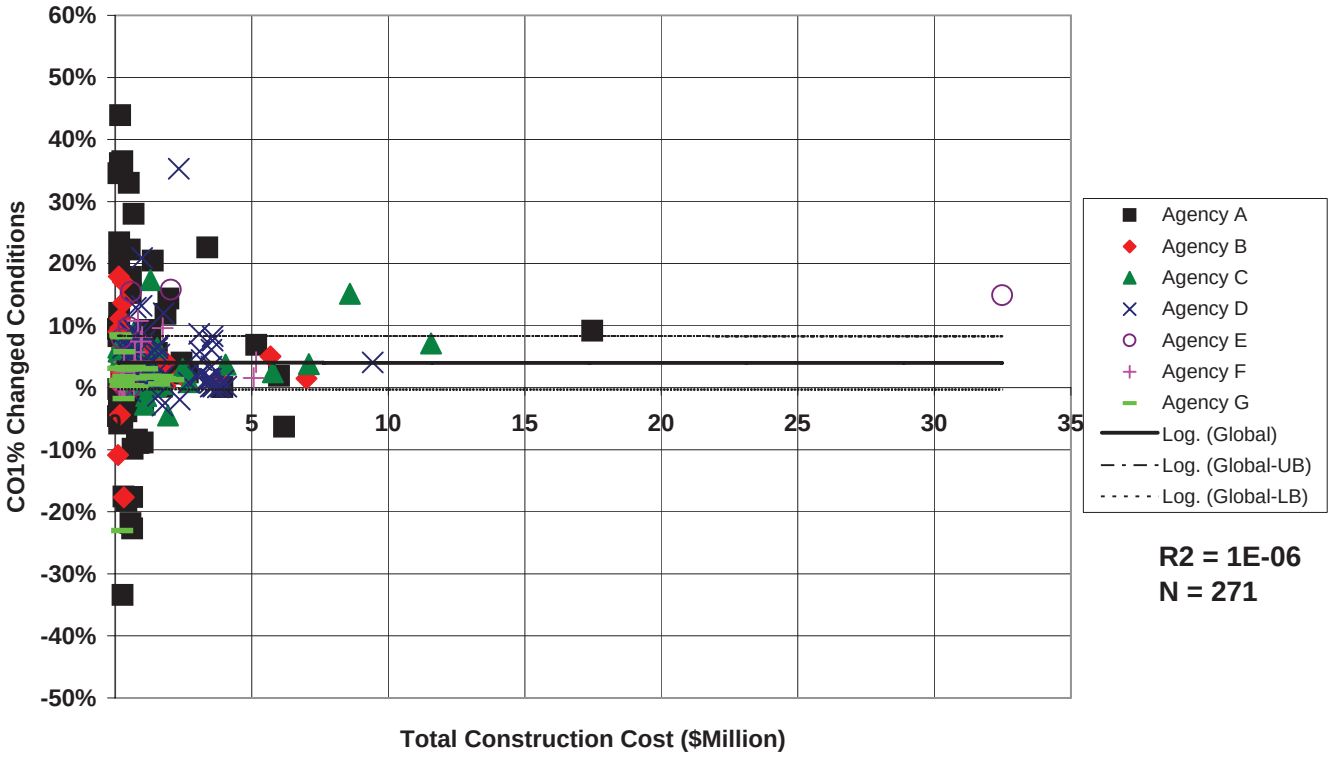


Figure 3-3 Changed Bid Documents Change Orders vs. TCC (All Project Types)

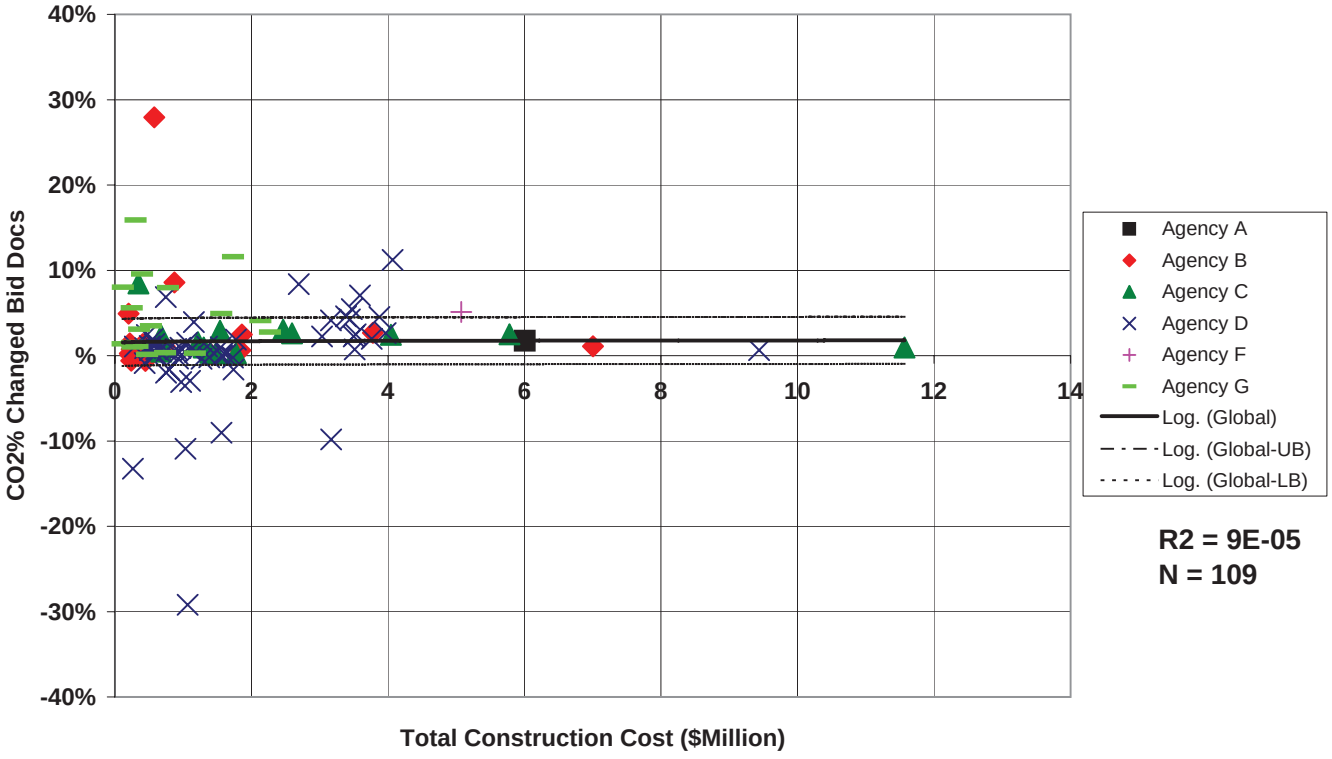
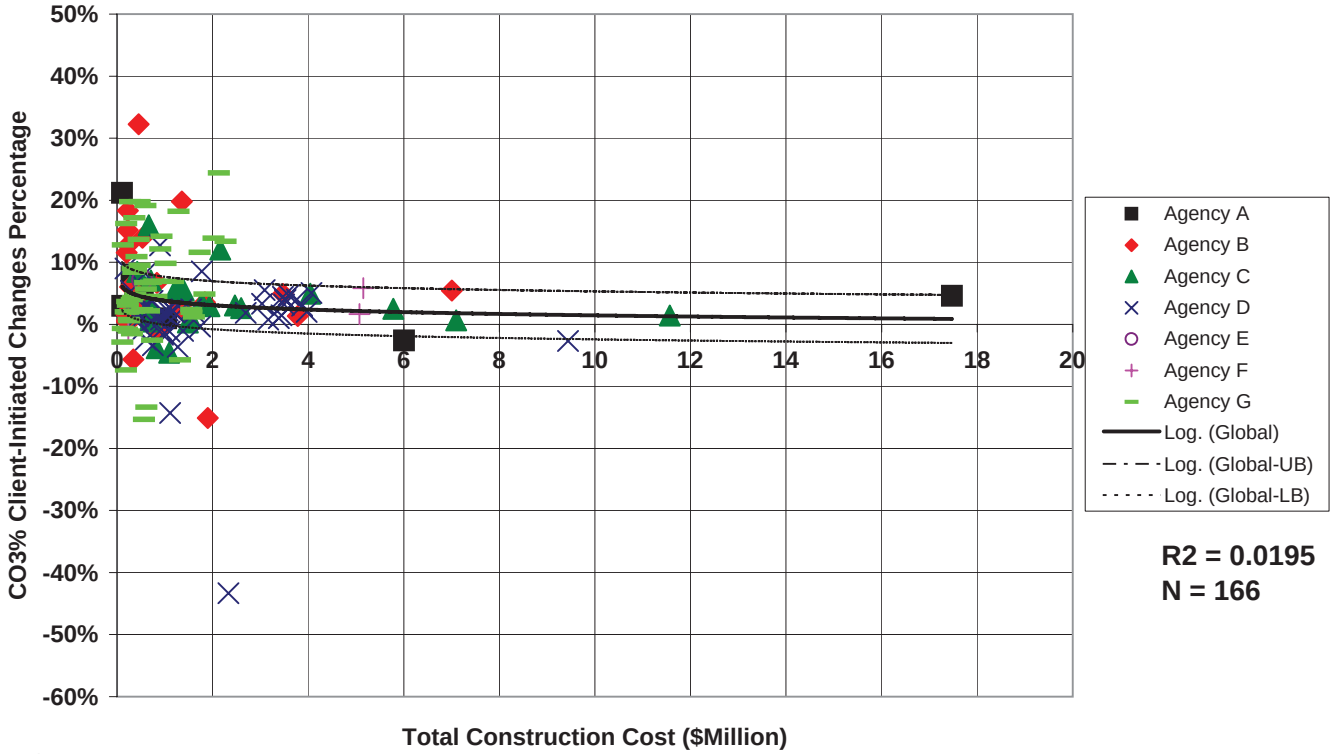


Figure 3-4 Client-Initiated Changes Change Orders vs. TCC (All Project Types)

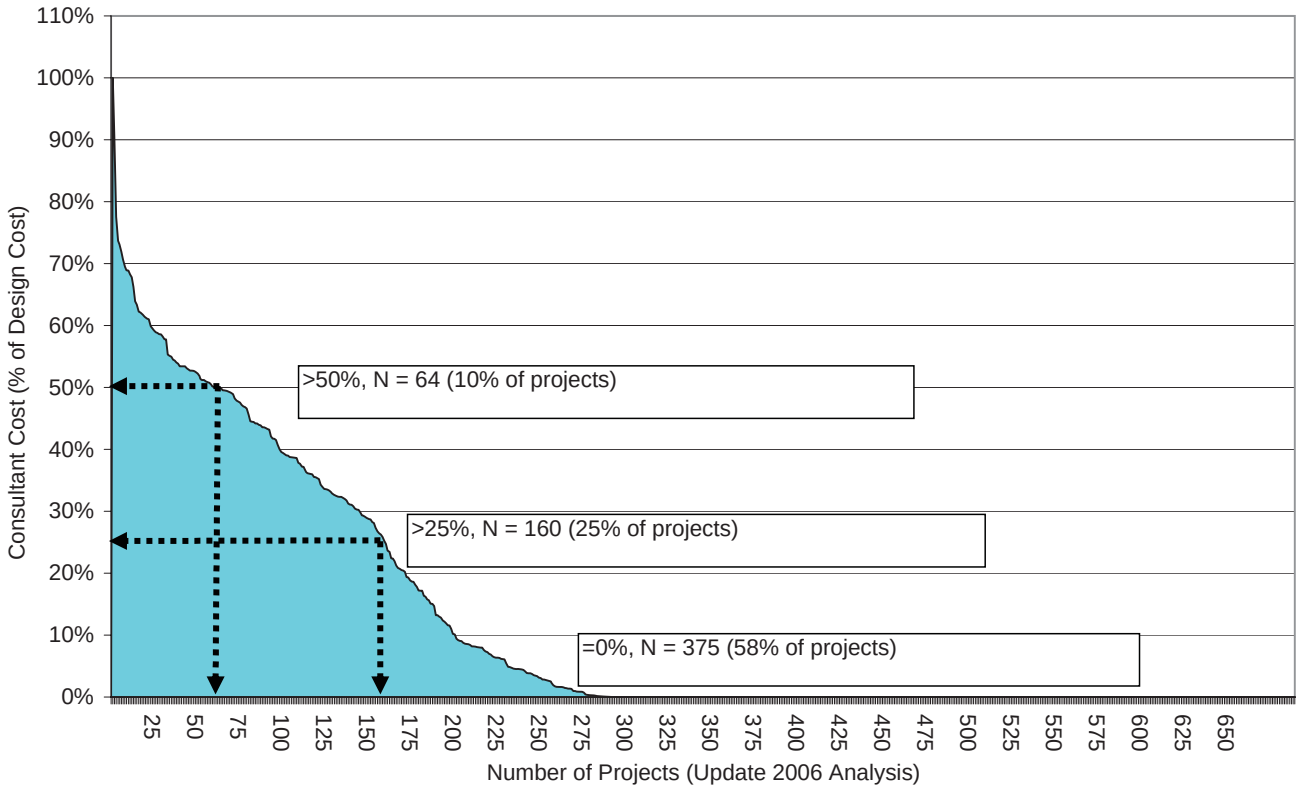


It is expected that in future report updates, the Study Team will continue to collect and analyze change order data to look for trends and inferences.

G. SPECIAL STUDY: CONSULTANT USAGE

The Study Team conducted a special analysis of consultant usage as it relates to project performance. A histogram of the *Update 2006* projects was prepared showing consultant usage as a percentage of project delivery cost, to identify potential groupings of consultant usage rates to compare. The histogram is shown in **Figure 3-5.**

Figure 3-5 Consultant Usage Histogram



While the agencies agree that consultant usage is generally increasing and will continue to escalate in the future, consultants were utilized in less than half of the projects in the *Update 2006* analyses. Out of the projects for which consultants were used, only about one-fourth of projects had consultant costs that exceeded 25 percent of the project delivery cost. Of these, only 64 projects had consultant costs exceeding 50 percent of project delivery costs, too few for meaningful analyses. Therefore, regressions were performed comparing projects for which consultant use exceeded 25 percent of project delivery cost and projects on which there were no consultant costs.

Similar to the analyses performed during *Update 2005*, consultant use in construction management by the agencies was quite low overall, therefore only performance data of design as a percentage of construction were evaluated. Due to the low number of data points in the analyses, performance was only evaluated by Project Type. The resulting curves are not shown in this report, pending further refinement of the analyses in a future study phase.

The Project Team agreed that the driving reason to use consultants is not to achieve cost reduction, but rather to acquire specific expertise, to meet aggressive schedule demands, to meet short-term peaks in workloads, or to otherwise meet staffing needs that cannot be met through exclusive use of agency staff. In fact, the use of consultants may increase project delivery costs versus delivery solely by an agency, for the following reasons:

- Agencies incur increased project management costs when consultants are used, since agencies and consultants both perform management activities over the same technical work.
- Consultants tend to be less familiar with the standards of a specific agency than the agencies themselves. The effort taken by consultant to familiarize themselves with local standards and incorporate them into the deliverables increases project delivery costs.
- Consultants tend to be less familiar with agencies' service area, system, facilities, and general geography than the agencies themselves. For the same reason cited above, this increases the costs for project delivery by consultants.

The preliminary analyses showed that on Municipal Facilities and Parks projects, more projects involved consultant usage than not. On Streets and Pipe Systems projects, far more projects were delivered solely by agency staff. In addition, the slope of the regression trendline for projects using consultants for over 25 percent of project delivery costs was steeper than for no consultant usage. At lower TCC values, design as a percentage of construction tended to be higher on projects where consultants were used.

The agencies generally agreed that while it still appears there were no clear conclusions that could be drawn from the analyses due to low R^2 values, limited data, and the wide variety of projects making up the data set, the following observations could be made:

- The design cost (as a percentage of TCC) for projects on which consultant usage exceeded 25 percent of project delivery was not necessarily reduced compared to projects with no consultant usage.
- For Municipal Facilities projects with a TCC greater than $1.5 million, design costs were lower when more than 25 percent of project delivery costs could be attributed to consultant use.

- The R^2 values were consistently higher for Municipal Facilities, Pipe Systems, and Parks projects where consultant usage exceeded 25 percent of project delivery cost versus those where there was no consultant usage. This indicates less data scatter and therefore more consistency in financial performance. This may be because the project scope, budget, and schedule must be better-defined when consultants are hired, as they are limited by contract.

- The R^2 value for Streets projects was higher with no consultant usage than with greater than 25 percent consultant usage. The Project Team suggested that these types of projects tend to be fairly routine and delivered primarily by the agency, though that seems to also be the case for Pipe Systems projects.

It isn't clear how much of the difference in delivery cost is related to differences in overhead accounting practices between consultants and agencies, which can vary significantly. The overhead rates of the agencies ranged from 90 to nearly 200 percent of direct labor cost, while in *Update 2005*, it was noted that consultant overhead rates ranged from 150 to 225 percent.

H. CONSTRUCTION CONTRACT AWARD DATA

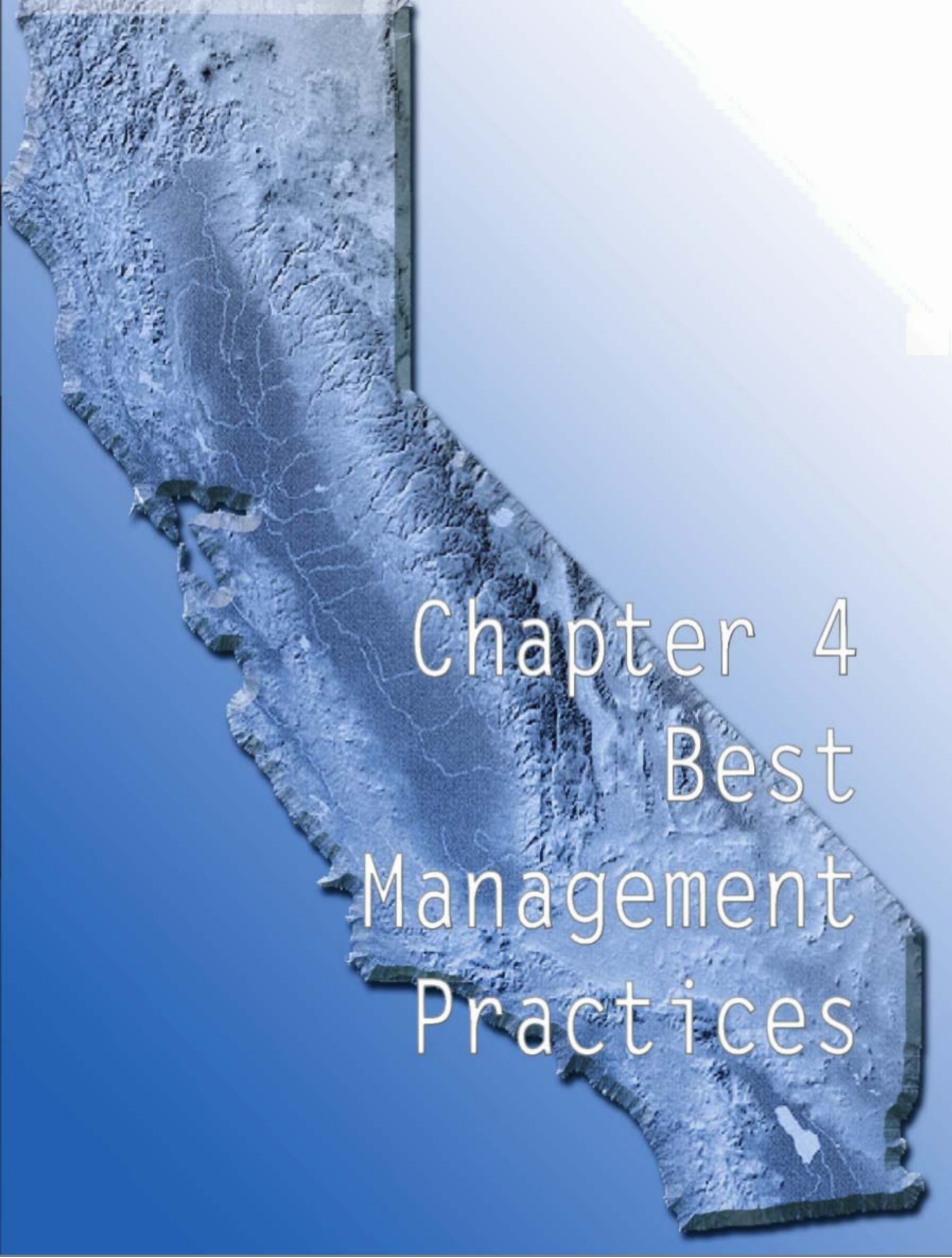
Design costs and construction award amounts for bid awards made by the participating agencies were collected for the period approximately covering July 1, 2004 to June 30, 2005. This was done so that the Study Team could anticipate the number of projects that would be submitted in future Study phases. Only projects that were expected to meet Study criteria were provided by the agencies. Please see **Table 3-8** for a summary of the information collected.

Together, the agencies awarded nearly 186 projects with a total construction value of $400 million between July 1, 2004 and June 30, 2005. These projects meet Study criteria and the agencies anticipate adding them to the database in future years. The project sizes ranged from $100,000 in construction to nearly $35 million. Both the average and median construction contract awards are larger than the TCC of projects included in the *Update 2006 Study*.

Table 3-8 Construction Contract Awards

	Count of Projects by Project Type					Total Awards ($M)	Avg. Award ($M)	Median Award ($M)
Agency	Muni	Streets	Pipes	Parks	Total			
Long Beach	2	5	0	1	8	$4.40	$0.50	$0.60
Los Angeles	13	4	17	0	34	$177.80	$5.20	$2.30
Oakland	9	18	12	7	46	$42.90	$0.90	$0.40
Sacramento	0	6	21	0	27	$12.40	$0.50	$0.20
San Diego	6	8	0	0	14	$38.60	$2.80	$1.30
San Francisco	4	4	6	5	19	$30.90	$1.60	$1.10
San Jose	6	16	11	5	38	$86.40	$2.30	$0.70
Total	**40**	**61**	**67**	**18**	**186**	**$393.20**	**$2.10**	**$0.70**

Note: These are projects for which contract awards were made between July 1, 2004 and June 30, 2005. These projects are not in the Study database. These projects are expected to be submitted to the Study once they are complete.



Chapter 4
Best Management Practices

CIP Benchmarking Study

CHAPTER 4 Best Management Practices

At the start of the Study, the agencies examined over 100 practices used in project delivery. They selected those practices to include in this Study that they did not already commonly use, but believed should be implemented as BMPs. Practices are added annually by the agencies to address specific challenges they encounter or reflect new learnings by the participants. Agency implementation of these selected practices has been and will continue to be tracked during the Study. Seven new BMPs were added to the list this year. These BMPs are believed to directly influence the cost of either design or construction management and, ultimately, project delivery efficiency.

A. PROGRESS ON BEST MANAGEMENT PRACTICE IMPLEMENTATION

To support the linking of BMPs to performance improvements, BMP implementation has been tracked and project completion dates have been collected on the Performance Questionnaire. It is anticipated that the performance data will eventually demonstrate that as BMPs were implemented, project delivery costs were reduced. However, it is recognized that "processes" become effective "practices" only after a learning curve and full implementation on projects. Therefore, obtaining empirical evidence of this trend is expected to take several years.

In *Update 2005,* the agencies continued to exchange ideas regarding strategies for implementing various BMPs using both the networking opportunities at the quarterly meetings and the online discussion forum. BMPs targeted for future implementation and progress on actual BMP implementation since the last Study update are summarized below. The agencies have continued to pursue full implementation of BMPs. As of *Update 2006*, the agencies have fully implemented more than 60 percent of all BMPs.

I. City of Los Angeles

Implemented from June 2005 to May 2006:

- Utilize a Board/Council project prioritization system.
- Limit Scope Changes to early stages of design.
- Require scope changes during design to be accompanied by Budget and Schedule approvals.
- Institutionalize Project Manager performance and accountability.
- Implement a financial system that tracks expenditures by category, adequate to monitor project hard and soft costs during project delivery.

Targeted June 2006 Onward:

- Implement verification procedures to ensure that PM training includes agency policies, procedures, forms, and standards of practice (scheduling, budgeting, claims avoidance, risk analyses, etc.).
- Bundle small projects whenever possible.

Targeted June 2006 Onward:

- Implement a rotating RFQ process for contracting small projects to streamline the bidding and award process. (Include criteria for exemptions from formal Council approval.)

- Create in-house project management team for small projects.

II. City of Long Beach

Implemented from June 2005 to May 2006:

- Implement a rotating RFQ process for contracting small projects to streamline the bidding and award process. (Include criteria for exemptions from formal Council approval.)

Targeted June 2006 Onward:

- Resource-load all CIP projects for design and construction.

- Develop and use a standardized Project Delivery Manual.

- Use a formal Quality Management System

- Institutionalize Project Manager performance and accountability.

- Implement a financial system that tracks expenditures by category, adequate to monitor project hard and soft costs during project delivery.

- Implement a Work Breakdown Structure (WBS) to measure progress on project deliverables.

- Monitor "earned value" versus budgeted and actual expenditures during project delivery.

- Implement and use a consultant rating system that identifies quality of consultant performance.

- Implement as-needed, rotating, or on-call contracts for design and construction management work that allow work to be authorized on a task order basis to expedite the delivery of smaller projects.

III. City of Oakland

Implemented from June 2005 to May 2006:

- Implement a financial system that tracks expenditures by category, adequate to monitor project hard and soft costs during project delivery.

Targeted June 2006 Onward:

- Utilize a Board/Council project prioritization system.

- Implement a rotating RFQ process for contracting small projects to streamline the bidding and award process. (Include criteria for exemptions from formal Council approval.)

- Develop and use a standardized Project Delivery Manual.

- Implement a Work Breakdown Structure (WBS) to measure progress on project deliverables.

- Implement verification procedures to ensure that PM training includes agency policies, procedures, forms, and standards of practice (scheduling, budgeting, claims avoidance, risk analyses, etc.).

IV. City of Sacramento

Implemented from June 2005 to May 2006:

Department of General Services

- Limit Scope Changes to early stages of design.
- Use a formal Quality Management System.
- Perform and use post-project reviews to identify lessons learned.
- Make bid documents available on-line.
- Implement verification procedures to ensure that PM training includes agency policies, procedures, forms, and standards of practice (scheduling, budgeting, claims avoidance, risk analyses, etc.).
- Bundle small projects whenever possible.

Department of Transportation

- Implement a financial system that tracks expenditures by category, adequate to monitor project hard and soft costs during project delivery.
- Implement a rotating RFQ process for contracting small projects to streamline the bidding and award process. (Include criteria for exemptions from formal Council approval.)
- Bundle small projects whenever possible.
- Implement as-needed, rotating, or on-call contracts for design and construction management work that allow work to be authorized on a task order basis to expedite the delivery of smaller projects.

Department of Utilities

- Limit Scope Changes to early stages of design.
- Include a formal Dispute Resolution Procedure in all contract agreements.
- Use a team building process for projects greater than $5 million.
- Bundle small projects whenever possible.
- Implement as-needed, rotating, or on-call contracts for design and construction management work that allow work to be authorized on a task order basis to expedite the delivery of smaller projects.

Targeted June 2006 Onward:

Department of General Services

- Utilize a Board/Council project prioritization system.
- Resource-load all CIP projects for design and construction.
- Define requirements for reliability, maintenance, and operation prior to design initiation.
- Involve the Construction Management Team prior to completion of design.
- Institutionalize Project Manager performance and accountability.

Department of Transportation

- Develop and use a standardized Project Delivery Manual.

- Make bid documents available online.
- Assign a client representative to every project.
- Provide formal training for Project Managers on a regular basis.
- Monitor "earned value" versus budgeted and actual expenditures during project delivery.
- Implement verification procedures to ensure that PM training includes agency policies, procedures, forms, and standards of practice (scheduling, budgeting, claims avoidance, risk analyses, etc.).

Department of Utilities

- Make bid documents available online.
- Implement a financial system that tracks expenditures by category, adequate to monitor project hard and soft costs during project delivery.

V. City of San Diego

Implemented from June 2005 to May 2006:

- Implement a Work Breakdown Structure (WBS) to measure progress on project deliverables.
- Bundle small projects whenever possible.

Targeted June 2006 Onward:

- Utilize a Board/Council project prioritization system.
- Resource-load all CIP projects for design and construction.
- Develop and use a standardized Project Delivery Manual.
- Implement a financial system that tracks expenditures by category, adequate to monitor project hard and soft costs during project delivery.
- Classify types of change orders.

VI. City and County of San Francisco

Implemented from June 2005 to May 2006:

- Implement a financial system that tracks expenditures by category, adequate to monitor project hard and soft costs during project delivery.
- Bundle small projects whenever possible.

Targeted June 2006 Onward:

- Limit Scope Changes to early stages of design.
- Require scope changes during design to be accompanied by Budget and Schedule approvals.

VII. City of San Jose

Implemented from June 2005 to May 2006:

- Delegate authority below Council to make contract awards under $1 million.
- Implement a rotating RFQ process for contracting small projects to streamline the bidding and award process. (Include criteria for exemptions from formal Council approval.)
- Implement a financial system that

tracks expenditures by category, adequate to monitor project hard and soft costs during project delivery.

- Bundle small projects whenever possible.

Targeted June 2006 Onward:

- Require scope changes during design to be accompanied by Budget and Schedule approvals.
- Use a formal Quality Management System.
- Classify types of change orders.
- Institutionalize Project Manager performance and accountability.
- Implement a Work Breakdown Structure (WBS) to measure progress on project deliverables.
- Monitor "earned value" versus budgeted and actual expenditures during project delivery.
- Implement verification procedures to ensure that PM training includes agency policies, procedures, forms, and standards of practice (scheduling, budgeting, claims avoidance, risk analyses, etc.).
- Delegate authority to the Public Works Director/City Engineer to approve consultant contracts under $250,000 when a formal RFP selection process is used.

Table 4-1 summarizes the BMPs that have been implemented by the participating agencies, as well as the priorities of those that are planned for implementation.

Table 4-1 Implementation of BMPs

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Planning	1.a.	Define capital projects well with respect to scope and budget including community and client approval at the end of the planning	✓	✓	✓	✓	✓	PI	PI	✓	✓	SC DU: Community involved after project is better-defined, typically at 30% design SD: Some Divisions only
	1.b.	Complete Feasibility Studies on projects prior to defining budget and scope	✓	✓	✓	✓	✓	PI	PI	✓	✓	LB: When applicable SC DU: Only on complex projects that require a Feasibility Study SD: Result of CIP Benchmarking SF: When applicable
Planning	1.d.	Utilize a Board/Council project prioritization system	✓	NI	2006	2007	✓	PI	2006	NI	NI	LA: Council allows Streets, Bridges and Stormwater programs a project priority system. SC DU: Getting closer to approved Asset Mgt system that would facilitate this BMP, but project drivers vary (permit requirements, projects in other departments, etc) SD: Result of CIP Benchmarking
	1.e.	Resource-load all CIP projects for design and construction	✓	PI: 2007	✓	2006	✓	PI	2006	NI	✓	LB: Software in development. SC DU: Estimate drafting only. SD: Result of CIP Benchmarking
	1.f.	Include a Master Schedule in the CIP that identifies start and finish dates for projects	✓	✓	✓	✓	✓	PI	PI	NI	✓	LB: Software in development. SC DU: Completion date only estimated, not determined by scheduling analyses.

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yyyy: Will be implemented in calendar year "yyyy"
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Table 4-1 Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Planning	1.i.	Show Projects on a Geographical Information System	✓	✓	PI	✓	✓	✓	✓	✓	✓	LB: Infrastructure only
Design	2.b.	Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start	✓	✓	✓	✓	✓	✓	PI	✓	✓	SC DU: General scope only for simple projects.
	2.f.	Define requirements for reliability, maintenance, and operation prior to design initiation	✓	✓	NI	2006	✓	NI	✓	✓	✓	SD: Some Divisions only
	2.i.	Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc.)	✓	✓	✓	✓	NI	✓	PI	✓	✓	SC DU: This is key to low delivery costs. Std special provisions are updated continuously for lessons learned, new requirements, changing technology, etc.

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Table 4-1 Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Design	2.k. 2003	Train in-house staff to use Green Building Standards	✓	TBD	✓	✓	NI	✓	✓	✓	✓	This BMP is intended to improve client satisfaction (quality) and may not reduce project delivery cost directly. SF: When applicable
	2.l. 2004	Limit Scope Changes to early stages of design	✓	✓	✓	✓	✓	✓	✓	2006	✓	SC DU: Control and minimize, but difficult to eliminate, since clients and engineers come up with new/ better solutions.
	2.m. 2004	Require scope changes during design to be accompanied by Budget and Schedule approvals	✓	✓	PI	2007	✓	NI	✓	2006	2006	
	2.n. 2006	Implement a rotating RFQ process for contracting small projects to streamline the bidding and award process. (Include criteria for exemptions from formal Council approval.)	PI	✓	2007	PI	✓	NI	TBD	TBD	✓	SC DT: Maintains on-call consultant list for various engineering, traffic, landscape, architecture, and geotechnical services.

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Table 4-1 Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Quality Assurance / Quality Control	3.I.a.	Develop and use a standardized Project Delivery Manual	✓	2007	2006	✓	2006	✓	PI: 2007	✓	✓	SC DU: Badly needs updating. SD: incorporated into PM training manual and std Primavera schedule template/descr. Details available as needed.
	3.II.b.	Perform a formal Value Engineering Study for projects larger than $1 million	✓	✓	NI	✓	✓	✓	✓	✓	✓	LA: For projects > $10M LB: As needed SC: As needed SF: As needed SJ: For projects > $5 million
	3.III.a.	Use a formal Quality Management System	✓	2006	NI	✓	✓	NI	✓	✓	2006	SD: Some Divisions only
	3.III.b	Perform and use post-project reviews to identify lessons learned	✓	TBD	✓	✓	✓	✓	✓	✓	✓	SC DU: For selected projects in one-on-one meetings with design and construction staff. Also includes feedback from client. Intended to promote candid

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Table 4-1 Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
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	✓	✓	✓	NI	NI	✓	✓	✓	✓	SD: Individual CO < $200,000 SF: At Bureau level SJ: Individual CO < $100,000
	4.I.m.	Classify types of change orders	✓	✓	✓	✓	✓	✓	PI: 2006	✓	2006	LA: Draft Special Order prepared. SD: Only for scope changes.
	4.II.a.	Include a formal Dispute Resolution Procedure in all contract	✓	NI	✓	✓	✓	✓	✓	✓	✓	
	4.III.a.	Use a team building process for projects greater than $5 million	✓	✓	✓	✓	✓	✓	✓	✓	✓	LB: As-needed SD: As-needed SF: As-needed SJ: For projects > $10 M SC DU: As-needed
	4.IV.a.	Involve the Construction Management Team prior to completion of design	✓	✓	✓	2006	✓	✓	✓	✓	✓	SD: Some Divisions only

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Table 4-1 Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Construction Management	4.V.a. 2003	Delegate authority below Council to make contract awards under $1	✓	✓	NI	NI	NI	NI	✓	✓	✓	
	4.V.b 2003	Establish a pre-qualification process for contractors on large, complex projects	✓	NI	✓	✓	NI	✓	✓	✓	✓	
	4.V.c 2003	Make bid documents available online	TBD	✓	TBD	✓	2006	2006	TBD	TBD	✓	LA: Not enough bids to make this useful. Resistance from smaller contractors who do not use the internet to conduct business. SD: Options being evaluated
Project Management	5.I.f.	Assign a client representative to every project	✓	✓	✓	✓	2006	✓	PI	✓	✓	SD: Only for large projects
	5.II.a	Provide formal training for Project Managers on a regular basis	✓	TBD	✓	✓	2006	NI	✓	✓	✓	LB: Program implementation put on hold due to budget cuts SD: Yearly PM academy, as funds allow SJ: Looking to improve program
	5.III.a.	Adopt and use a Project Control System on all projects	✓	✓	✓	✓	✓	NI	✓	✓	✓	SD: Project controls incorporated into Primavera schedule
	5.I.j 2003	Create in-house project management team for small projects	PI	NI	✓	✓	NI	NI	PI	NI	✓	SC DU: Not enough PMs to justify this. Don't want to restrict staff to small, less-rewarding projects. SD: Some Divisions only
	5.I.k 2004	Institutionalize Project Manager performance and accountability	✓	2006	PI	2006	✓	NI	NI	TBD	2006	SC DU: There is interest but no definite plan. SD: Only non-standardized goals
	5.III.e 2006	Implement a financial system that tracks expenditures by category, adequate to monitor project hard and soft costs during project delivery.	✓	2006	✓	PI	✓	2007	2007	✓	✓	LA: UPRS, Reports, Page 3 SC DT: Will complete automated report system by 2006. SC DU: Intend to utilize SC DT's software if it proves to function well with our PM Database.

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Table 4-1 Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Project Management	5.III.f 2006	Implement a Work Breakdown Structure (WBS) to measure progress on project deliverables.	TBD	2006	2007	PI	PI	NI	✓	TBD	2006	SC DT: Working to/ Update: Provide Microsoft Project to all Project Managers and produce schedules with tasks/sub-task schedules
	5.III.g 2006	Monitor "earned value" versus budgeted and actual expenditures during project delivery.	TBD	2007	PI	TBD	PI 2007	NI	PI	TBD	2006	
	5.II.d 2006	Implement verification procedures to ensure that PM training includes agency policies, procedures, forms, and standards of practice (scheduling, budgeting, claims avoidance, risk analyses, etc.).	✓	TBD	2007	✓	2007	NI	TBD	TBD	2007	
	5.IV.a 2006	Bundle small projects whenever possible.	✓	NI	PI	✓	✓	✓	✓	✓	✓	

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Table 4 -1 Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Consultant Selection and Use	6.c.	Include a standard consultant contract in the RFQ/RFP with a standard indemnification clause	✓	✓	✓	✓	✓	PI	✓	✓	✓	SD: Some Divisions only
	6.e.	Delegate authority to the Public Works Director/City Engineer to approve consultant contracts under $250,000 when a formal RFP selection process is used	NI	NI	NI	NI	NI	NI	✓	✓	2006	SC DU: Threshold is $100,000.
	6.g.	Implement and use a consultant rating system that identifies quality of consultant performance	✓	2006	✓	✓	NI	✓	✓	✓	✓	SC DU: Track performance for those selected for "support services." SJ: Need to incorporate more post-project review.
	6.m 2006	Implement as-needed, rotating, or on-call contracts for design and construction management work that allow work to be authorized on a task order basis to expedite the delivery of smaller projects.	✓	2006	✓	2006	✓	✓	✓	✓	✓	

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B. NEW BEST MANAGEMENT PRACTICES

In *Update 2006,* the Project Team added several new BMPs to the BMP implementation tracking list. These BMPs were:

- 2.n 2006: Implement a rotating RFQ process for contracting small projects to streamline the bidding and award process. (Include criteria for exemptions from formal Council approval.)
- 5.III.e 2006: Implement a financial system that tracks expenditures by category, adequate to monitor project hard and soft costs during project delivery.
- 5.III.f 2006: Implement a Work Breakdown Structure (WBS) to measure progress on project deliverables.
- 5.III.g 2006: Monitor "earned value" versus budgeted and actual expenditures during project delivery.
- 5.II.d 2006: Implement verification procedures to ensure that PM training includes agency policies, procedures, forms, and standards of practice (scheduling, budgeting, claims avoidance, risk analyses, etc).
- 5.IV.a 2006: Bundle small projects whenever possible.
- 6.m 2006: Implement as-needed, rotating, or on-call contracts for design and construction management work that allow work to be authorized on a task order basis to expedite the delivery of smaller projects.

It is anticipated that full implementation of the BMPs in the implementation list will improve project delivery performance.

C. DEFINING IMPLEMENTATION

A continuing objective of this Study is to eventually link the implementation of BMPs to incremental improvements in project delivery performance. To do so, the point at which a practice is fully implemented and impacting project delivery costs must be defined.

As a first step, it must be recognized that one cannot mandate a process be used and then expect immediate results. Implementation can be a lengthy process that will begin only with a commitment and policy directive by agency management. The process must allow for a learning curve by project managers and lead to consistent use on appropriate projects within the organization.

The evidence of implementation is the deliverable, or documentation, produced as a result of performing the BMP. The point at which a BMP is fully implemented is when the documentation is consistently integrated into the project record on projects delivered by the agency. Once the point in time is known, it may be compared with changes in performance to measure influence.

To support the analyses of BMP implementation on projects, the agencies agreed to complete a simple matrix for two randomly-selected, recently-completed projects to indicate which BMPs, listed as implemented in **Table 4-1** had been used at the time the project was delivered. The matrix included a section for the agency to indicate the deliverable or other support documentation for the implementation confirmation.

- The City of Los Angeles identified documents verifying the use of 25 of 33 implemented BMPs on one sample project and all 33 of 33 BMPs on the other sample project.
- The City of Long Beach identified documents verifying the use of 11 of

19 and 9 of 19 of their implemented BMPs, respectively, on the two sample projects.

- The City of Sacramento, Department of Utilities identified documents verifying the use of 8 of 14 and 6 of 14 of their implemented BMPs, respectively, on the two sample projects.

- The City of San Diego identified documents verifying the use of 19 of 22 and 20 of 22 of their implemented BMPs, respectively, on the two sample projects.

- The City of San Jose identified documents verifying the use of 22 of 30 and 26 of 30 of their implemented BMPs, respectively, on the two sample projects.

- The City and County of San Francisco identified documents verifying the use of 12 of 21 and 21 of 24 of their implemented BMPs, respectively, on the two sample projects.

- The City of Oakland identified documents verifying the use of 19 of 23 of their implemented BMPs on one sample project. It was determined that the other sample project was delivered in partnership with another entity and was inappropriate to include here.

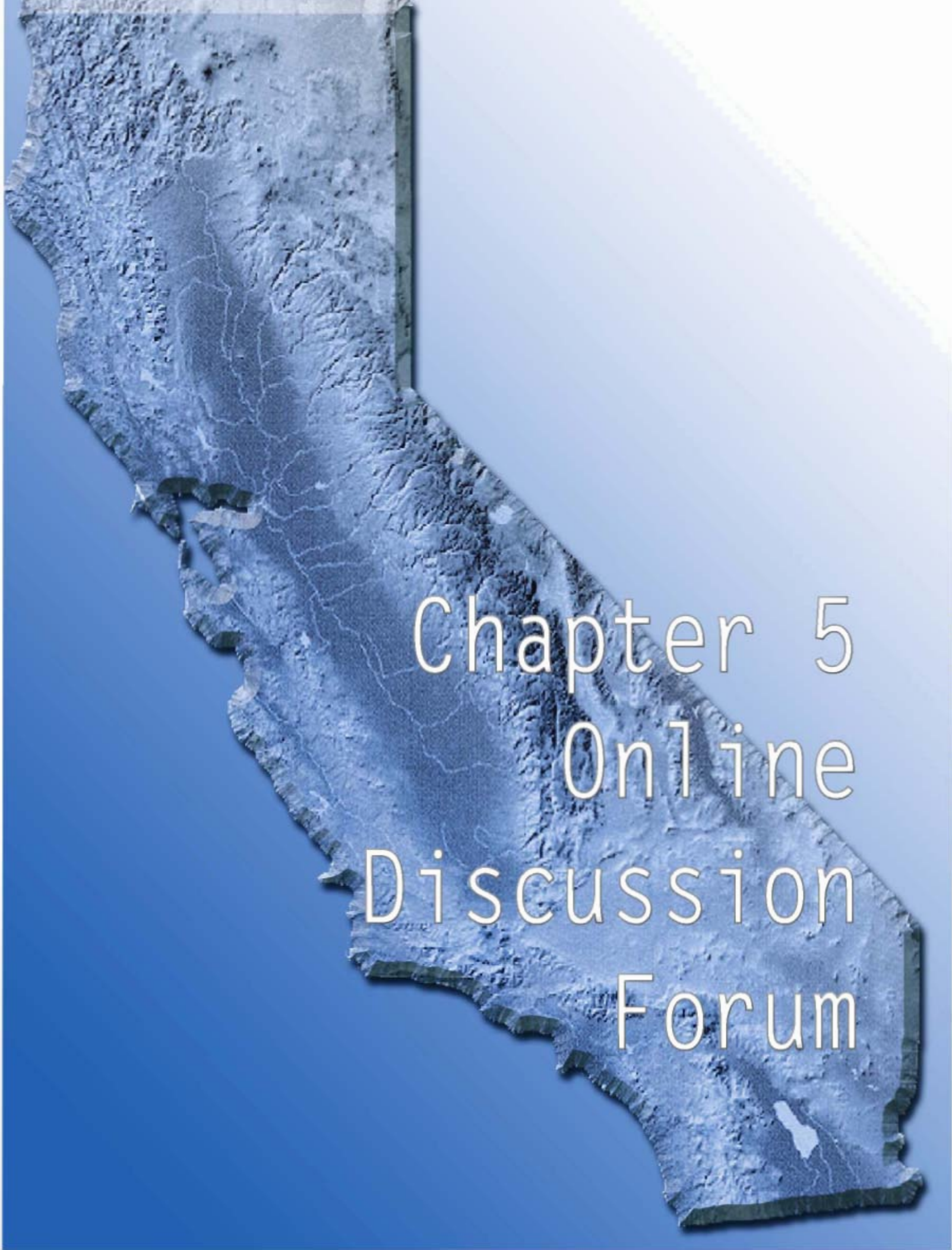
In addition to verifying that BMPs that had been targeted and implemented over the previous four years of this study were being put to use, the exercise was fruitful in that:

- It was recognized that some of the BMPs were not applicable to some projects. For example, not all projects had a construction value that triggered the requirement for a value engineering study.

- The agencies shared the steps and challenges in the actual implementation process for various BMPs.

- The agencies were reminded that more emphasis needs to be placed upon actual implementation of the BMPs and that there should be some form of executive commitment and oversight.

The participating agencies have each committed to improve project delivery. They each acknowledge that improvement will occur only if changes are made in the way project delivery is performed. The focus on efficient and effective practices that improve performance and reduce costs will continue. Actual implementation will also continue to be monitored so that accurate conclusions relating implementation to performance improvement can be made.



Chapter 5
Online Discussion Forum

CIP Benchmarking Study

CHAPTER 5 Online Discussion Forum

Among the primary benefits accruing to the participating agencies during this multi-year Study has been the opportunity to discuss the challenges of public works project delivery with their peers. These successful open forum communications included online discussion topics that influence project delivery efficiency. A summary of discussions from *Study 2002* to *Update 2005* is included in the *Update 2005* report.

Selected topics from discussions during *Update 2006* are presented here. The discussions and solutions to issues are provided herein in the hope that they may be helpful to agencies struggling with similar issues and concerns. The discussion topics include:

- Change Orders and Contingency Encumbrance
- Scheduling and Cost Estimating Staff
- Street Light Technology Survey
- Small Business Performance Bonds
- Increasing the Number of Construction Bids
- Utilities Relocation
- Pavement Design

An archive of the full discussion forum is posted confidentially on the Study website for access by the participants.

A. CHANGE ORDERS AND CONTINGENCY ENCUMBRANCE

The Project Team identified the change order process as a candidate for improvement early in the Study. The City of San Diego is examining the possibility of encumbering the project contingencies into the total contract amounts and delegating authority to the department head for change order approval within the contingency amounts. This authority would expedite contractor payment on change order work. To that end, the City of San Diego initiated a survey of the construction change order process among the agencies. The participants' responses are summarized in **Table 5-1**.

Table 5-1 City of San Diego's Survey of the Construction Change Order Process

	Question	San Jose	Oakland	Los Angeles	San Francisco	Sacramento	Long Beach	San Diego
1	Do you have a manual or automated construction change order process?	Manual.	Manual.	Manual and Online system.	Internal Automated.	Manual.	Manual.	Manual.
2	How many signatures are required besides the contractor's to approve a construction change order (CCO)?	2 for CCOs within the contingency amount.	See answers to Questions 3 and 4 below.	3 to 4.	6	3 to 4 depending on the sum of all CCO's	5	9 for CCOs within the contingency amount.
3	What is the highest level of authority required to approve construction change orders?	Department head ≤ contingency and $100K unless specially authorized.	Council or Board.	Council or Board.	Deputy Director	None. Depends on the sum of all CCO's.	Department head.	Mayor or Council.
4	Does the level of approval authority change depending on the amount of the CCO?	Yes. Section Managers ≤ $5K Division Mangaers ≤$20K Director and Deputies≤ $100K.	Supervisor ≤$10K. Department Head ≤$25K. Director ≤25% of the contract amount. City Council < budgetary limit.	Yes Poject Manager ≤ $100K. Board > $100K.	No	Yes. Dept. Head for contract amount <$100K and all CCOs <$100K. For contracts over $100K, Dept. Head ≤ 6 to 10% of contract, depending on contract amount. Council and City Mgr. for all others.	Yes. Dept. Head ≤ 15% of contract amount. City Manager ≤ 25%.	Deputy Director ≤ contingency and $200K. Mayor and Council for all others.
5	Do you use purchase orders to track construction contracts including CCOs?	No.	No. Use MS Access database software for CCOs.	No.	No. Use database	Yes.	Yes.	Yes.

Table 5-1 City of San Diego's Survey of the Construction Change Order Process (con't)

	Question	San Jose	Oakland	Los Angeles	San Francisco	Sacramento	Long Beach	San Diego
6	What is the average duration from approved draft (point in time in which the contractor and agency have agreed on time, scope and money) until the payment has been approved and issued?	1 month (work is completed immediately, 2 weeks for pay letter preparation and approval and 2 weeks to process a check).	2 months.	1 month.	2 months.	2 months.	2 months.	2 to 3 months.
7	What contingency percentage does your organization use for construction contracts?	15% for rehab projects, 10% for buildings, and 5% for roadwork and utilities.	10%.	10%.	10%.	10%.	15%.	5%.
8	Does the contracting community complain about the length of time it takes your agency to make payment on CCOs?	Rarely.	Rarely.	Sometimes.	Sometimes.	Rarely.	Rarely.	Sometimes.
9	Does your agency require an invoice from the contractor to initiate payment for the CCO after the CCO has been approved?	Yes.	Yes.	Yes.	Yes.	No. The approved CCO is part of the monthly progress	Yes.	Yes.
10	Does your organization have a set of guidelines for CCO management?	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.
11	What is the single most important thing your agency does to expedite the payment process for CCOs?	There are three: Insist upon a signed CCO prior to the start of work; get inspector concurrence with accuracy of invoiced work and get complete backup submitted with the invoice.	High priority is placed on an expeditious review and approval of CCOs. RE's performance appraisal reflects performance in this area and Supervisor assures prompt processing of CCOs.	For large and/or complicated CCOs, we and the contractor agreed to the time and cost impact for a portion of the change, and then we issue CCOs to cover that portion. This expedites the payment process for the agreed portion of the CCOs.	Follow Up	Hand-carry CCOs for signatures.		Use of Field Orders as a bid item to handle small and unforeseen CCO items .

The Public Works Director in the City and County of San Francisco has the authority to approve and pay change order costs within the designated change order contingency amount, similar to the authority the City of San Diego is seeking.

The City of Los Angeles, Bureau of Engineering writes an Award Report to the Board of Public Works in which a contingency amount of 10 to 20 percent is included in the contract award for change orders. The Bureau is allowed to process change orders up to $100,000 without Board approval. Board reports are required when change orders exceed $100,000 or if the cumulative change order values exceed 25 percent of the contract amount or the contingency budget.

The City of San Jose generally does not encumber the City Council-approved project contingency amount. The exceptions occur when there is a high probability for change orders and concern regarding the budget source and the future availability of adequate funds.

The disadvantage of encumbering these funds is that financial administration staff must address the task of un-encumbering unused funds. These unused funds are therefore not available for end-of-year reconciliation.

The City of San Jose Director of Public Works has authority to issue change orders summarized in Table 5-2.

Table 5-2 City of San Jose Director of Public Works Change Order Approval Authority

Contract Condition	Authority
Any contract with an original amount not exceeding $100,000	•Cumulative change orders up to $10,000.
Any contract (other than Airport Master Plan Projects) with an original amount exceeding $100,000	•A single change order up to $100,000; and •Cumulative change orders up to the contingency.
Airport Master Plan Projects with an original amount greater than $100,000	•A single change order up to $100,000 or 1% of the contract award, whichever is larger; and •Cumulative change orders up to the contingency amount.

The Director of Public Works at the City of Sacramento has authority to approve change orders to an amount which varies according to project type and construction award value.

The City of Long Beach budgets for change orders in a contingency amount, but does not encumber the funds until they are required.

Additionally, the City of Oakland authorizes staff to execute change orders from 10 to 25 percent of the contract amount depending on the size of the project. Change orders rarely go to City Council for approval, since the 10 percent level is rarely exceeded.

Finally, the City of San Diego continues to seek ways to expedite the change order process in order to preserve the momentum of the construction process and progress. An element of this is to eliminate the requirement for approvals by financial administration staff within acceptable limits.

B. SCHEDULING AND COST ESTIMATING STAFF

The City and County of San Francisco initiated a discussion on the potential for establishing in-house positions to provide scheduling and estimating construction support.

Recognizing that scheduling and cost estimating is an important aspect in the delivery of their capital improvement program, the City and County of San Francisco Department of Public Works is considering creating separate positions that specialize in scheduling and cost estimating. Staff in these positions would perform services on more complex projects where outside services would otherwise be contracted. The requirements for these positions would be different from existing engineering and architectural positions, making it easier to hire staff with the specialized skillset, but not other required engineering or architectural qualifications.

The scheduler's duties would include being the in-house expert on project scheduling, assisting project managers in developing project schedules, assisting the designers in determining contract durations, assisting the construction managers in evaluating contractor's schedules, and teaching scheduling to staff.

The cost estimator's duties would include being the in-house cost estimating expert, assisting the designer in preparing the Engineer's Estimate and in evaluating bids, assisting the construction manager in evaluating contractor's cost proposals and negotiating change orders, and coaching staff in developing cost estimating skills.

The responses received from the participating agencies are summarized in **Table 5-3**. Long Beach and Oakland are not included in the table because they responded "No" to question 1, "Does your city have in-house schedulers and cost estimators whose sole duties are to perform scheduling and cost estimating?"

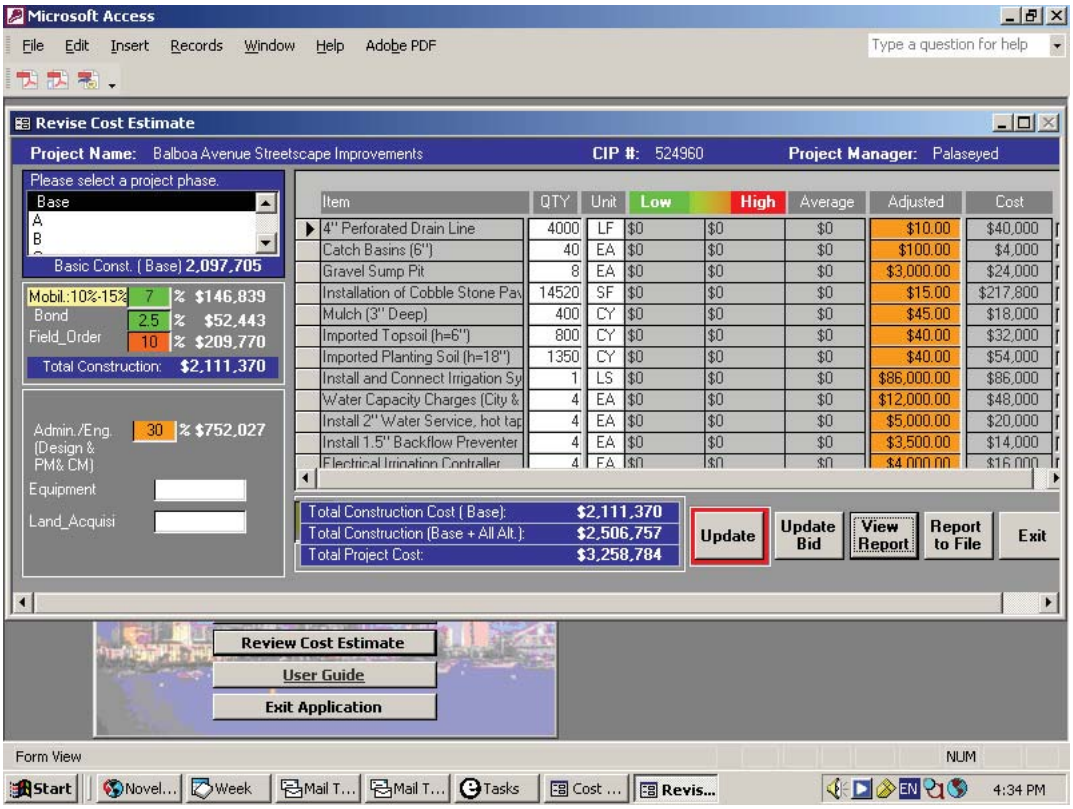
As indicated above, the City of San Diego provides its project managers with online tools to assist with cost estimate preparation. **Figure 5-1** is an image of the City of San Diego's online estimating tool.

The City of Los Angeles has formal positions for both Construction Estimators and Senior Construction Estimators.

Table 5-3 City and County of San Francisco's Survey on Scheduling and Cost Estimating Staff

Item	Question	San Diego	Sacramento	San Jose	Los Angeles
1	Does your city have in-house schedulers and cost estimators whose sole duties are to perform scheduling and cost estimating?	We do not have full time estimators. For our CIP projects where we don't have a prime consultant, the estimate is done either by the project manager/designer or an independent consultant. However, tools that assist our PM's are provided such as an on-line estimating system that links to eBidBoard for construction prices and areas for the soft costs	We do not have separate classifications for estimating and scheduling, but we do have a Funding and Project Dev. Unit that specializes in planning, scoping, estimating, prioritizing, budgeting, and scheduling in coordination with our project engineers and managers.	No. Project Managers, Engineers, Architects, and Technicians are responsible for scheduling and cost estimating. Our online system contains a cost estimating module that assists staff in the cost estimating process. Consultants are used for large or complex projects.	We do not have in-house schedulers but we do have an official classification, "Construction Estimator."
2	Do these schedulers and cost estimators have separate distinct civil service classifications? What are their class titles?				The cost estimators have separate and distinct civil service classifications as follows: Construction Estimator, Electrical Construction Estimator, Mechanical Construction Estimator, and Senior Construction Estimator.
3	Is there a promotional ladder?				There is a one step promotional ladder from construction estimator to Senior Construction Estimator.
4	How many filled positions in each class?				Construction Estimator: 5 of 7 filled; Electrical Construction Estimator: 3 of 3 filled; Mechanical Construction Estimator: 1 of 2 filled; Senior Construction Estimator: 7 of 9 filled
5	How does their level of compensation compare with that of the engineers (or architects)?				Assuming our comparison is to a full Civil Engineer position, the construction estimator would be approximately 80% of the full engineer salary and the Senior Construction Estimator would be approximately 90% of the full engineer salary.

Figure 5-1 City of San Diego's Online Cost Estimating Tool



C. STREET LIGHT TECHNOLOGY SURVEY

The City of San Jose conducted a street light technology survey by circulating a questionnaire on project delivery issues. Responses are summarized in **Table 5-4**.

Table 5-4 City of San Jose's Street Light Technology Survey

	Question	Long Beach	Los Angeles	Oakland	Sacramento	San Diego	San Francisco	San Jose
1	How many streetlights are in your City?	20,000 to 50,000.	Over 80,000.	20,000 to 50,000.	20,000 to 50,000.	20,000 to 50,000.	20,000 to 50,000.	50,000 to 80,000.
2	How are budget reductions impacting O&M of street lights?	Considerably.	Considerably. City of LA is funded by assessments. Passage of Prop 218 has frozen our district which is impacting future projection and will impact our O&M if additional funding sources are not identified.	Considerably.	Not at all.	Considerably.	Considerably.	Severely.
3	What special efforts are you making to reduce O&M costs.	No street lights and upgrades are being done at this time.	Consolidation of all maintenance utilizing City resources, utilizing new lamp technology to reduce expenditures, conversion of all high voltage circuits.	Use energy- efficient light sources, electronic ballasts, and time clocks. Recommend proactive re-lamping program.	Installing LED traffic signal displays; utilizing senior maintenance workers in street light crews; in-sourcing portions of work that had been done by contractors; utilizing student interns where applicable.	None.	Conversion of high voltage series street light loops to low- voltage multiple circuits. Standardize fixture types/ materials, looking at new technologies (bulb types, poles, induction lights) that require less maintenance.	Performing review and study of new technologies. Considering disconnecting street lights. Looking at new technologies (bulb types, poles, induction lights) that require less maintenance. Support California Streetlight Association's effort to limit increases in PG&E's street light rates (see http://cal-sla.org/ for more info).
4	Does your city use solar power to operate street lights or outdoor area lights?	Considering.	Considering.	Considering.	Tested.	Few solar lights were installed and maintained by the community.	Tested.	Considering.
5	Does your city use LED, induction, or quartz street lights or outdoor area lights?	Not at all.	Considering LED and quartz. Installed induction.	Tested and installed LED.	Use LED often. Installed induction.	Installed induction.	Installed induction.	Considering LED, induction, and quartz.
6	Does your city use any other new technologies for street lights or outdoor area lights?	No.	Remote monitoring system so we know when a light has gone out.	We have used LED up lights and compact fluorescents in outdoor wall packs and stair lights.	Not at all.	Not at all.	Not at all.	Not at all.
7	Please list the make and model of solar, LED, quartz or induction street lights that your city uses.		Induction lights by Phillips.	Previously tested a LED streetlight from Luzbright. Getting ready to try a LED streetlight by LEDtronics.	Carmanah Solar. Phillips Induction Lights.	Induction lamps by Phillips.	Induction by Holophane, Memphis tear drop, Granville post tops. Solar Lights are SolarPal PM Model Cobra Head Fixture.	Induction - Holophane Granville post tops.

D. SMALL BUSINESS PERFORMANCE BONDS

The City of San Jose's Small Business Development Commission began exploring how to assist small and or new contractors obtain performance bonds so that they could compete for larger projects. One concept considered was to establish a pool that contractors participate in by paying a fee. They would then receive coverage through this pooled program administered by the City of San Jose, rather than providing an actual performance bond. In response to their exploratory inquiries, the following input was received.

The City and County of San Francisco has a Surety Bond Program that is designed to assist Disadvantaged Business Enterprises (DBEs) obtain bid, performance, and payment bonds. This program receives partial funding from the City and County of San Francisco and provides bond guarantees to surety companies up to 40 percent of the bond or $750,000, whichever is less. The program also includes accounting assistance, individual counseling, and workshops on topics such as bonding, financing and business management.

The City of Los Angeles has a Bond Assistance Program. The Program is run by a consultant and is funded by the City of Los Angeles. The consultant provides bond procurement counseling and assistance with financial statements. There is also a surety application peer review program. Additionally, the City of Los Angeles provides bond guarantees up to 40 percent of the bond or $250,000, whichever is less.

The Cities of Oakland, Sacramento, and Long Beach do not have bond assistance programs.

E. INCREASING THE NUMBER OF CONSTRUCTION BIDS RECEIVED

The City of Oakland initiated a discussion related to the low number of bidders responding to the City of Oakland's advertisements for bids on public works projects after experiencing an average of two bids per street or pipeline project in the preceding year. The City of Oakland requested information on programs that other participant agencies had implemented to improve the bidding environment.

The City of Sacramento, Department of Utilities has reviewed its requirements and procedures and attempted to reduce onerous requirements. Other bidding processes have been streamlined and language that is unreasonable, unenforceable, or contract language that would be intimidating to new bidders have been changed. Finally, project managers are being asked to call prospective bidders to encourage bidding. The City of Sacramento, Department of Utilities believes this is worth the time and results in more bids.

The City of Sacramento, Department of Utilities also noted an increase in contractor bid amounts. This may be due in part to material costs increases over the past two years. However, the bigger influence appears to be the volume of work and a shortage of contractors. For example, the City of Sacramento, Department of Utilities has experienced significant increases in prices from concrete subconsultants. If the material costs are isolated, the escalation in steel, concrete, and lumber (for concrete forms) costs does not fully account for the increase. It is more likely that the subcontractors are bidding high because of a lack of competition and contractors are being more selective about which owners to work for.

The City of San Jose has been aggressive in taking steps to improve the bidding environment:

- Almost all bid documents are available online through outside vendors. This allows contractors to peruse, purchase, and print selected sheets without leaving their office. Purchasing a complete set of Contract Documents can be expensive for smaller subcontractors. This system has been especially helpful to get more subcontractors interested in bidding on projects, as it allows contractors on the site viewing other agency projects to also access City of San Jose bid documents.

- The City of San Jose has a database system which issues automatic notices to contractors who have subscribed to its email service whenever a project is available for bid, based on project type.

- A 3-week bidding period is usually allowed.

- Plans and specs are available at Builder Exchanges.

- The City of San Jose does not have requirements for Minority-owned Business Enterprises (MBE), Women-owned Business Enterprises (WBE), or Disadvantaged Business Enterprises (DBE). In addition, there is no local preference except on projects with construction value less than $100,000.

The City of San Jose has been issuing a steady stream of projects for the last 4 years, so contractors are encouraged to often seek out work. (The number of project awards made by fiscal year (FY) are: FY 01/02: 131; FY 02/03: 155; FY 03/04: 145; and FY 04/05: 120).

The City of Long Beach has also been proactive in improving contractor response to bid solicitations:

- Bidder outreach includes the use of an online vendor database/procurement website. Typically, over 100 vendors are contacted upon advertisement of projects. The online system automatically emails contractors who have registered on the City of Long Beach procurement website.

- The City of Long Beach has held "Open House" sessions with the public on how to do business with the City of Long Beach, in particular the Department of Public Works, for several years. The Chambers of Commerce and multiple MBE, WBE, and special interest groups are included in the vendor database.

- A 3 1/2-week bidding period is provided. Bids are always advertised on a Friday and always opened on a Wednesday. This aids contractors in scheduling their estimating and bidding loads and reduces scheduling conflicts.

- Plans and specs are made available at no cost to area Plan Rooms.

- There are no requirements for MBE, WBE, DBE, or local preference unless required by the funding type. The City of Long Beach is considering a SBE program.

- Performance in bidder outreach is measured by comparing the number of contract documents sold to the number of bidders participating. A codified target has not been set, but a target of approximately 50 percent may be considered desirable. Therefore, if 16 sets of contract documents were sold and 8 bids were received, the target would be met.

The City and County of San Francisco commented that it has also seen low bidder response.

It ranged from an average of 2.4 bidders for street projects to 3.3 bidders for parks projects.

Table 5-5 summarizes the bidder response rate for selected agencies.

F. UTILITIES RELOCATION

The Project Team discussed the issue of handling utilities relocation on roadway projects.

The City and County of San Francisco responded that private utilities, like PG&E and SBC, are asked to relocate their own facilities prior to starting the roadway project. Private utilities pay for the relocation. To minimize the impacts to residents, the inclusion of the private utility work (along with their funding) into the City and County of San Francisco contracts has been considered. However, the legal and contracting issues are as yet unresolved.

If a water line relocation is caused by the City and County of San Francisco's roadway project, the relocation cost is included in the construction contract. However, if the City and County of San Francisco's Water Department wants to replace or relocate an existing main, while the City and County of San Francisco is doing a roadway project, the relocation work may also be included in the roadway project construction contract, but will be paid for by the Water Department.

Relocations for the City of San Jose-owned water system are handled much the same way as the City and County of San Francisco. The privately-owned San Jose Water Company and Great Oaks Water Company are required by franchise agreement to relocate their own facilities at their cost. Each can decide to relocate in kind or can upgrade if they wish, but all at their own expense. PG&E, Comcast, SBC and others are required to relocate, at their expense, prior to or during our construction. Like the City and County of San Francisco, the City of San Jose has not been successful in integrating major private utility work into its project construction contracts.

In the City of Sacramento, water mains are either publicly-owned by the City of Sacramento or privately-owned by local water districts. The City of Sacramento, Department of Utilities owns and maintains water mains within the street right-of-way. On a street project, the City of Sacramento will design water main relocations and include them in the construction contract. Who pays for the relocation depends upon field conditions. There is a Cost Sharing Agreement between the City of Sacramento, Department of Utilities and the City of Sacramento, Department of Transportation that determines cost-sharing for various field conditions.

Private water company facilities are considered to be in City of Sacramento right-of-way with the City of Sacramento having senior rights. Therefore, the City of Sacramento will enter into an agreement to relocate water lines at cost to the private water company and include the work in the construction contract.

In the City of Long Beach, utilities are generally relocated prior to construction. Who pays for the relocation of privately-owned utilities depends on who has prior rights and what the franchise agreements stipulate. The privately-owned utility pays for relocation the majority of the time. Both water and gas utilities are owned by the City of Long Beach, and are treated in much the same manner as privately-owned utilities. If the respective City of Long Beach Department that owns the water or gas line is doing the work, the trench may be patched back with temporary paving. The City of Long Beach Department performing the roadway project will perform the final permanent resurfacing.

The City of San Diego often combines construction contracts for relocating utilities such as water, sewer, and dry utilities. Recently, a project was completed where relocating overhead

Table 5-5 City of Oakland's
Survey on Project Bid Response Rate

City	Period	Count	Pipes	Streets	Muni	Parks
Los Angeles		*# of Projects Bid*	32	24	18	2
		# of Bids Received	119	75	59	9
		Average # of Bids per Project	3.72	3.13	3.28	4.5
Oakland	5-Oct to 5-Aug	*# of Projects Bid*	15	10	8	3
		# of Bids Received	31	22	32	3
		Average # of Bids per Project	2.1	2.2	4	1
Sacramento		*# of Projects Bid*	3	28		
		# of Bids Received	8	85		
		Average # of Bids per Project	2.7	3.0		
San Francisco	4-Oct to 5-Aug	*# of Projects Bid*	21	11	10	7
		# of Bids Received	63	26	27	23
		Average # of Bids per Project	3	2.4	2.7	3.3
San Jose	4-Oct to 5-Aug	*# of Projects Bid*	12	32	24	14
		# of Bids Received	48	169	96	67
		Average # of Bids per Project	4	5.28	4	4.79

utilities to underground was performed under the same contract as a roadway reconstruction contract (through a subcontractor). This arrangement worked out well for the City of San Diego. The issue of payment depends upon prior rights. Any privately-owned utility in existing public right-of-way must be moved at cost to the private utility. But if the utility was in an easement, then the City of San Diego pays through the roadway project.

The City of Los Angeles' procedures provide that for any project in the public right-of-way, the utility company may be asked to relocate their line at their own cost after all other feasible alternatives have been pursued. Utility companies are required to perform their relocation work before the City of Los Angeles starts construction.

Within the City of Oakland, privately-owned utility conflicts and relocations are coordinated through a monthly meeting between the City of Oakland and utility agencies. Also, plans are sent to utility agencies for their review at the 90-percent design phase. Discussions are frequently started earlier when potential conflicts are identified. Relocation of private utilities such as gas and telephone are normally scheduled just prior to beginning of construction. The work is performed at the expense of the utility companies and most local utility companies use their own forces to perform relocation work.

In the City of Oakland, water is provided by a public entity called East Bay Municipal Utility District. Relocation of water lines takes extensive coordination. The rule of "prior in time, prior in right" governs relocation disputes.

G. PAVEMENT DESIGN

The City and County of San Francisco initiated a discussion regarding design procedures and standards for pavement sections on arterial roadways. The agencies were asked:

(1) What is your typical pavement section for arterials? Do you use thick lift asphalt concrete (AC), and do you use different AC mixes for the different layers?

(2) Do you follow a local standard, or do you follow pavement design formulae such as Caltrans, AASHTO, etc.?

The City and County of San Francisco's standard pavement section is a 2-inch asphalt wearing surface over 8 inches of concrete base over compacted fill or basement soil. Traffic Indices (TIs), Correlation of Resistance values (R-values), etc., are not used as a basis for design.

In the City of Long Beach, a typical section would be asphalt concrete over aggregate base over native soil. Pavement layer thicknesses would depend on TI and soil stability. A typical section is 5 inches of AC over 8 inches of aggregate base. The asphalt concrete would be placed in lifts as needed to obtain proper asphalt compaction, finished with a surface wearing course. A "full depth" asphalt would be used directly on top of subgrade where that was shown to be most economical. The difference in the AC between courses would be the gradation, typically specifying 1-inch maximum aggregate size (dense medium coarse according to "Standard Specifications for Public Works Construction," also known as "Greenbook") for the lower courses and ¾-inch maximum aggregate size (Greenbook dense medium) for the surface course. For new pavement sections, the City's practice has been to follow the Caltrans Highway Design Manual.

In the City of San Diego, allowable pavement types are either AC and base, concrete, or a full-depth AC for special conditions. Sections for a prime arterial range from 3.5 inches of AC and 11 inches of cement-treated base (CTB) (or 8 inches of Portland Cement Concrete [PCC]) to 7 inches of AC and 22 inches of CTB (or 9 inches of PCC with 6 inches of CTB), depending on the R-value. All AC installations use different

aggregate gradations, depending on the thickness of the AC layer. Local standards for pavement design are used. The standards are in a table and use R-Values and TI/Average Daily Traffic (ADT) to determine the pavement section. This table was developed from the Caltrans method and other references.

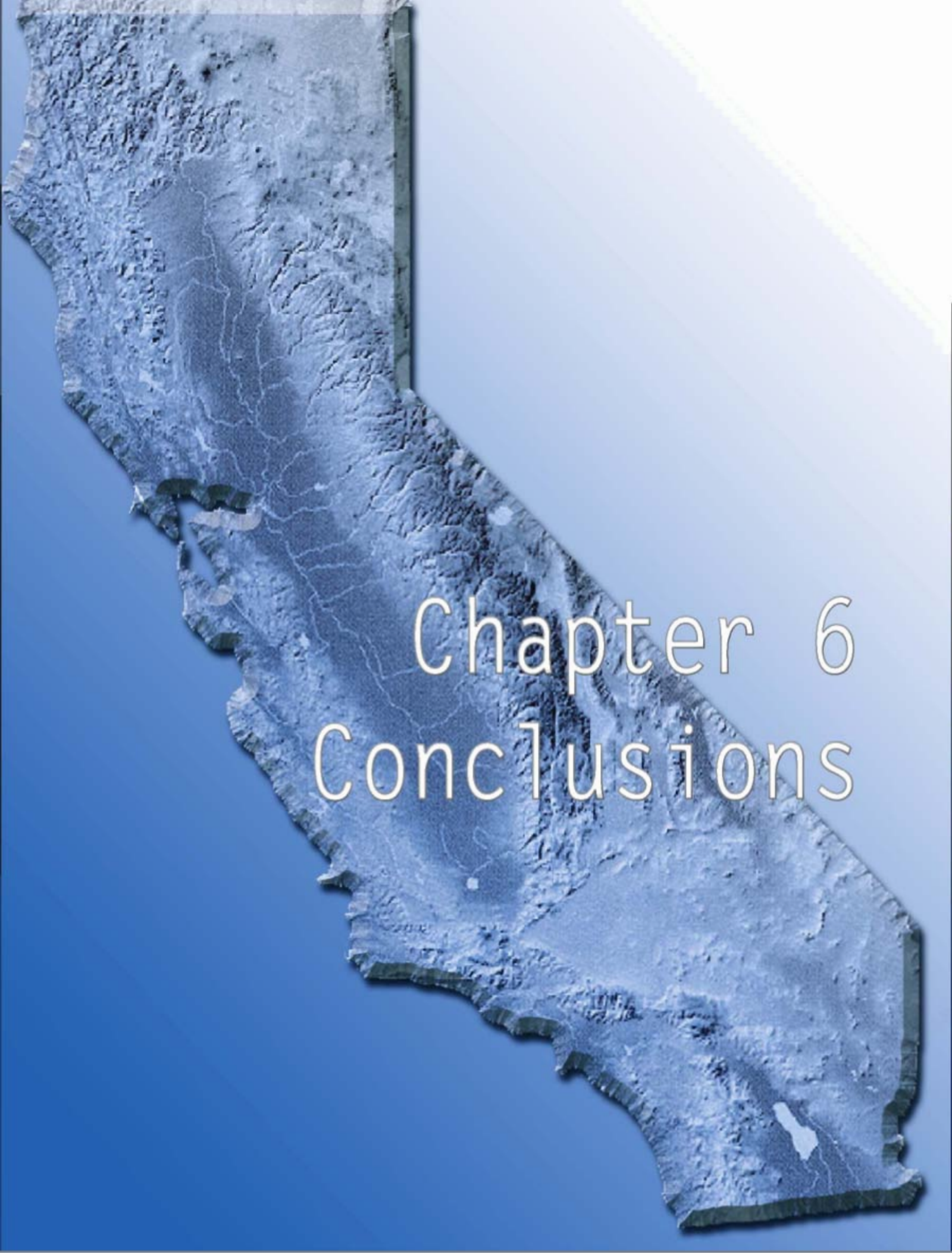
The Materials Testing Lab of the City of San Jose uses the 2001 Caltrans pavement design manual. Soil samples are collected at new pavement locations and R-Value tests are performed. Then the TI of the roadway and the R-Value results are input into the pavement design formula and the pavement section is generated. There are no typical or standard sections.

Three equivalent pavement sections are designed:

- Hot Mix Asphalt Concrete (HMAC) and Class 3 AB
- HMAC and Class 2 AB
- Deep-lift HMAC

For non-deep-lift sections, the HMAC in the layers consist of ¾- inch coarse Type A HMAC (base) and ¾- inch medium Type A HMAC (surface). For deep-lift sections, all ¾- inch medium Type B HMAC is used.

The City of Los Angeles has two bureaus that are responsible for the design and construction of the street system. The Bureau of Street Services reconstructs existing streets with a structural section identical to the original structural section. They use one class and grade of asphalt for the reconstructed streets. The Bureau of Engineering, however, designs a new structural section using the Caltrans design method based on TI and R-values. The Bureau of Engineering currently uses multiple classes and grades of asphalt based on the number of Equivalent Single Axle Loads (ESALs) the pavement will be subjected to. The typical pavement section for an arterial street consists of 2 inches of ½-inch nominal size aggregate on 6 to 8 inches of 3/8-inch nominal size aggregate. The grade of asphalt binder is AR-8000. The grade of asphalt binder will change next year as the state changes from the AR grading system to a PG grading system. Currently, it appears that the City of Los Angeles will change to PG 64-10.



Chapter 6
Conclusions

CIP Benchmarking Study

CHAPTER 6 Conclusions

A. PERFORMANCE BENCHMARKING

The distribution of projects contributed by any given agency to the database is driven by the needs of its community. These needs change over time. Because of this, agencies do not contribute data equally to the various classifications. If the distribution of projects becomes more uniform among all classifications for each agency, the reliability of the models will be improved.

After five years of data collection, the performance benchmarking effort in *Update 2006* showed that the performance models are driven by a large number of relatively small projects (below $1M in TCC). Thus there continue to be data gaps to be filled to improve the usefulness of results from the data regressions. The models can be improved for medium-sized and larger-sized projects if more data are collected for TCC values above $1M. However, as discussed above, it is not clear if the agencies will find this to be practical given the actual types and sizes of projects they deliver.

In spite of the limitations on the regression results, the process of collecting the requested data benefits the agencies in that they are able to verify that this data is accessible and correct. Additionally, the process of data collection allows agencies to identify and implement improvements to their project delivery cost accounting systems and processes. The descriptive results of the R^2 statistic allow the agencies to better-understand the amount of scatter in the project delivery costs, even if the p-values indicate that most regressions can be used with caution and professional judgement for budgeting projects and programs.

Monitoring and correcting data collection procedures by the participating agencies is important to improve confidence in the data and obtain consistent results from the analyses. This has been and will continue to be an important part of the study for several years.

Additional conclusions from performance benchmarking are presented here:

- Generally, the relative cost of design, construction management, and overall project delivery decreases as TCC increases. This is consistent with what is intuitively expected due to economies of scale in project delivery.

- Median total construction cost values of projects in the Study are stable on projects completed between 2001 and 2005. Average total construction costs decreased between 2001 and 2004 and increased between 2004 and 2005.

- Project delivery costs as a percentage of total construction cost increased on projects completed between 2001 and 2004.

The increase in project delivery costs may be because:

1. Project delivery costs as a percentage of total construction cost tend to be higher on smaller projects than larger ones. Thus, some of the increase in project delivery costs may be explained by the decreasing average total construction cost of projects over the same period in the dataset.

2. Agencies also report that as time goes on, it costs more to meet increasingly-stringent

regulatory and municipal requirements.

3. Better data tracking and collection may have also resulted in higher reported project delivery costs.

It is expected that as the improvements in data collection methods and full BMP implementation improve, project delivery costs will begin to decline.

Other conclusions include:

- Change orders may be limited in practice by the project's contingency budget. The special study on change orders also showed that change orders due to unforeseen and changed conditions averaged 5 percent of TCC; those due to changes in bid documents averaged 3 percent; and those due to changes in scope averaged 2 percent.

- When consultant usage exceeded 25 percent of project delivery cost, the design cost as a percentage of the total construction cost was not necessarily reduced compared to projects with no consultant usage.

- The increase in design costs associated with using consultants on smaller or more specialized projects may be justified in many cases where consultants offer specialized technical expertise, the projects are complex, there is an aggressive project schedule, there are peak workload demands that can't easily be met using in-house staff, or there are other resource limitations on in-house staff.

B. BEST MANAGEMENT PRACTICES

The agencies have continued to fully implement selected BMPs. As of *Update 2006*, the agencies have fully implemented more than 60 percent of all BMPs. A sampling of implementation on projects indicated that agency BMP implementation status reporting generally appears accurate. However, there is some variability and latitude regarding what constitutes BMP "implementation". To enhance the potential to link practices to performance in future Studies, better BMP implementation documentation may be useful.

C. ONLINE DISCUSSION FORUM

The agencies have noted throughout the life of the Study that a key benefit of participation is the open exchange of ideas with regard to project delivery processes. Tracking the implementation of BMPs, identifying new BMPs, and sharing and developing strategies to address issues they face are important steps towards improving project delivery performance. To that end, the participants will continue sharing information through the Online Discussion Forum and during the quarterly meetings, and presenting the more interesting results to the public through the Study reports.

D. PLANNING FOR UPDATE 2007

Over the course of *Update 2006,* the Project Team identified a number of activities to consider including next year in *Update 2007.* These activities include:

- Preparing project case studies to investigate issues of BMPs and performance in greater detail. For example, the Project Team may want to investigate the influence of alternative project delivery methods, such as design-build, on the efficiency of project delivery.

- Continuing to perform outlier elimination from the analyses.

- Performing capital cost benchmarking on a unit cost basis for selected

types of projects, such as buildings and pipelines.

- Evaluating the use of adjustments to the data based upon region, project completion date, and/or agency overhead rates.

E. ACKNOWLEDGEMENTS

The participation and contribution of the following individuals to the Study is gratefully acknowledged. This work would not have been possible without their contributions.

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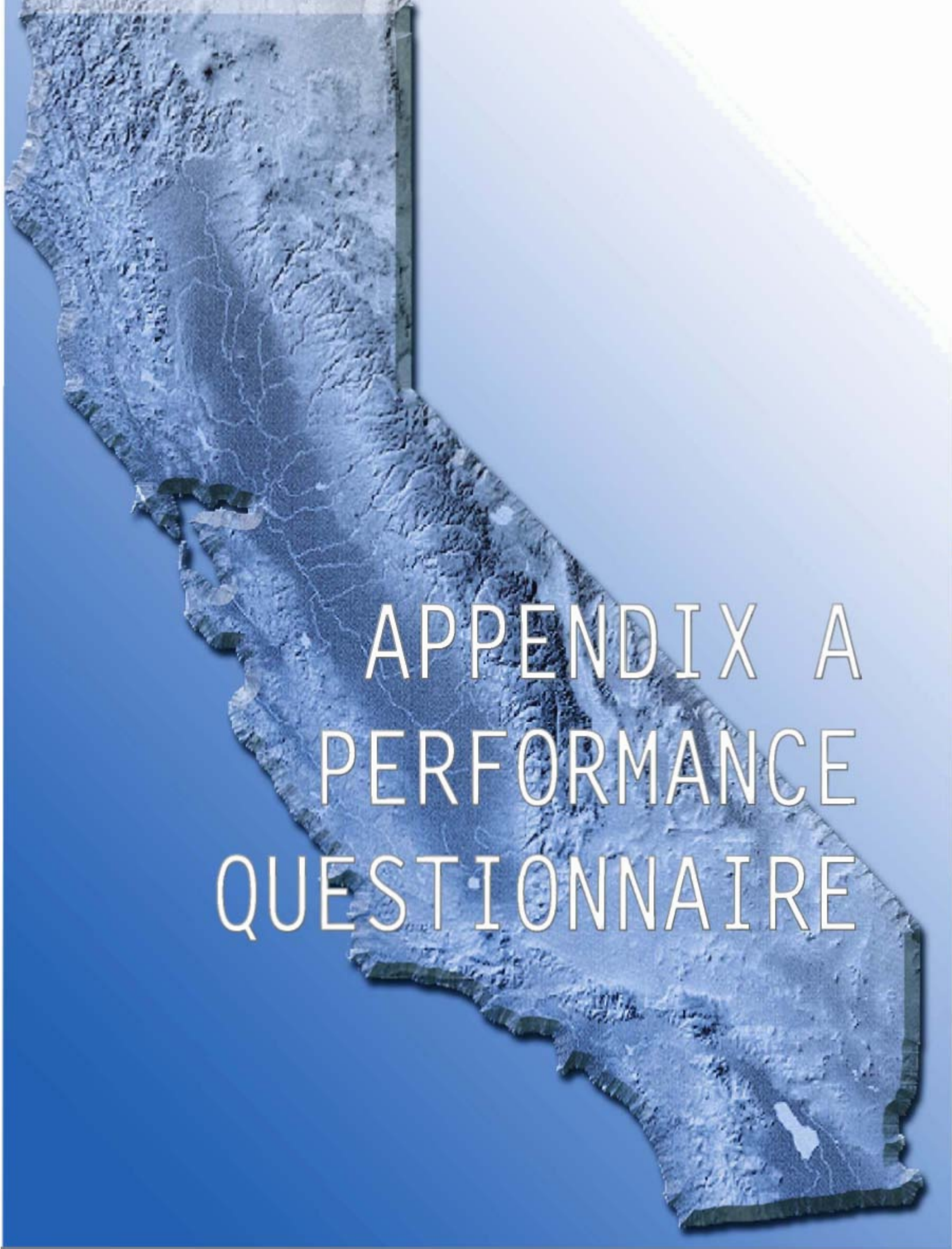


APPENDIX A
PERFORMANCE QUESTIONNAIRE

CIP Benchmarking Study

APPENDIX A

Performance Questionnaire

Agency: | Project Name:

Project type:

New/Rehab Index: | ☐ LEED Green Building

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 — Changed Conditions | Changed Bid Documents | Client-Initiated Changes: | Total Change Orders $-

UTILITY RELOCATION COST

CITY FORCES CONSTRUCTION

TOTAL CONSTRUCTION COST (TCC)

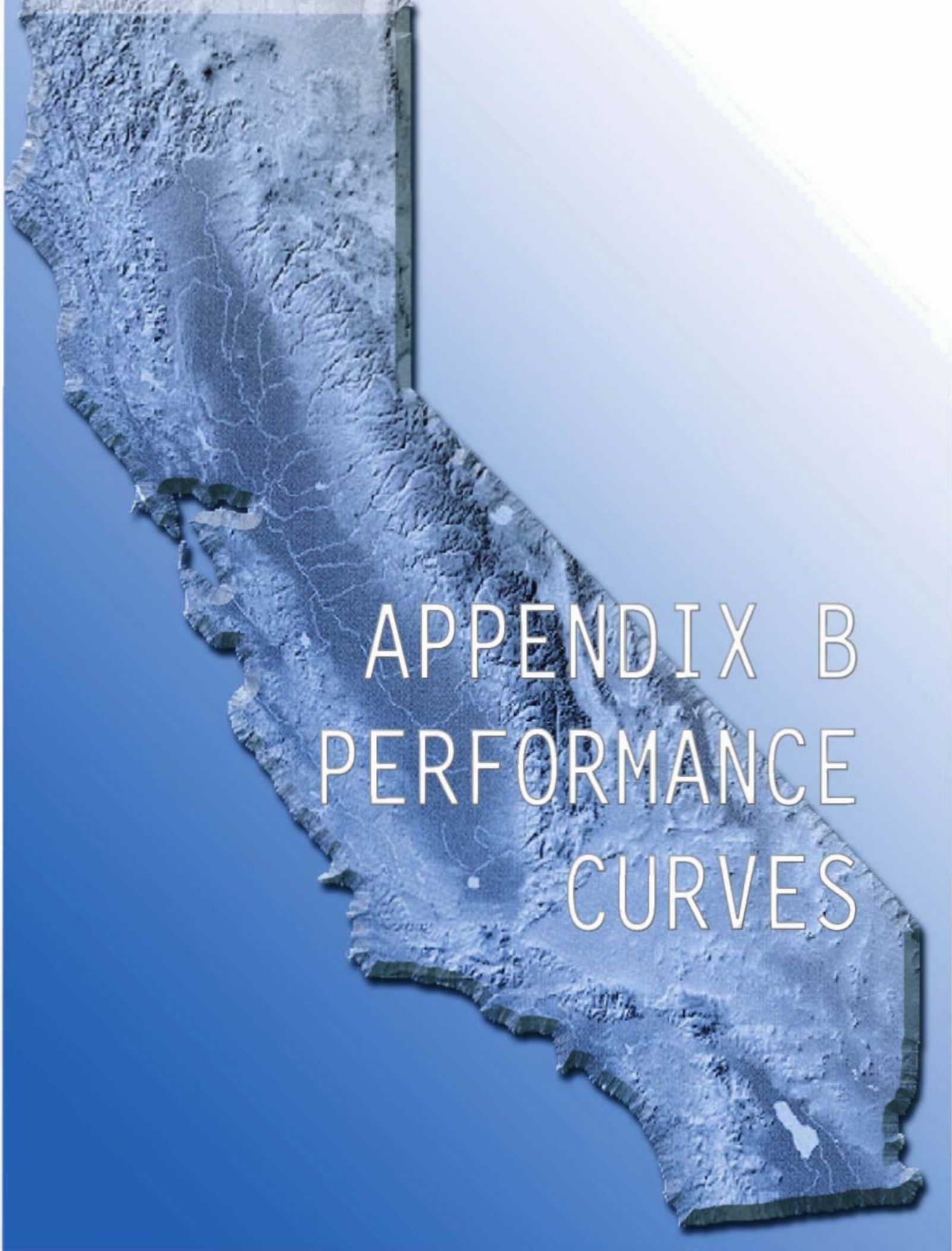
LAND ACQUISITION

PROJECT COMPLETION DATE

TOTAL PROJECT COST $ -

NUMBER OF BIDS RECEIVED

(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)



APPENDIX B
PERFORMANCE CURVES

CIP Benchmarking Study

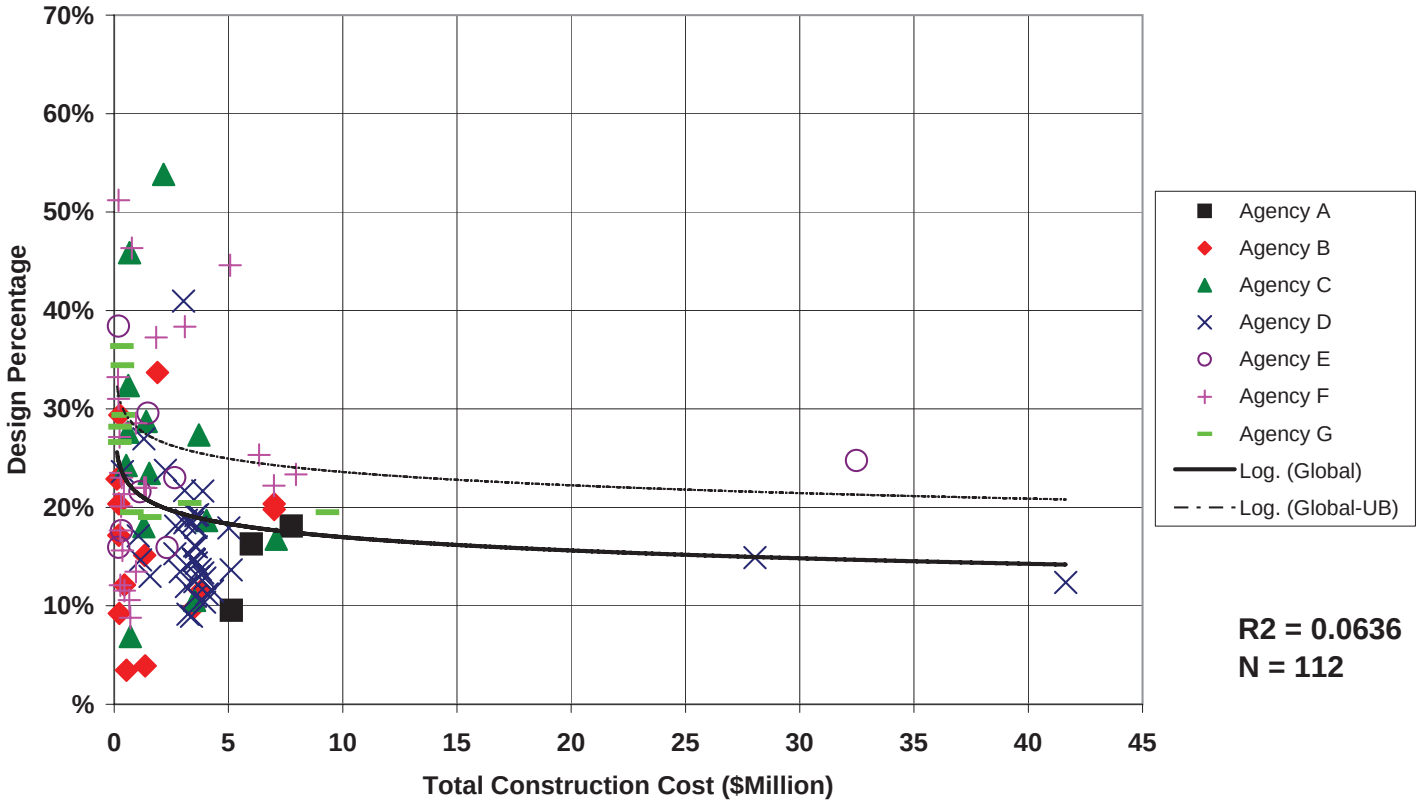
APPENDIX B

Performance Curves

CURVES GROUP 1

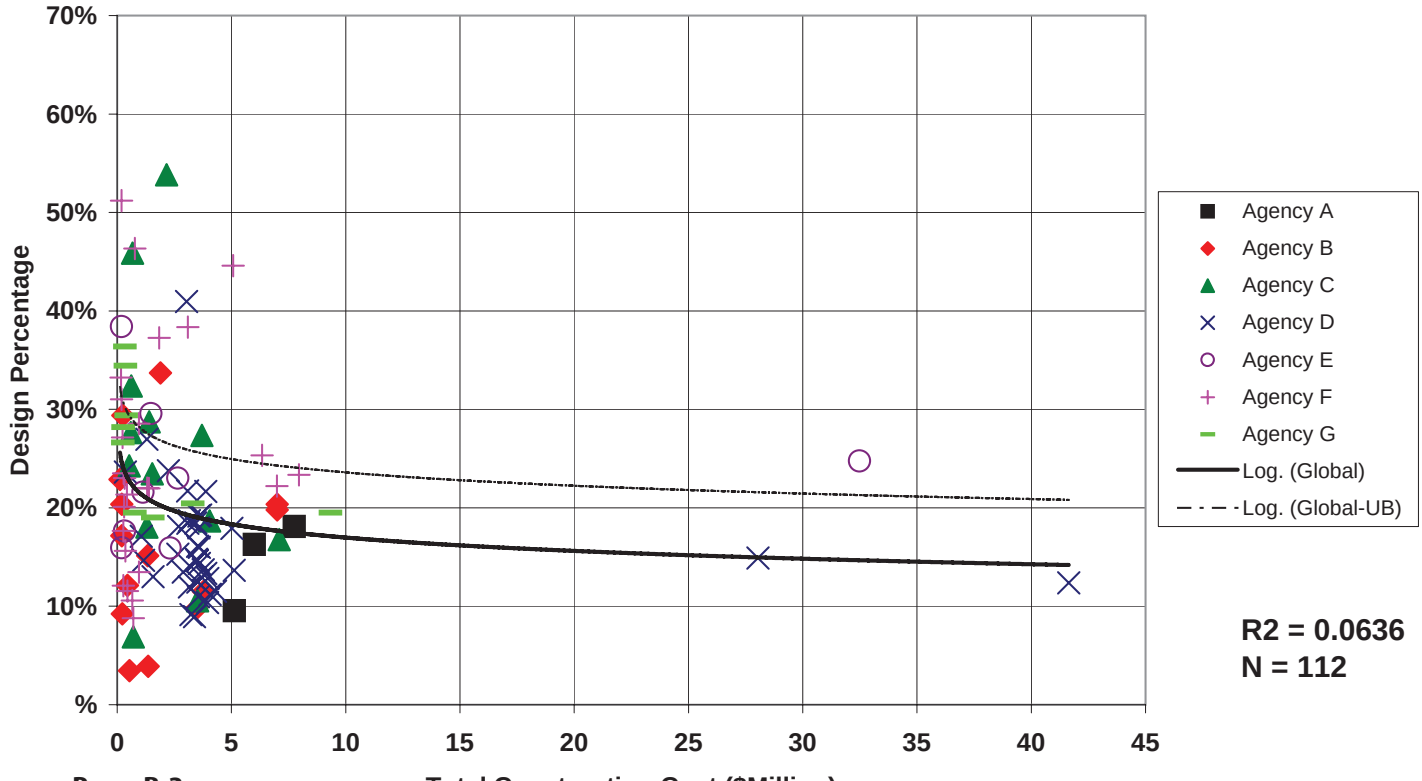
Design as Percentage of Total Construction Cost vs. Total Construction Cost

Municipal Facilities – All Classifications
Design Percentage Versus Total Construction Cost
Full Analysis



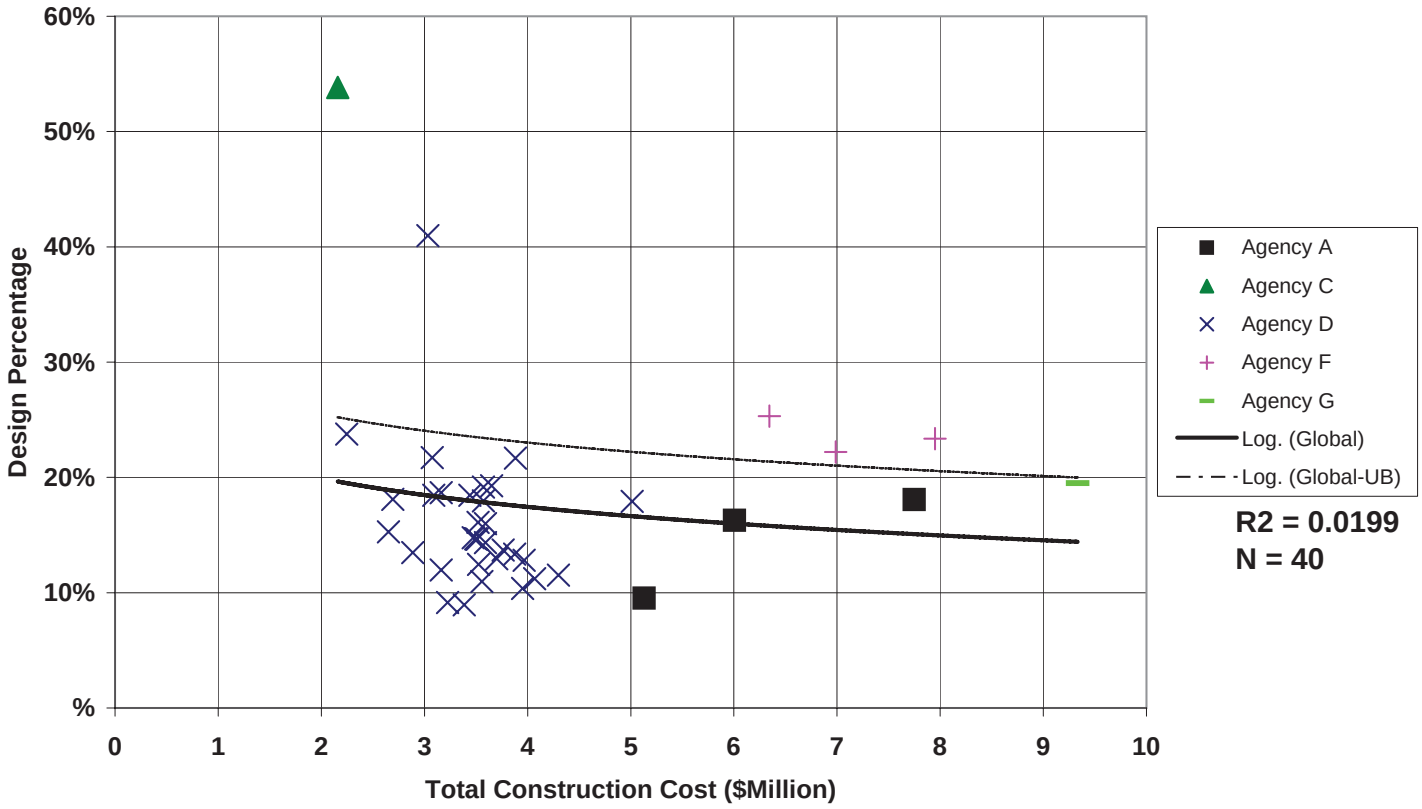
R2 = 0.0636
N = 112

Municipal Facilities – All Classifications
Design Percentage Versus Total Construction Cost
Zoomed Vied

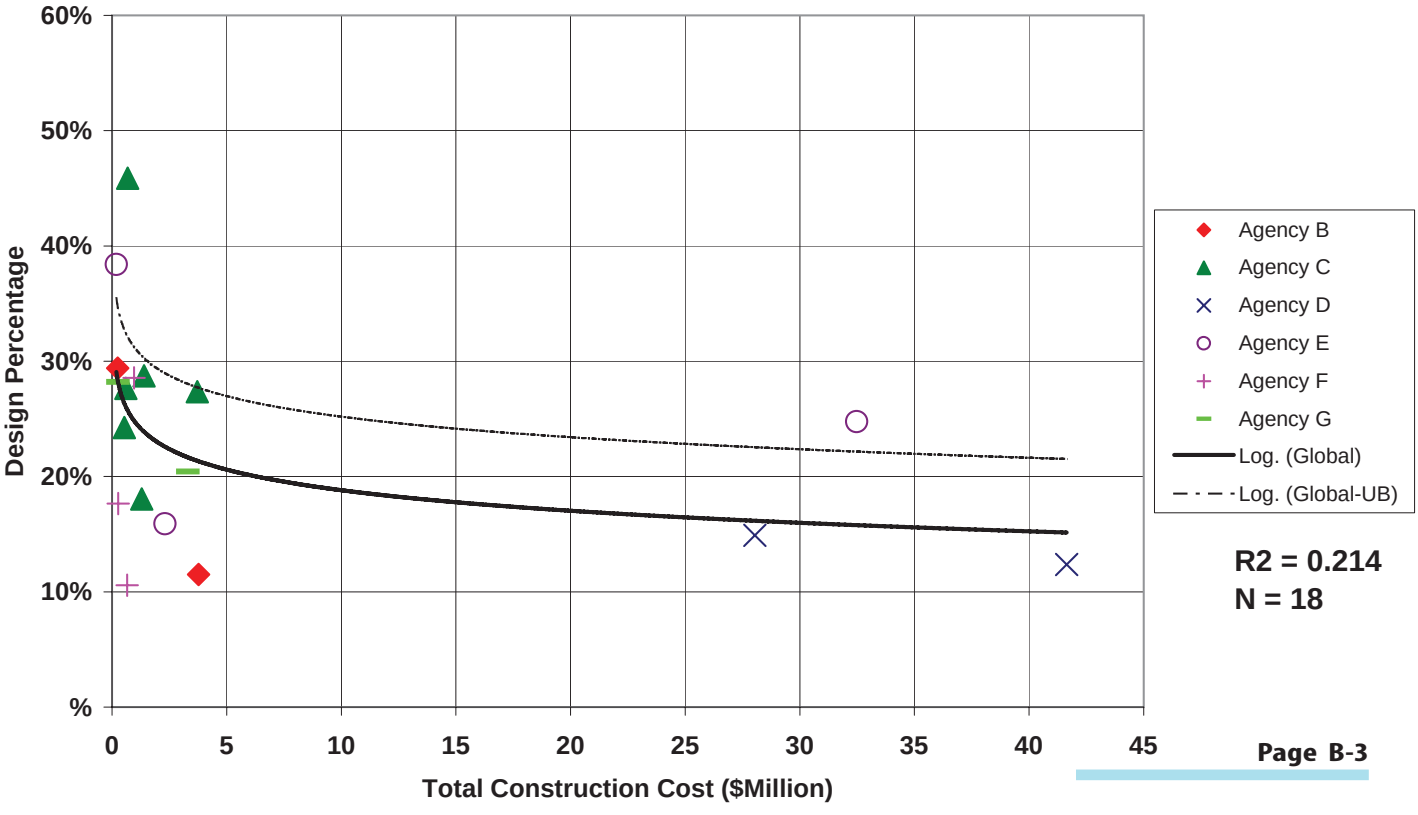


R2 = 0.0636
N = 112

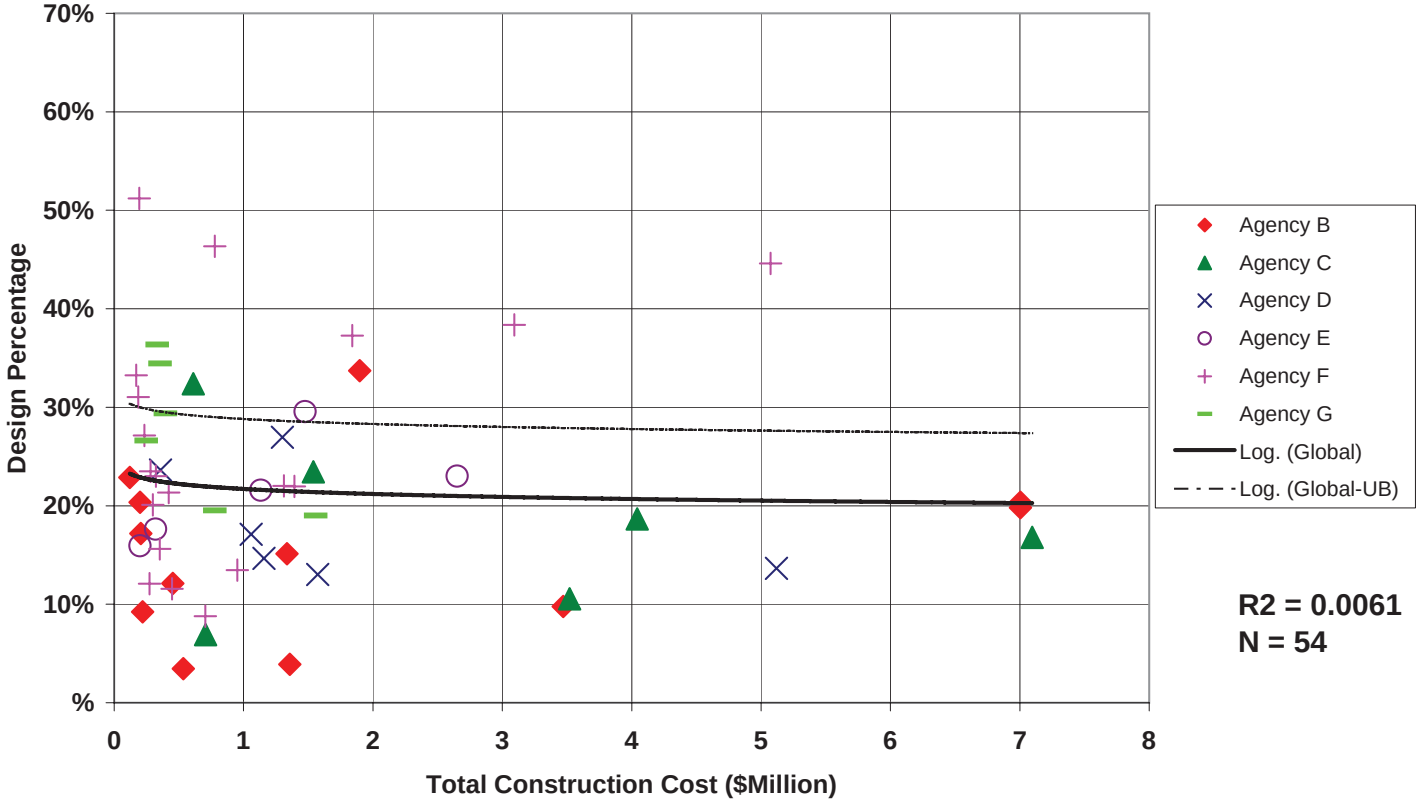
Municipal Facilities - Libraries
Design Percentage Versus Total Construction Cost



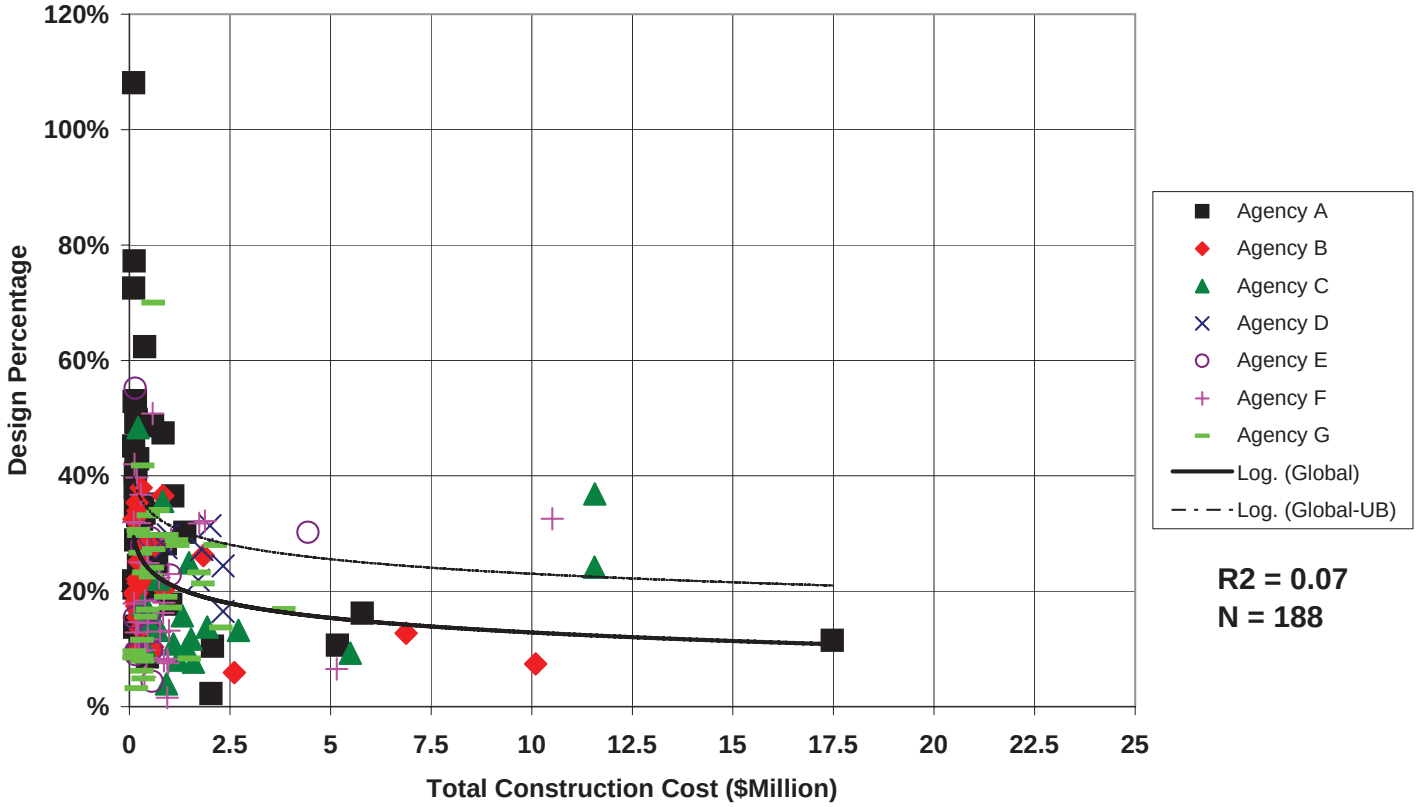
Municipal Facilities - Police/Fire Station
Design Percentage Versus Total Construction Cost



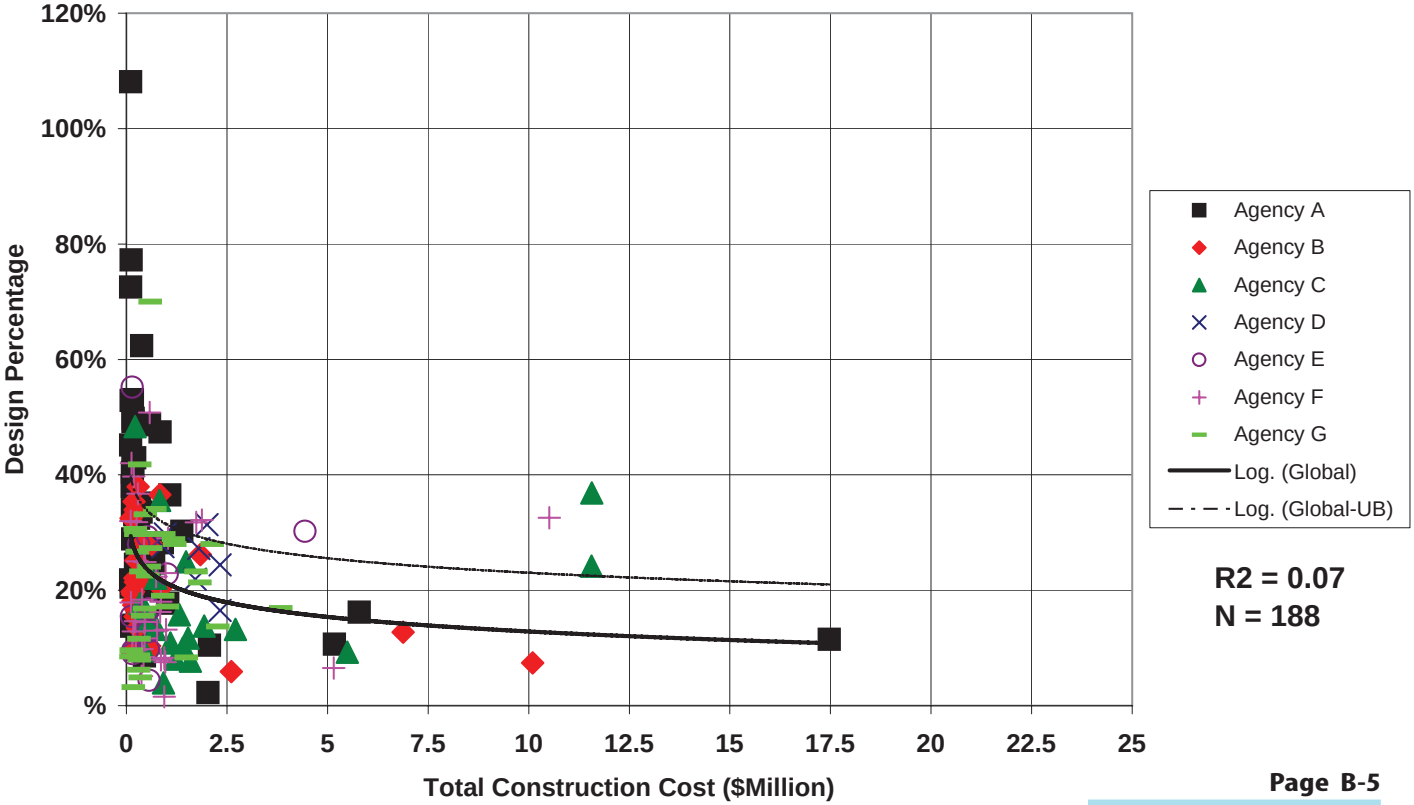
Municipal Facilities - Comm./Rec. Center/Child Care/Gym
Design Percentage Versus Total Construction Cost



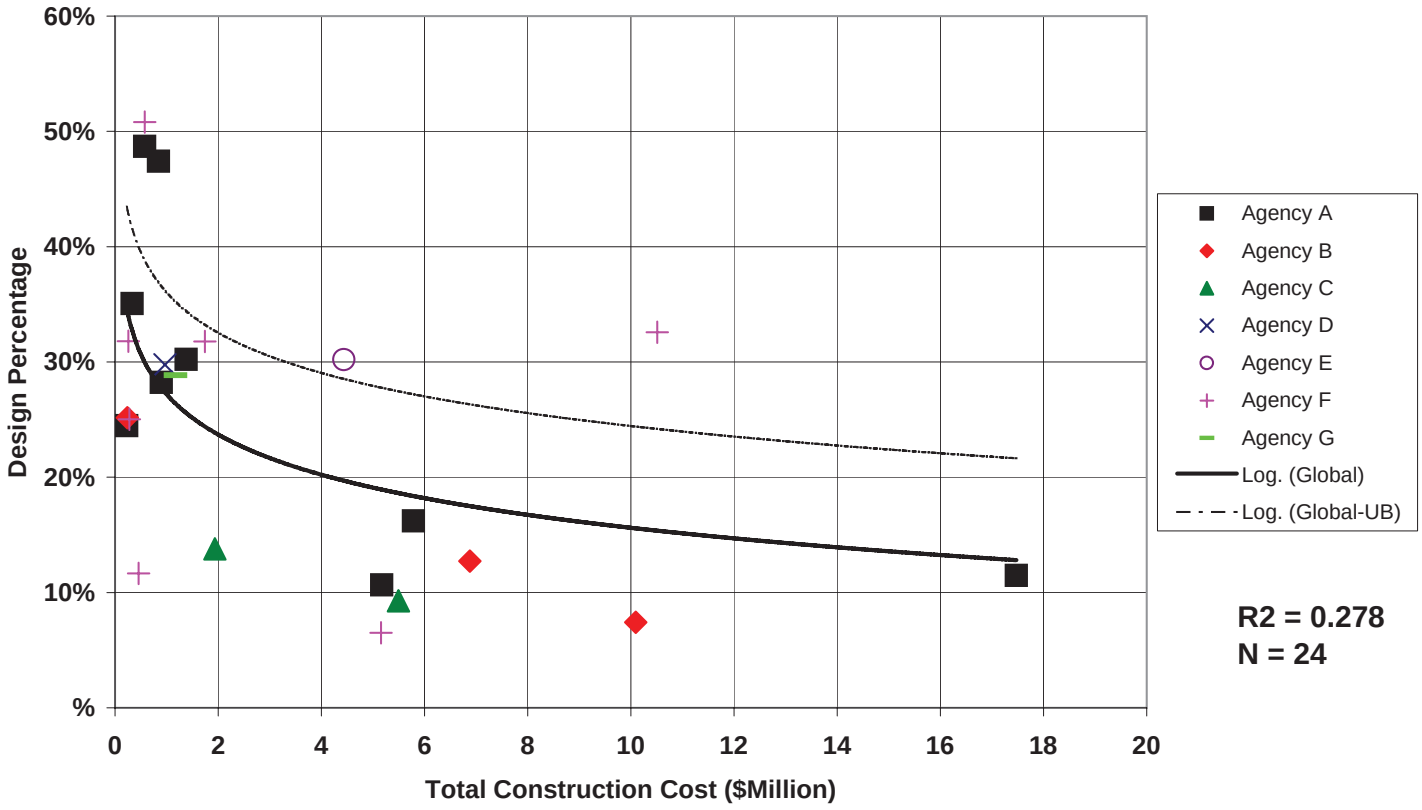
Streets – All Classifications
Design Percentage Versus Total Construction Cost
Full Analysis



Streets – All Classifications
Design Percentage Versus Total Construction Cost
Zoomed View

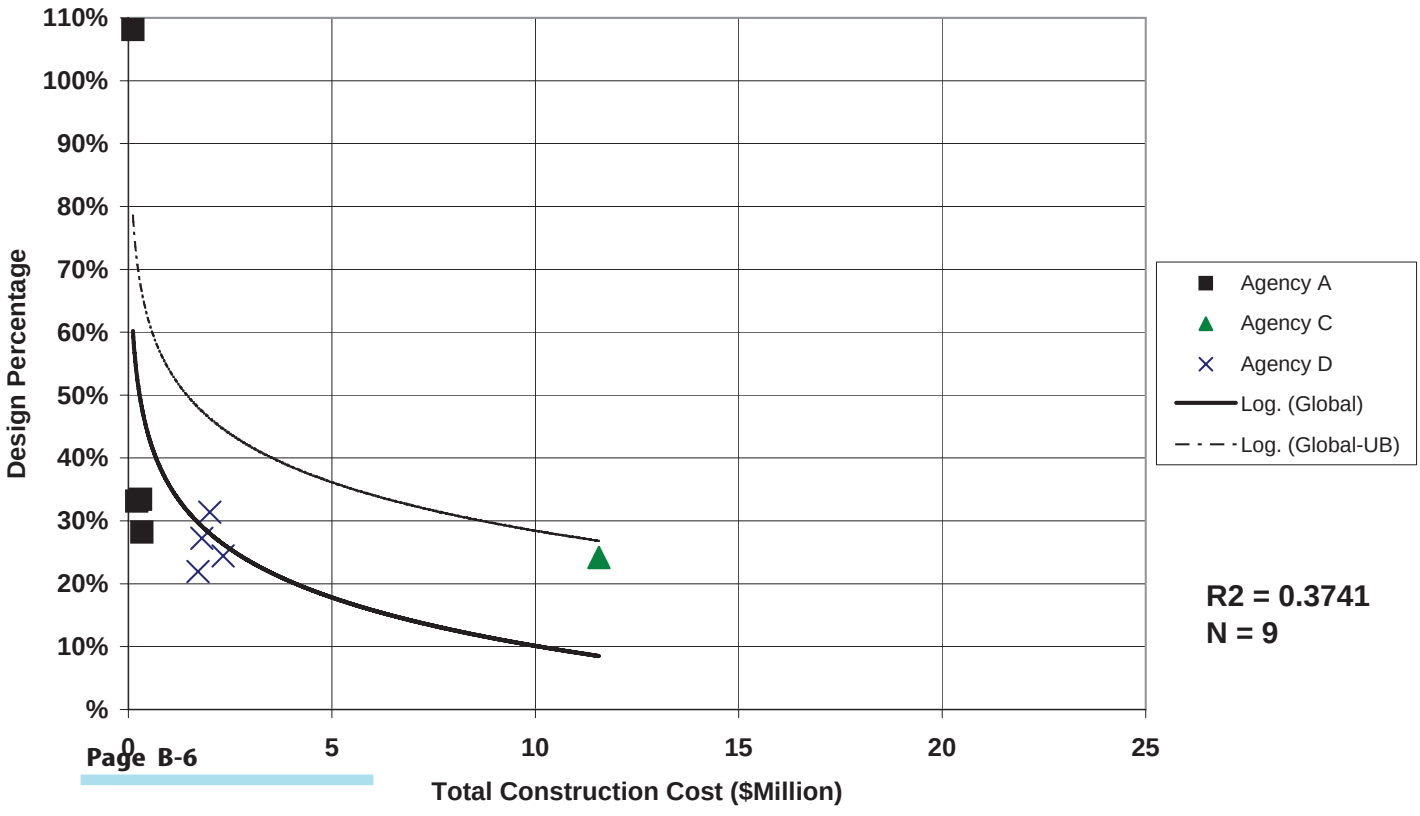


Streets - Widening/New/Grade Separation
Design Percentage Versus Total Construction Cost



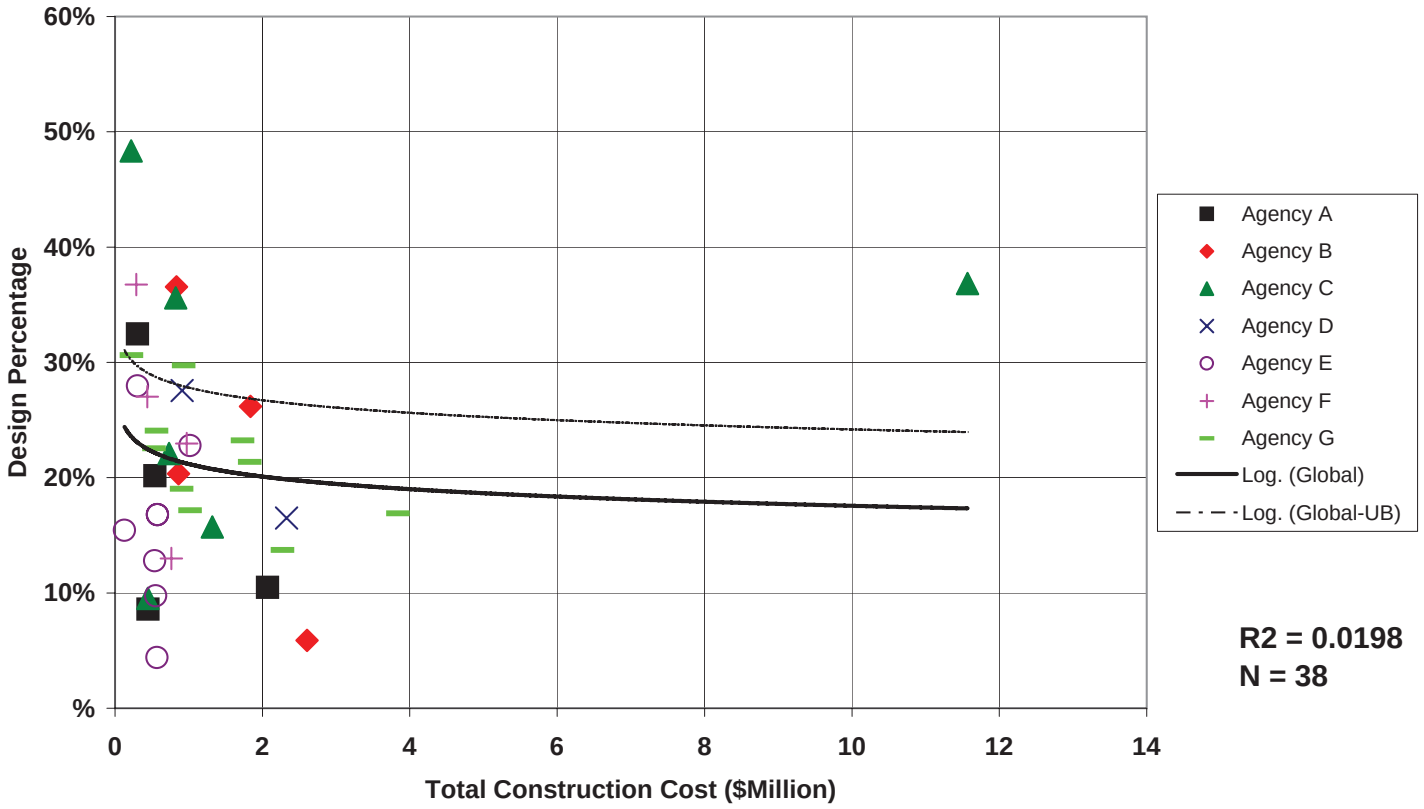
R2 = 0.278
N = 24

Streets - Bridges (New/Retrofit)
Design Percentage Versus Total Construction Cost



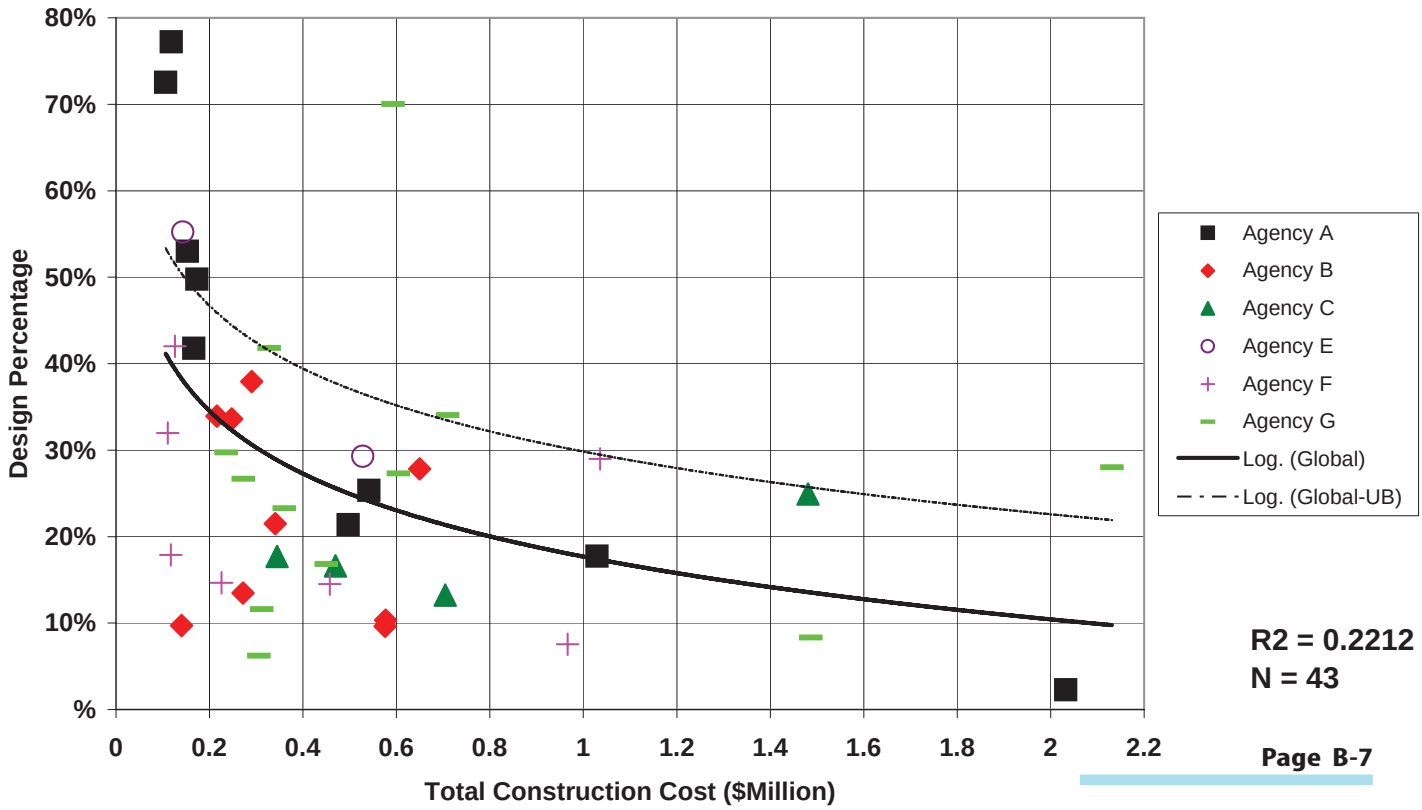
R2 = 0.3741
N = 9

Streets - Reconstruction
Design Percentage Versus Total Construction Cost



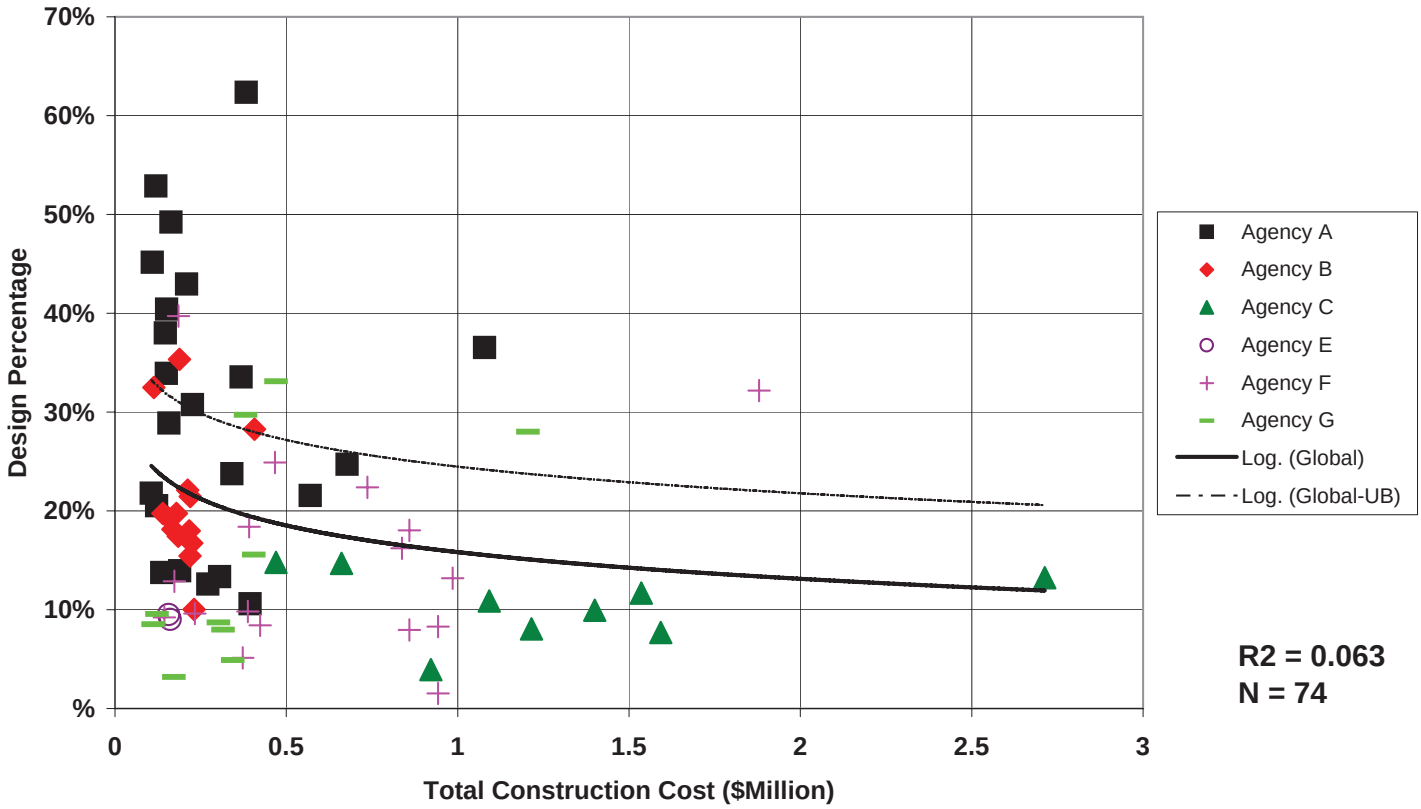
R2 = 0.0198
N = 38

Streets - Bike/Pedestrian/Streetscapes
Design Percentage Versus Total Construction Cost

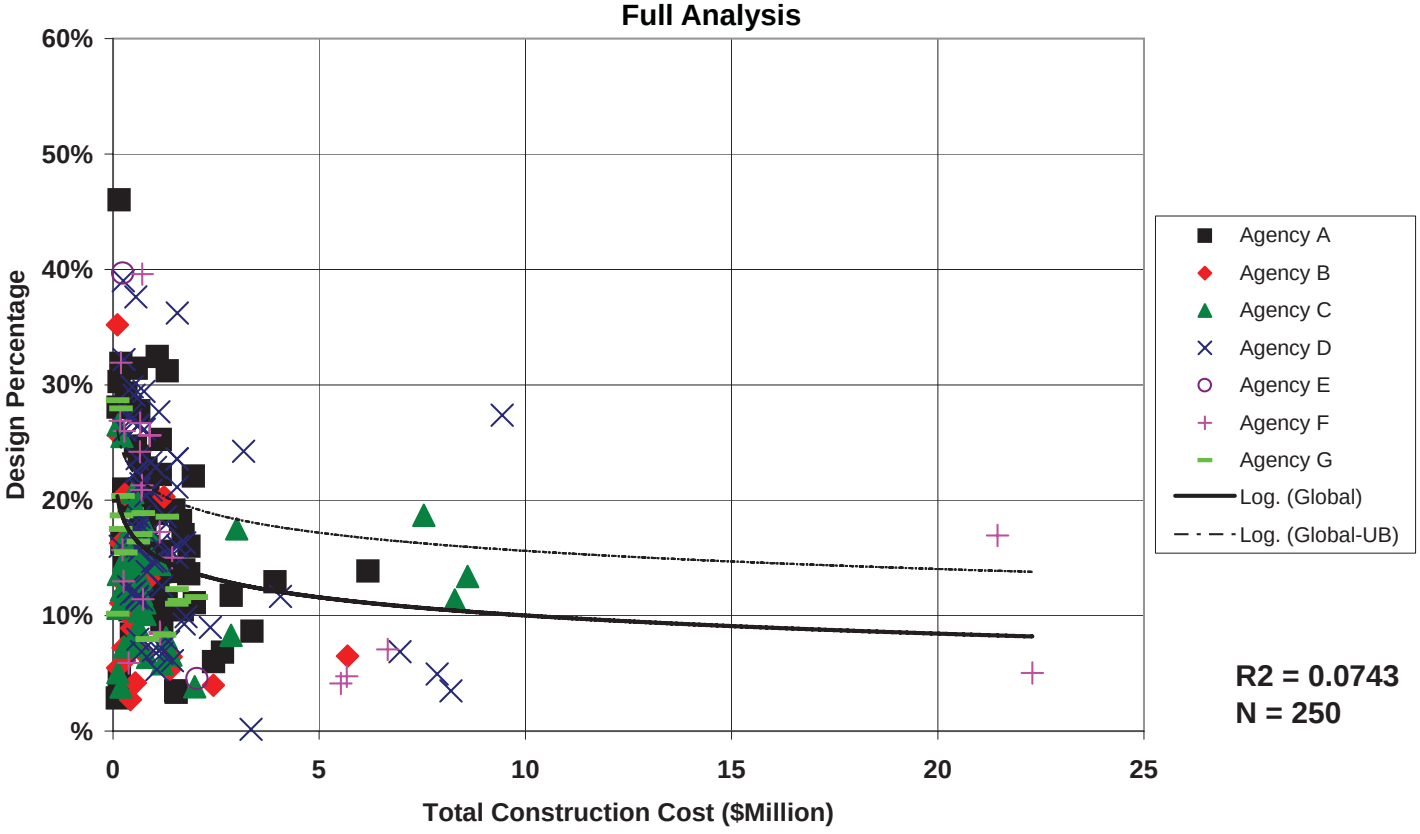


R2 = 0.2212
N = 43

Streets - Signals
Design Percentage Versus Total Construction Cost

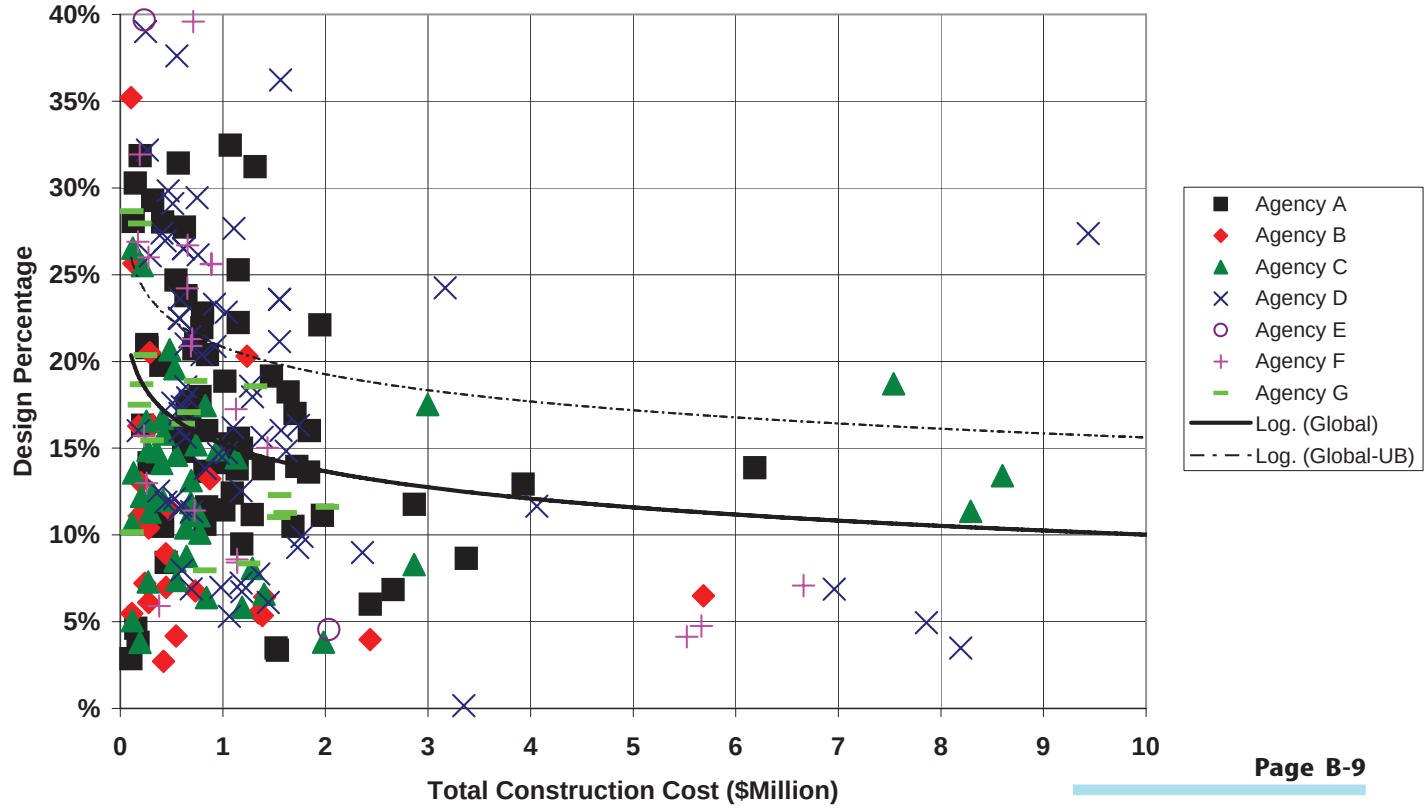


Pipe Systems – All Classifications
Design Percentage Versus Total Construction Cost
Full Analysis

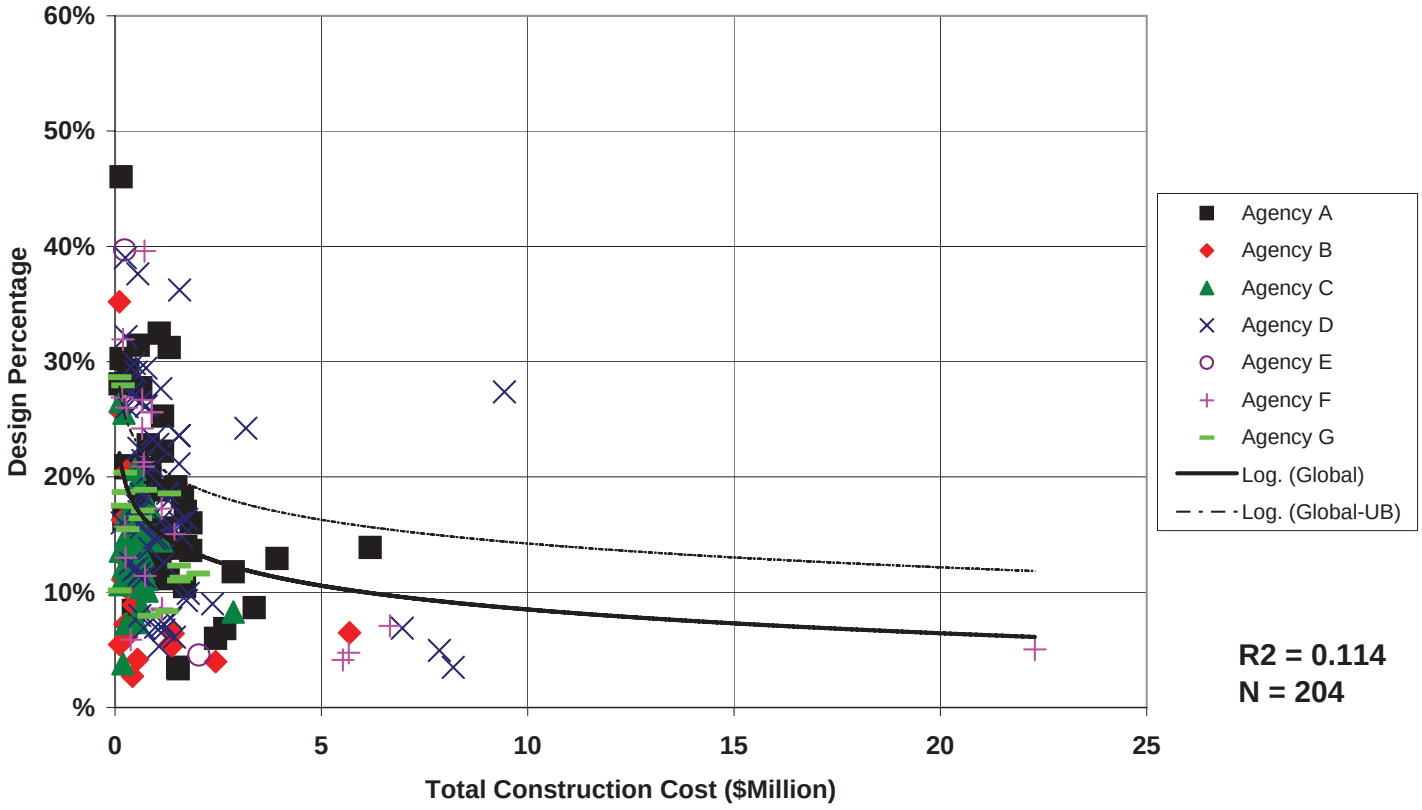


R2 = 0.0743
N = 250

Pipe Systems – All Classifications
Design Percentage Versus Total Construction Cost
Zoomed View

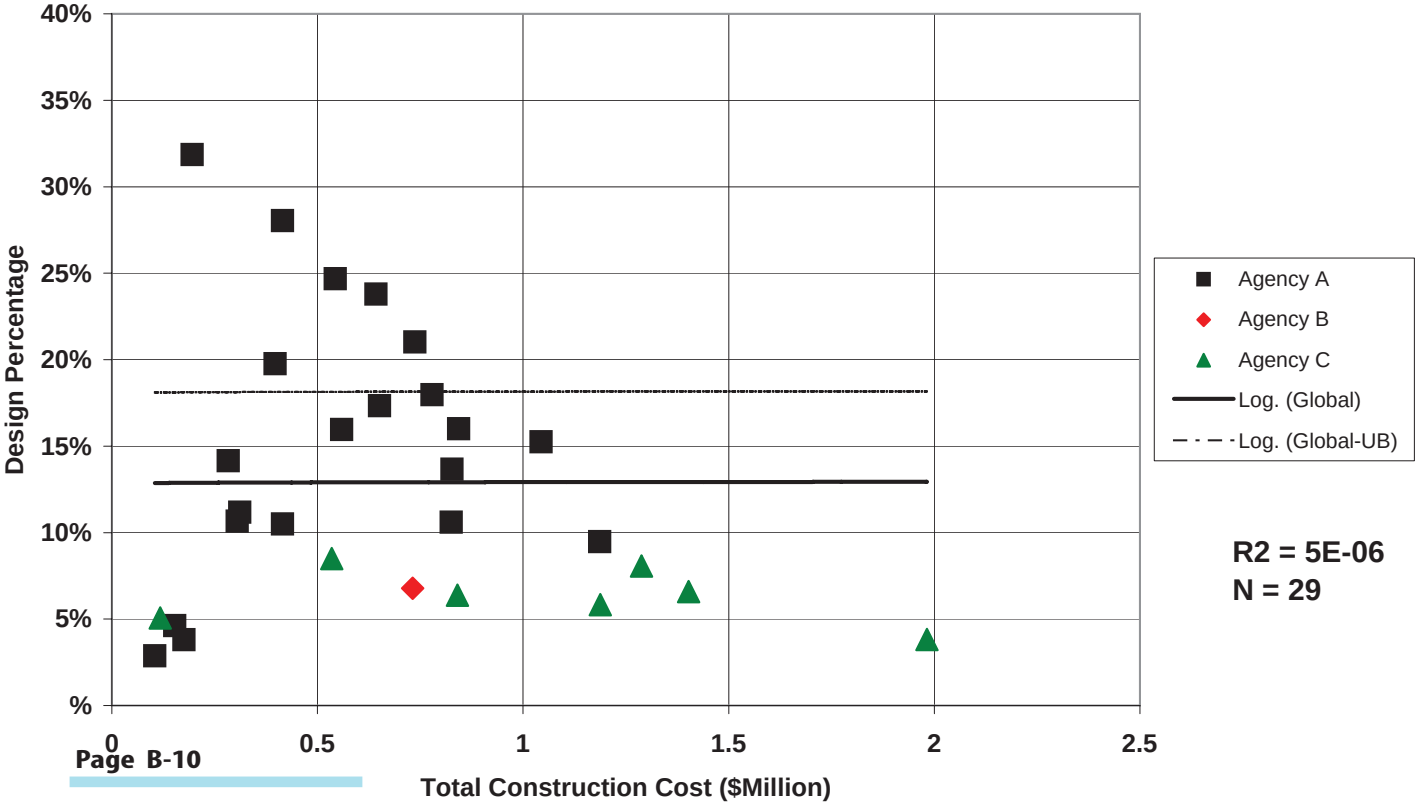


Pipe Systems - Gravity System (Storm Drains/Sewers)
Design Percentage Versus Total Construction Cost



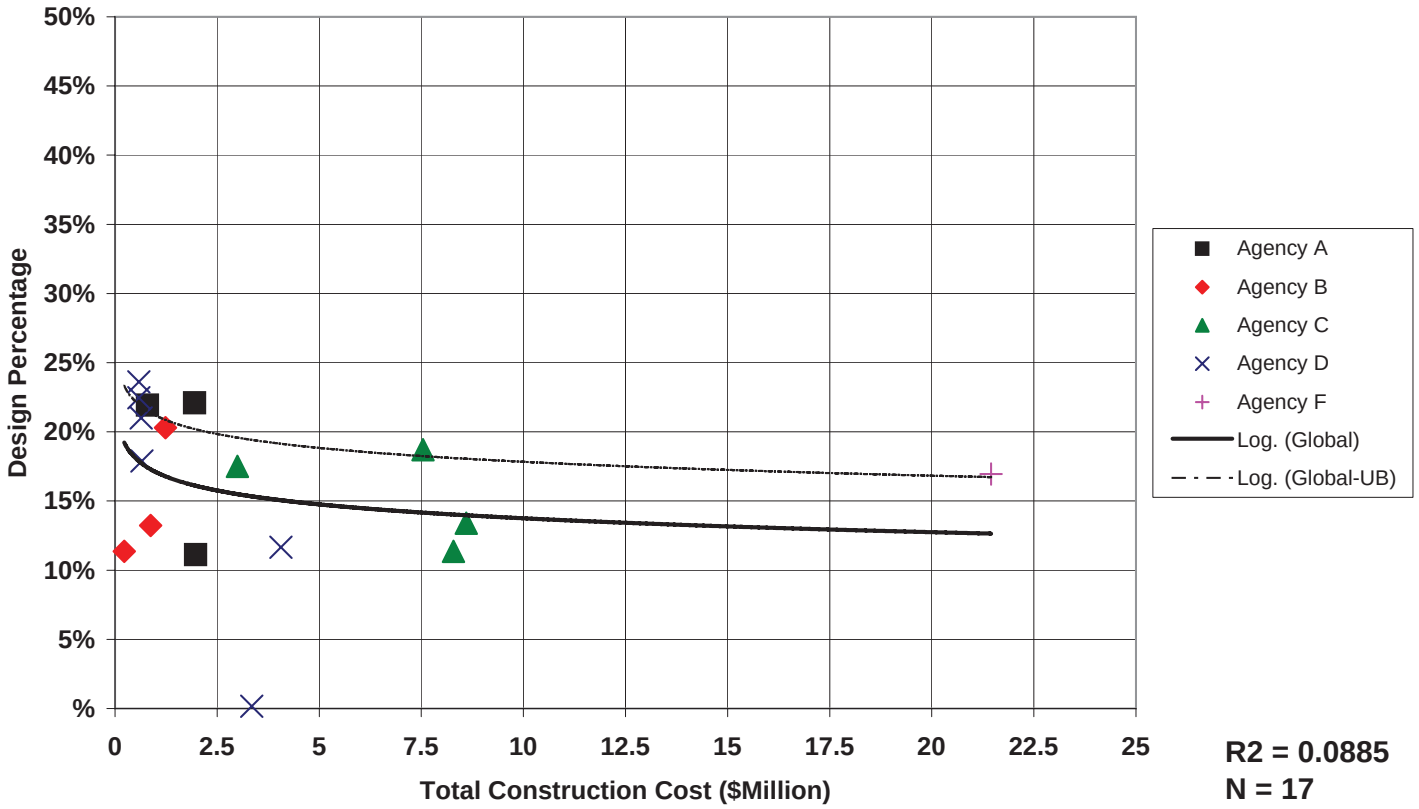
R2 = 0.114
N = 204

Pipe Systems - Pressure Systems
Design Percentage Versus Total Construction Cost



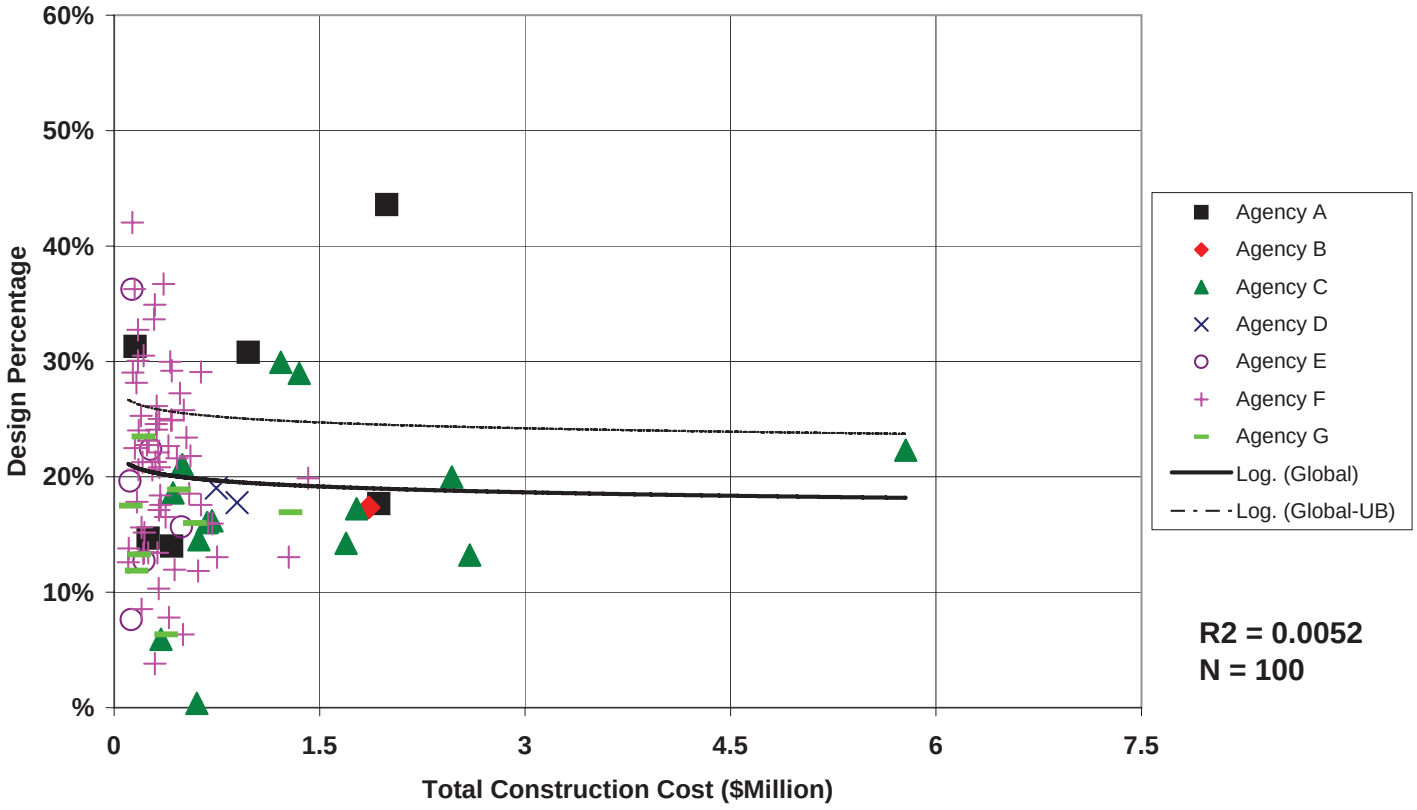
R2 = 5E-06
N = 29

Pipe Systems - Pump Stations
Design Percentage Versus Total Construction Cost



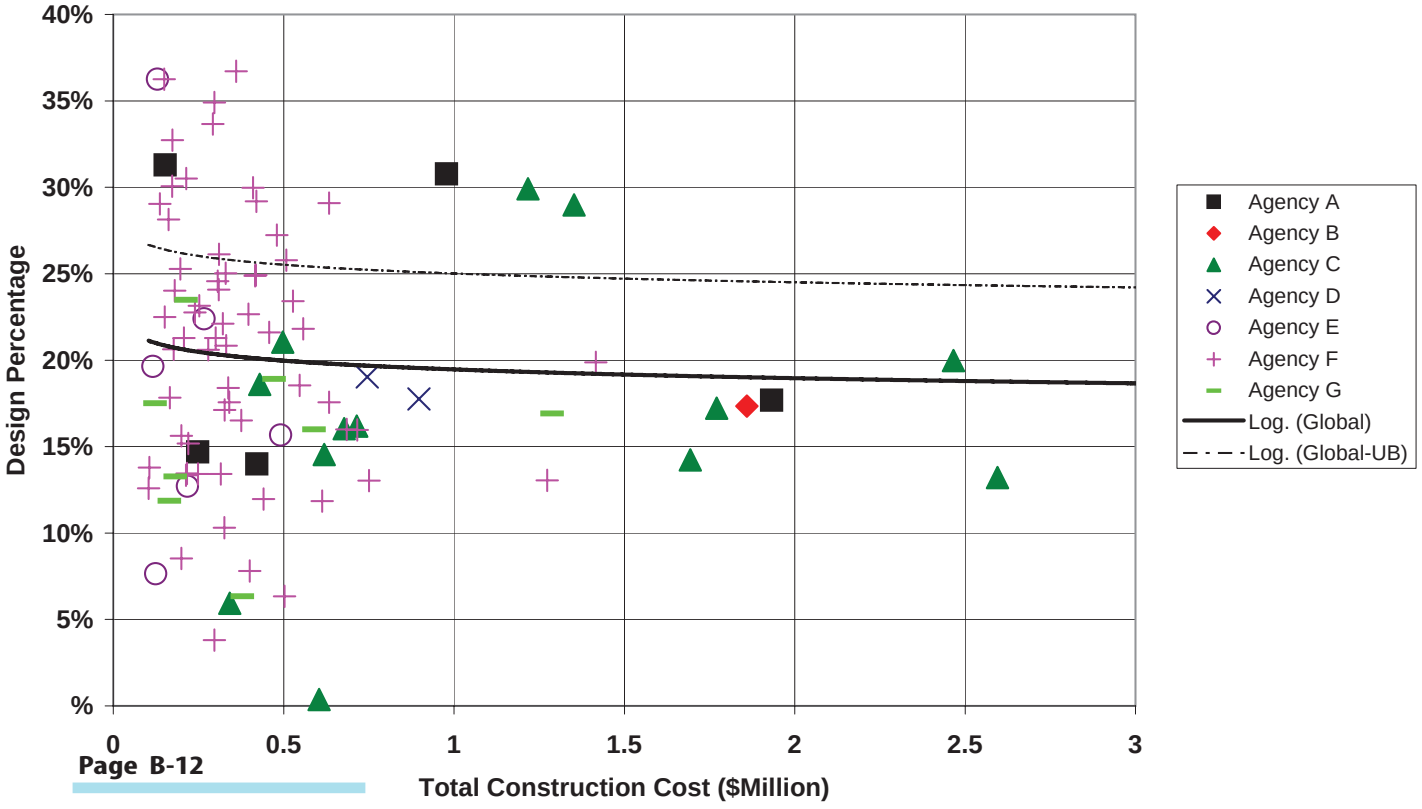
R2 = 0.0885
N = 17

Parks – All Classifications
Design Percentage Versus Total Construction Cost
Full Analysis

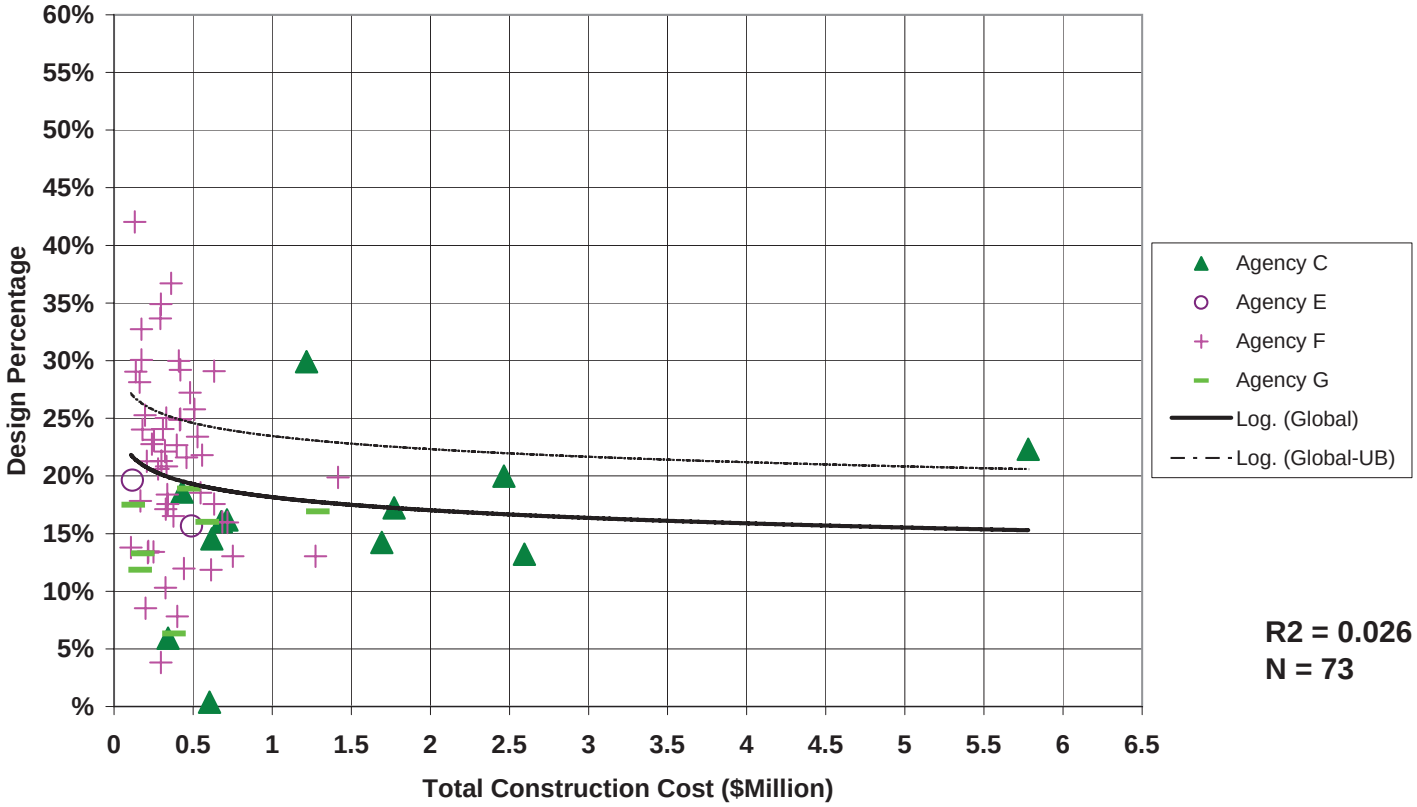


R2 = 0.0052
N = 100

Parks – All Classifications
Design Percentage Versus Total Construction Cost
Zoomed View

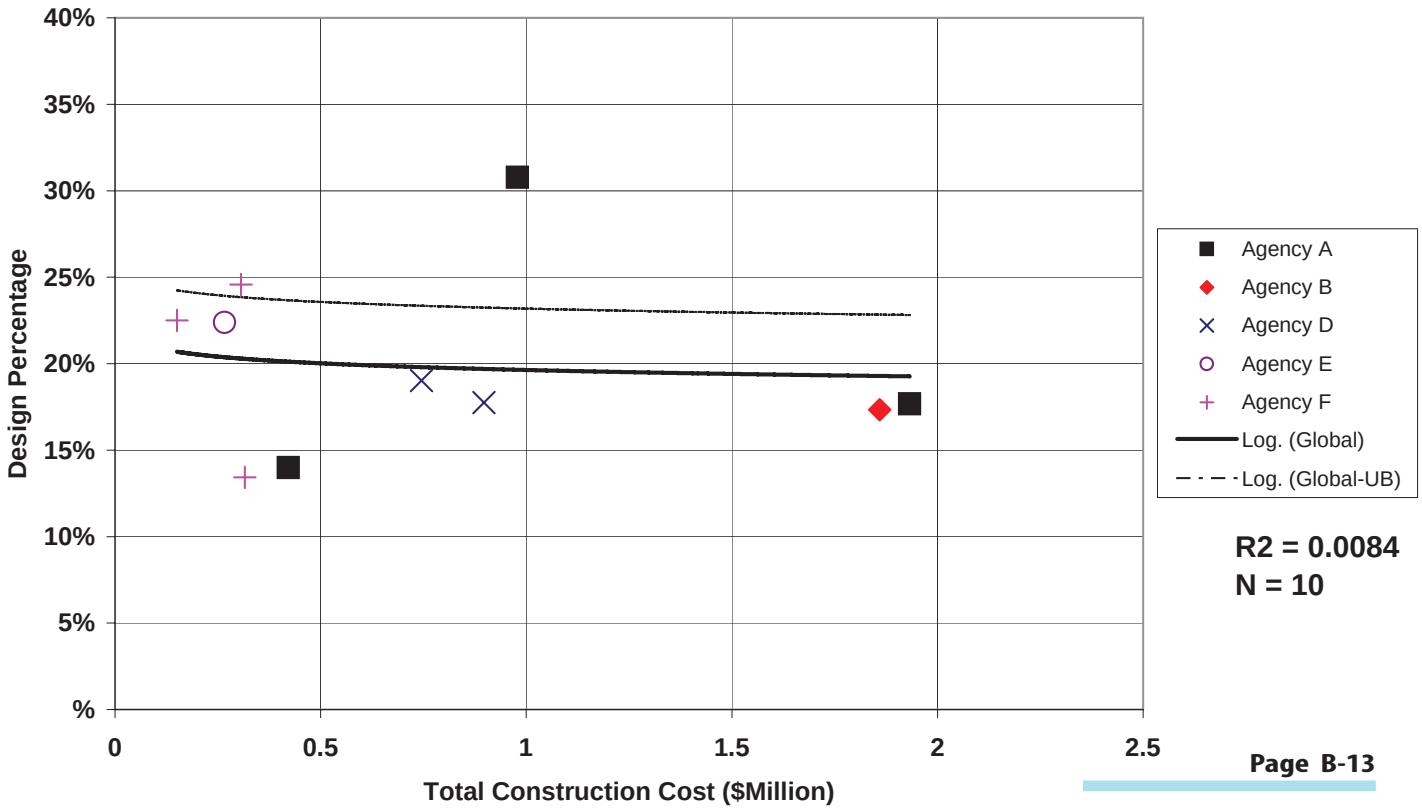


Parks - Playgrounds
Design Percentage Versus Total Construction Cost



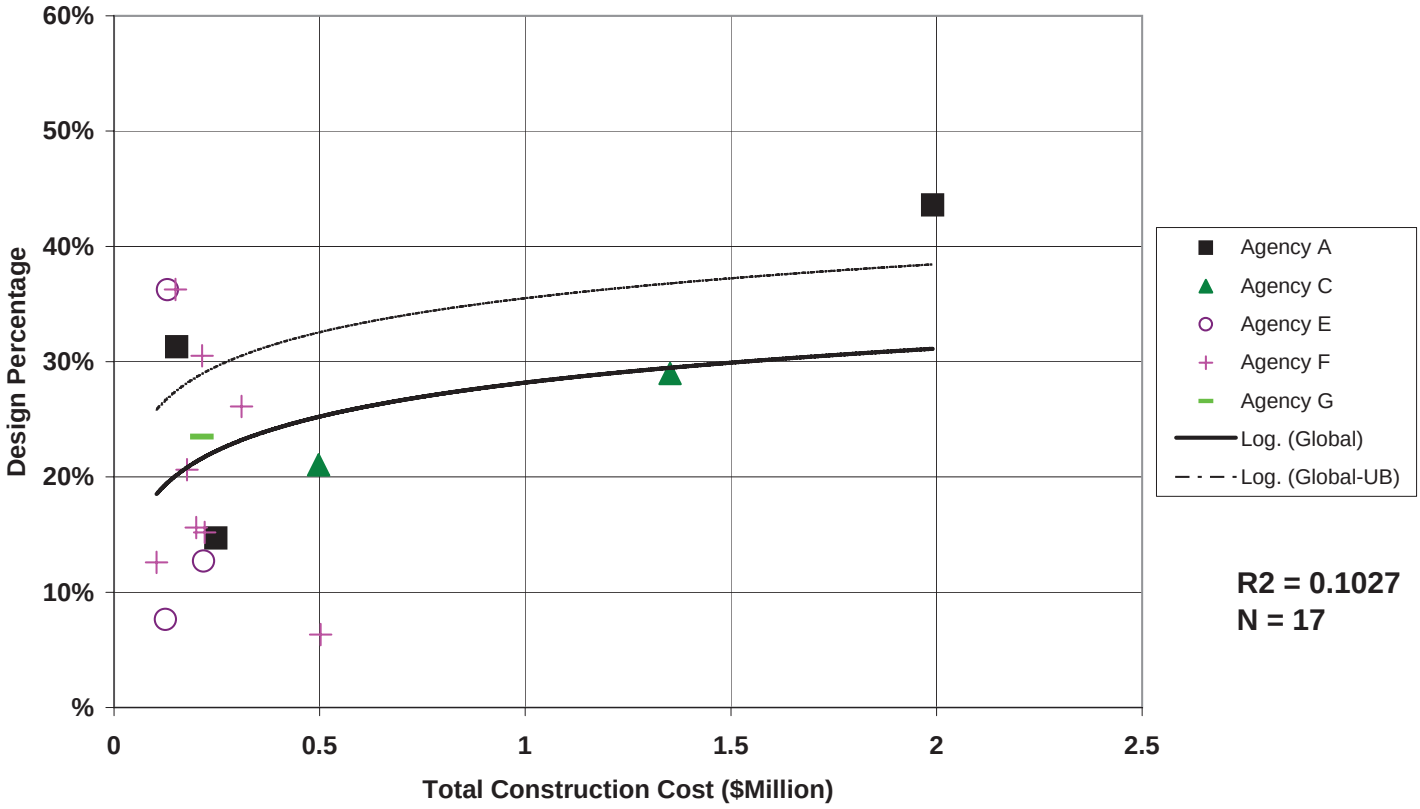
R2 = 0.026
N = 73

Parks - Sportfields
Design Percentage Versus Total Construction Cost



R2 = 0.0084
N = 10

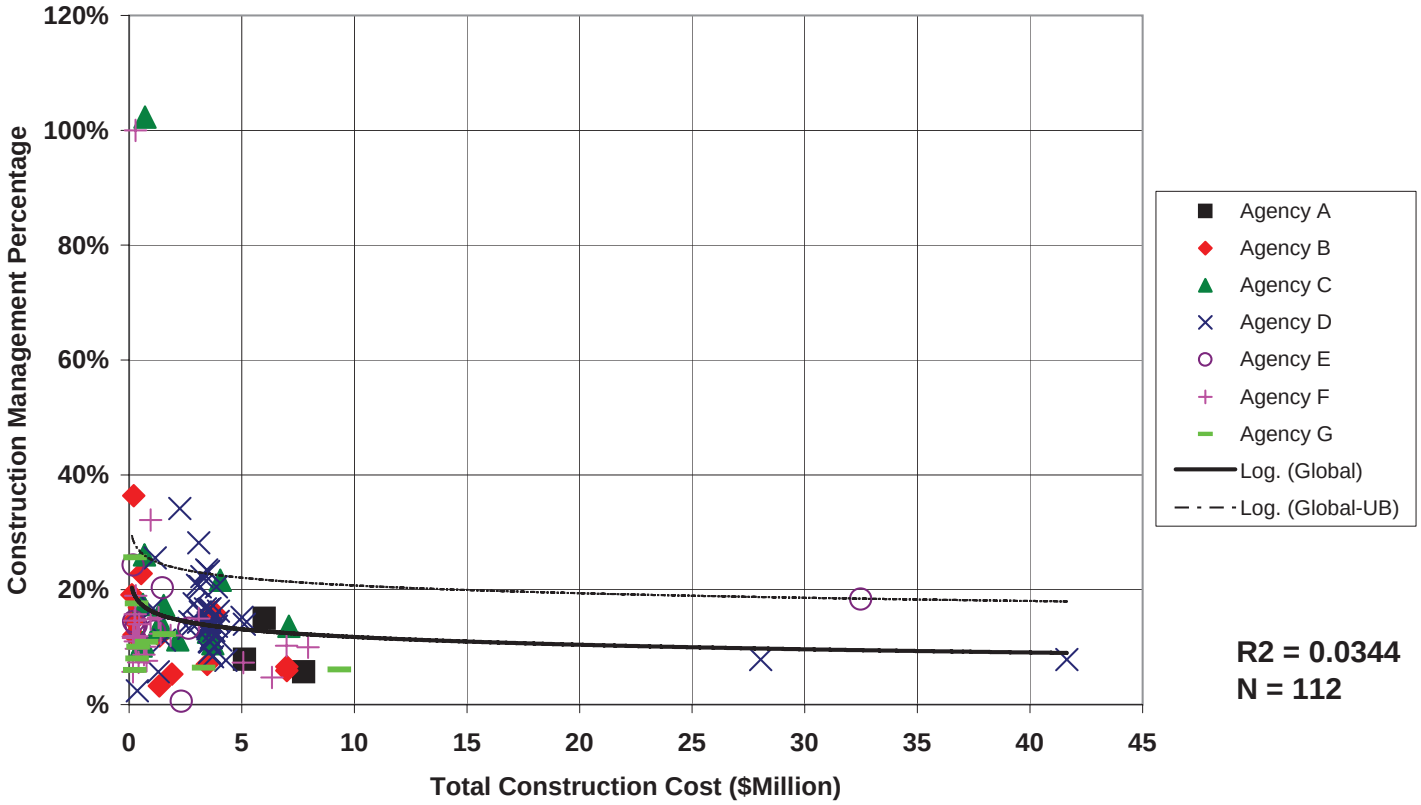
Parks - Restrooms
Design Percentage Versus Total Construction Cost



CURVES GROUP 2

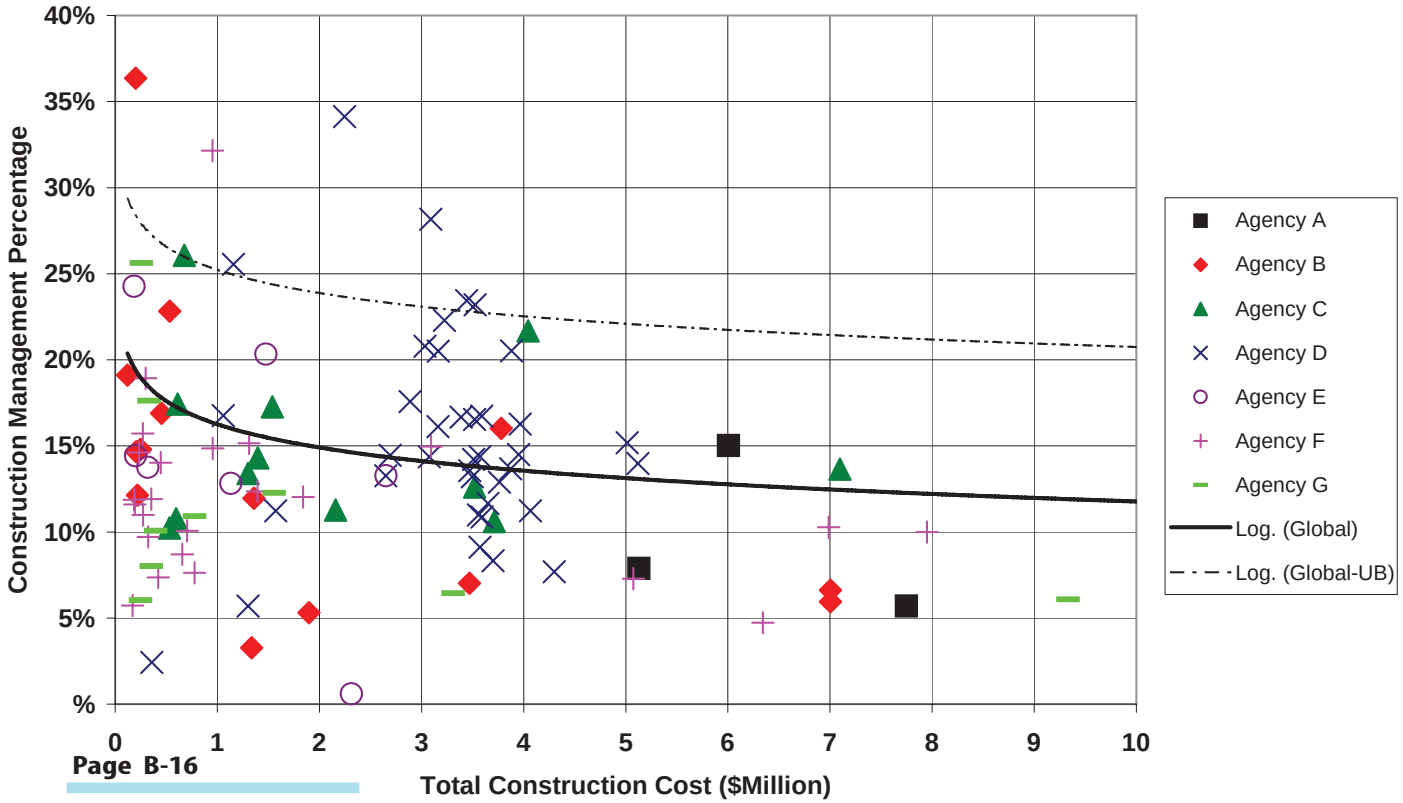
Construction Management as Percentage of Total Construction Cost vs. Total Construction Cost

Municipal Facilities – All Classifications
Construction Management Percentage Versus Total Construction Cost
Full Analysis

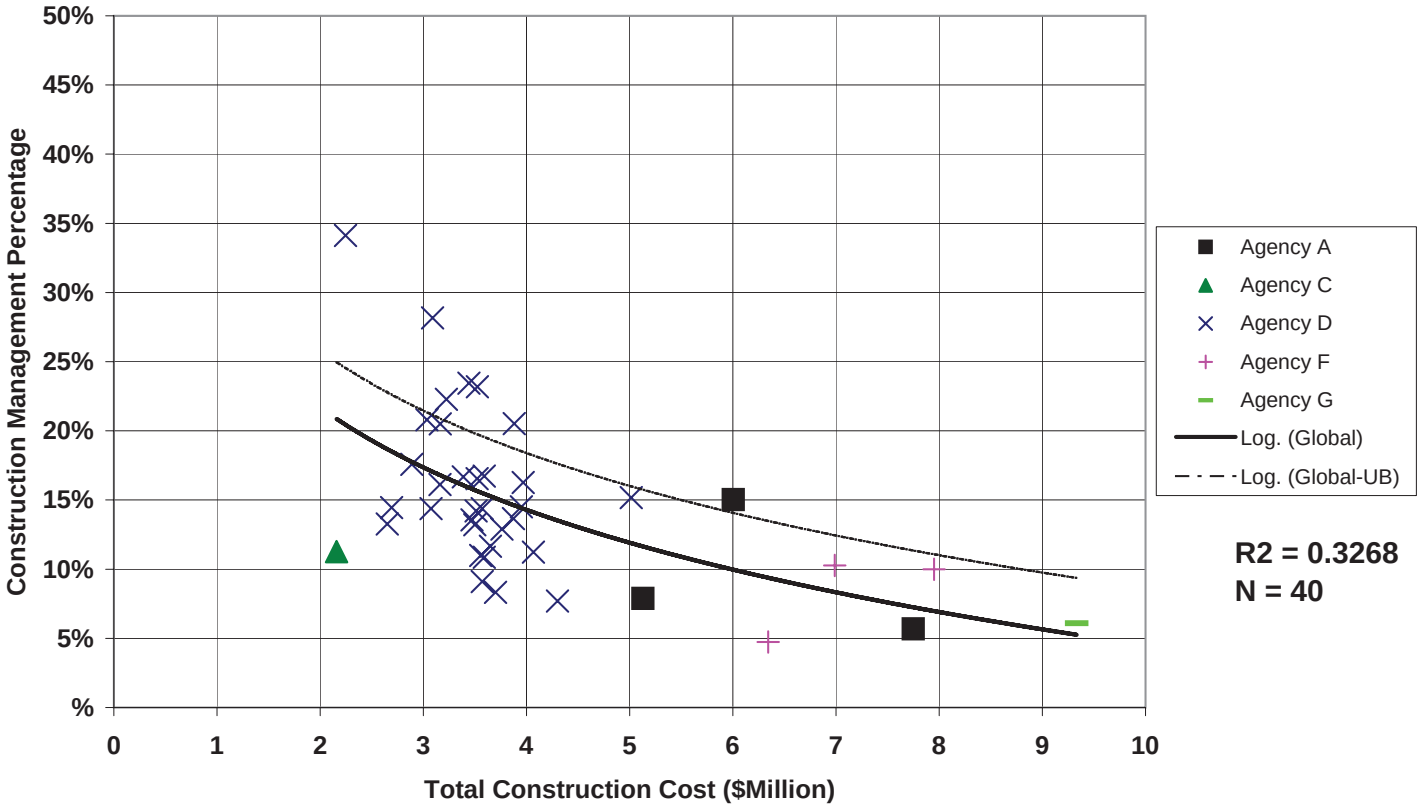


R2 = 0.0344
N = 112

Municipal Facilities – All Classifications
Construction Management Percentage Versus Total Construction Cost
Zoomed View

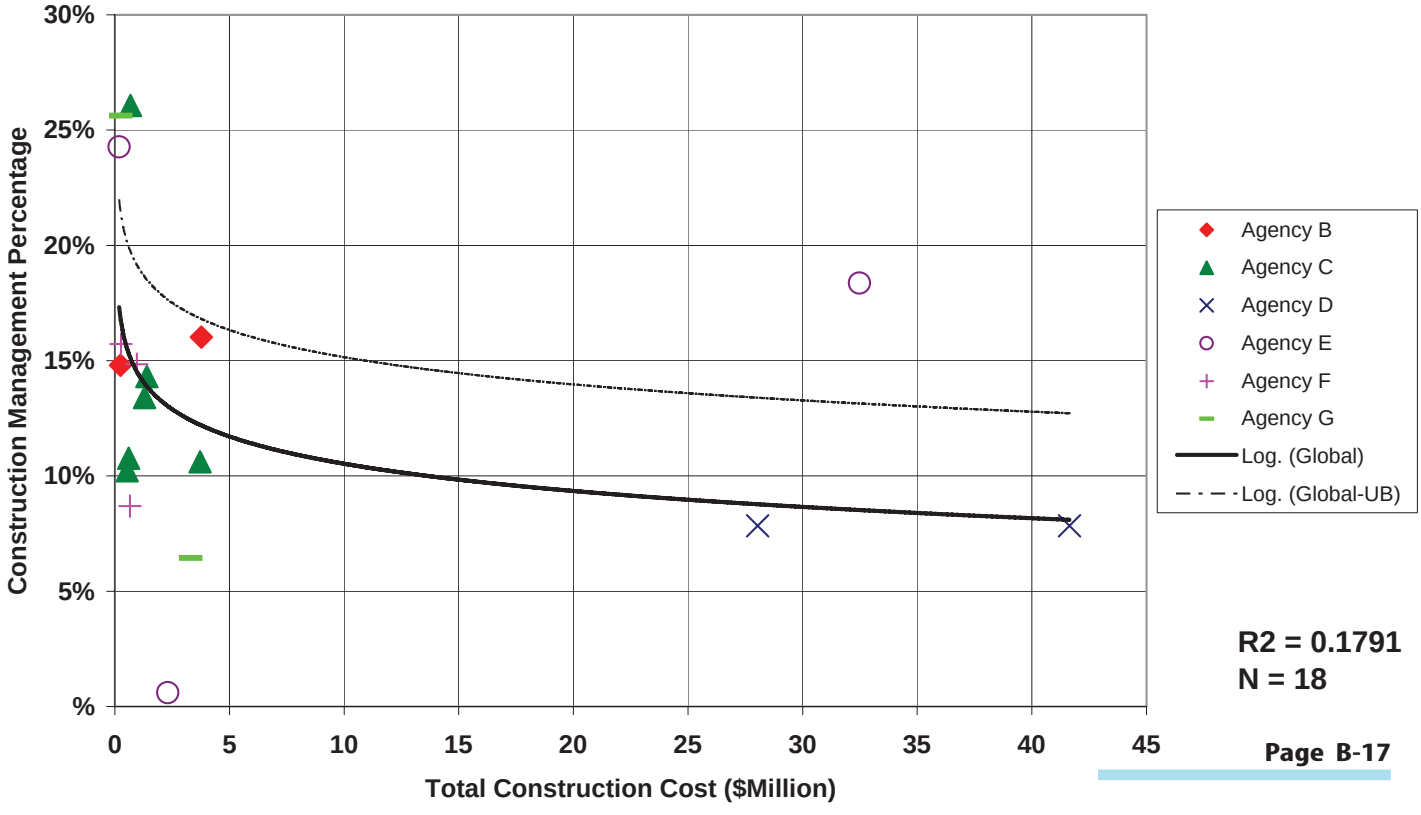


Municipal Facilities - Libraries
Construction Management Percentage Versus Total Construction Cost



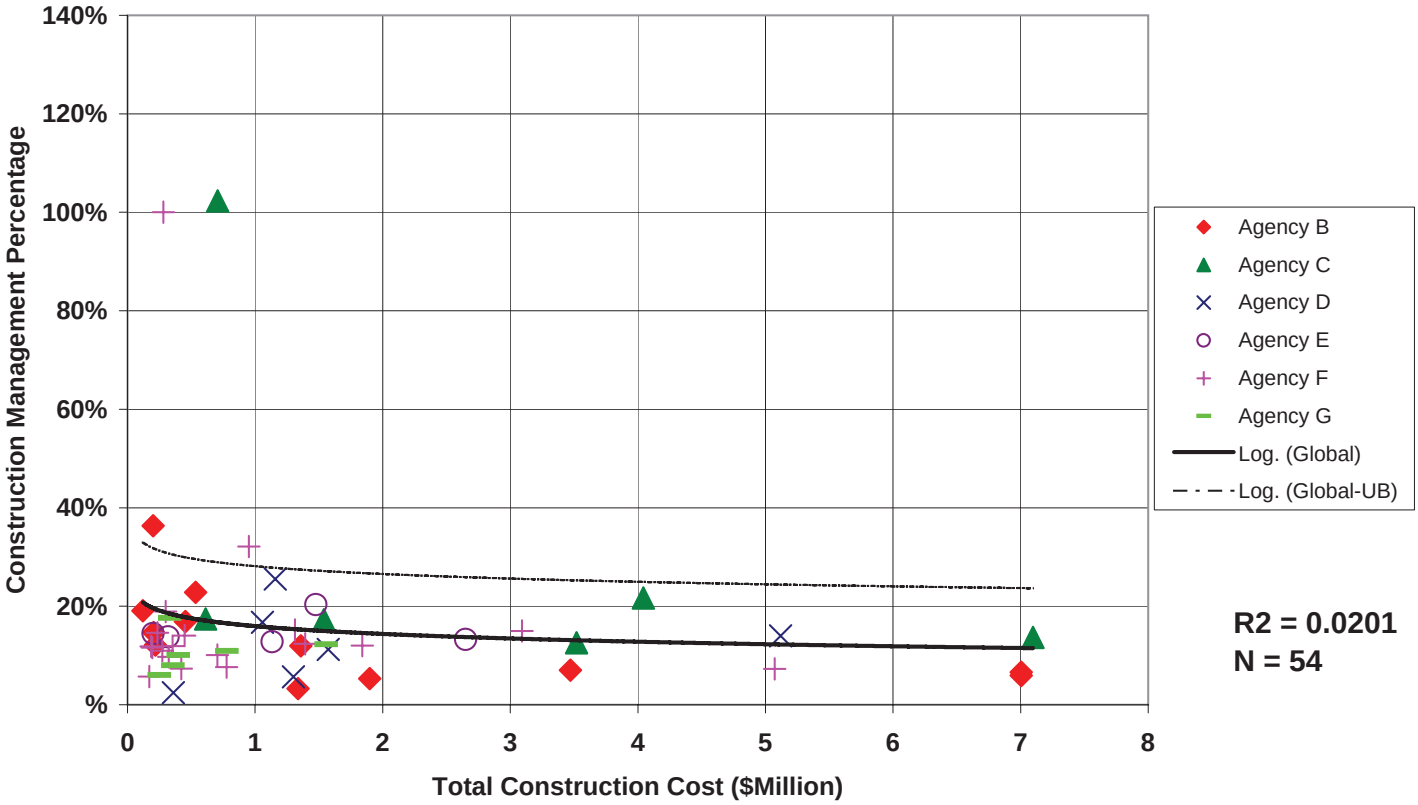
R2 = 0.3268
N = 40

Municipal Facilities - Police/Fire Station
Construction Management Percentage Versus Total Construction Cost

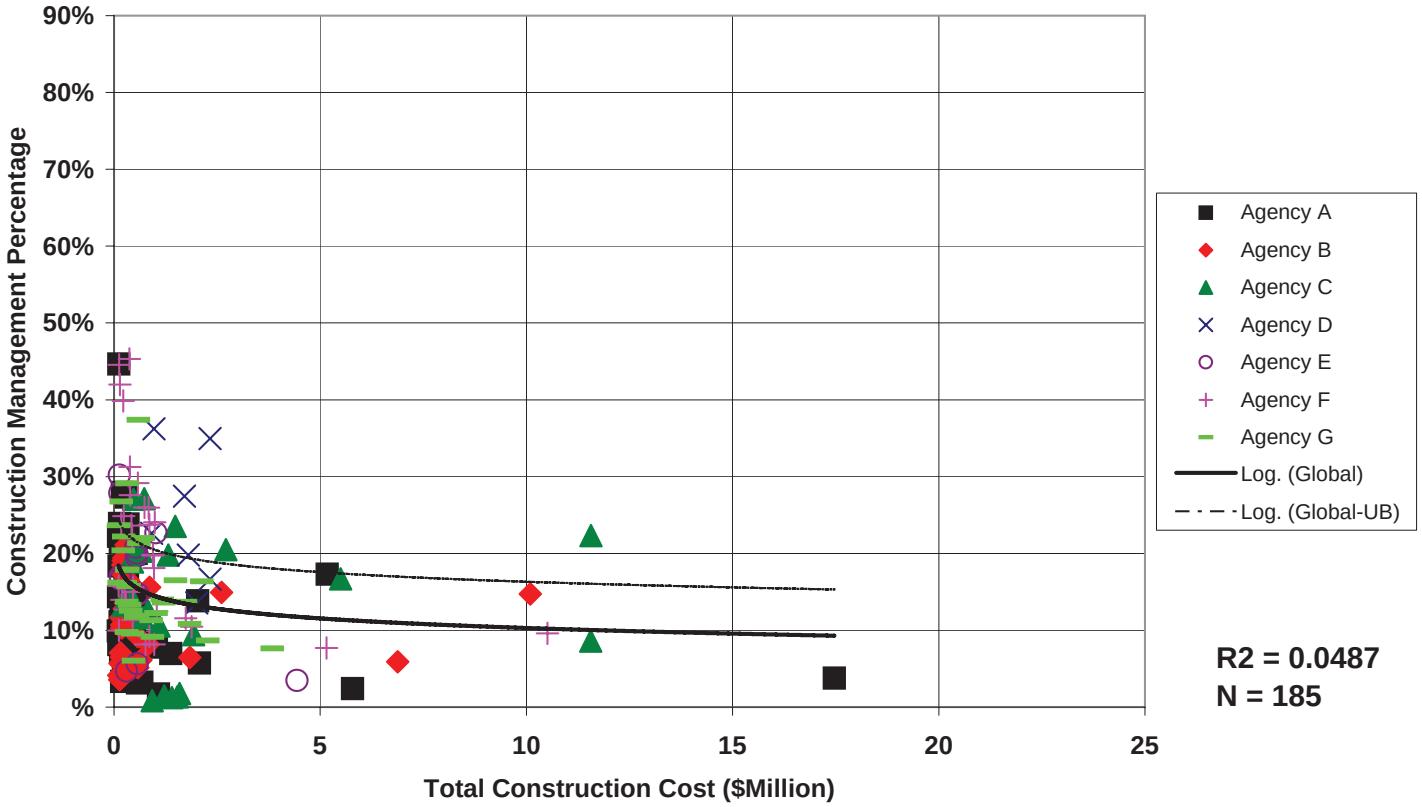


R2 = 0.1791
N = 18

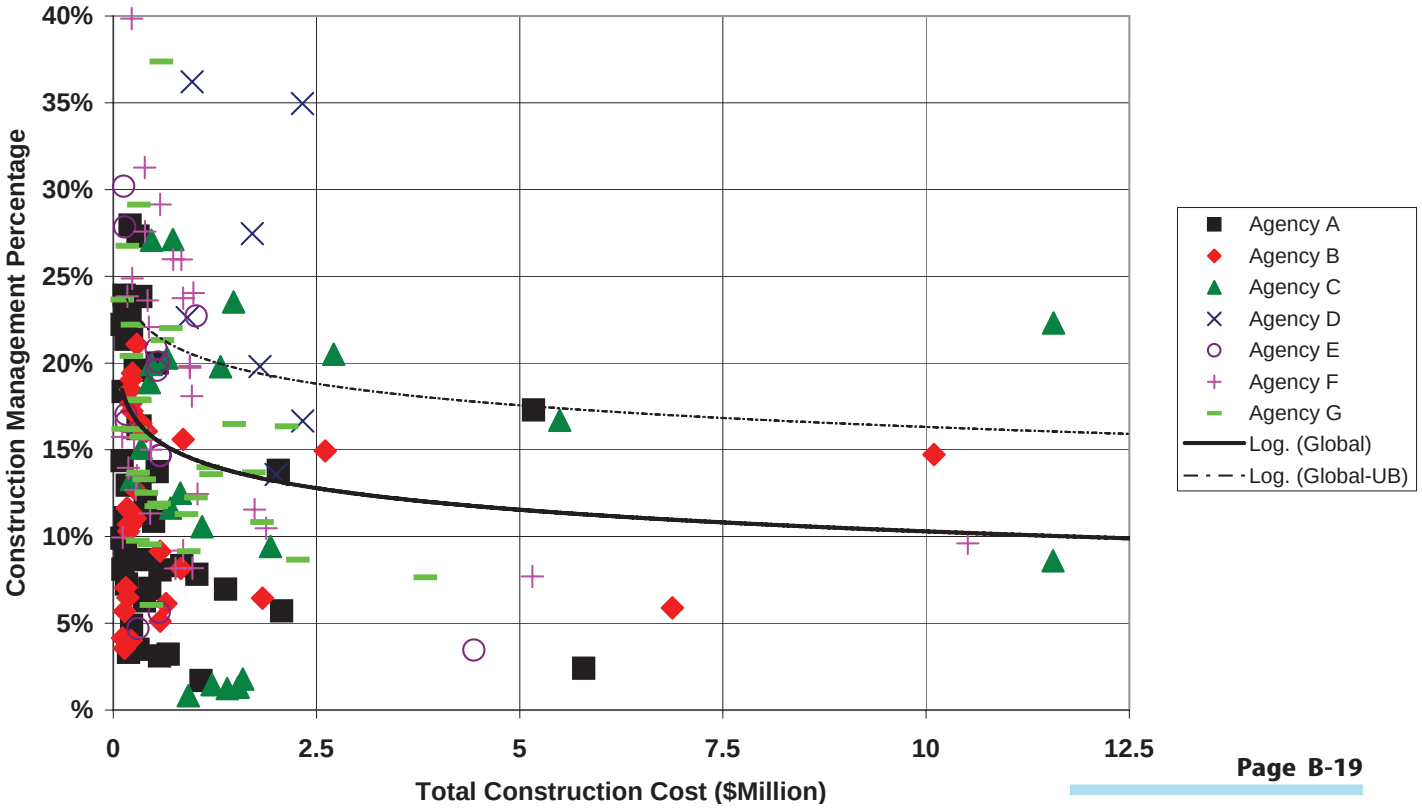
Municipal Facilities - Comm./Rec. Center/Child Care/Gym
Construction Management Percentage Versus Total Construction Cost



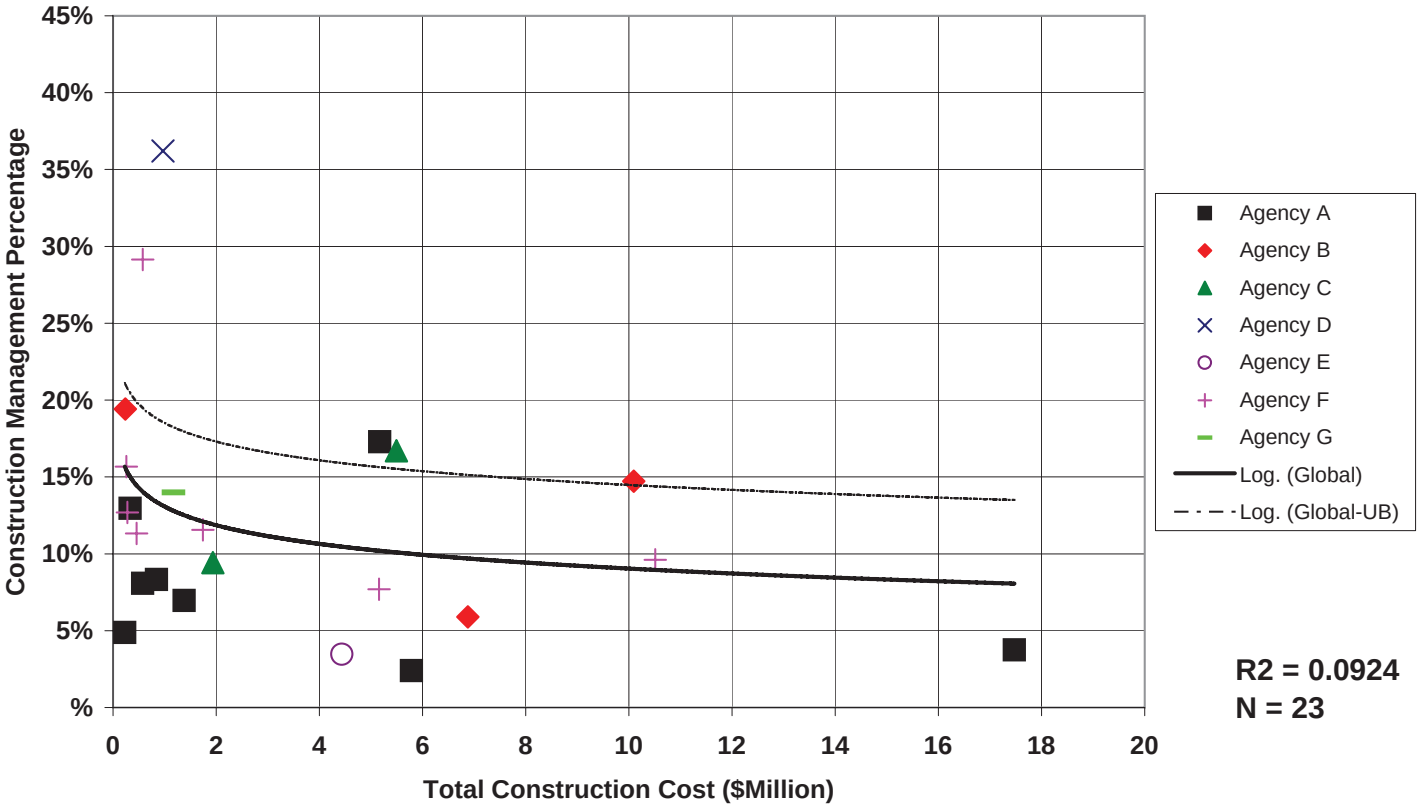
Streets – All Classifications
Construction Management Percentage Versus Total Construction Cost
Full Analysis



Streets – All Classifications
Construction Management Percentage Versus Total Construction Cost
Zoomed View

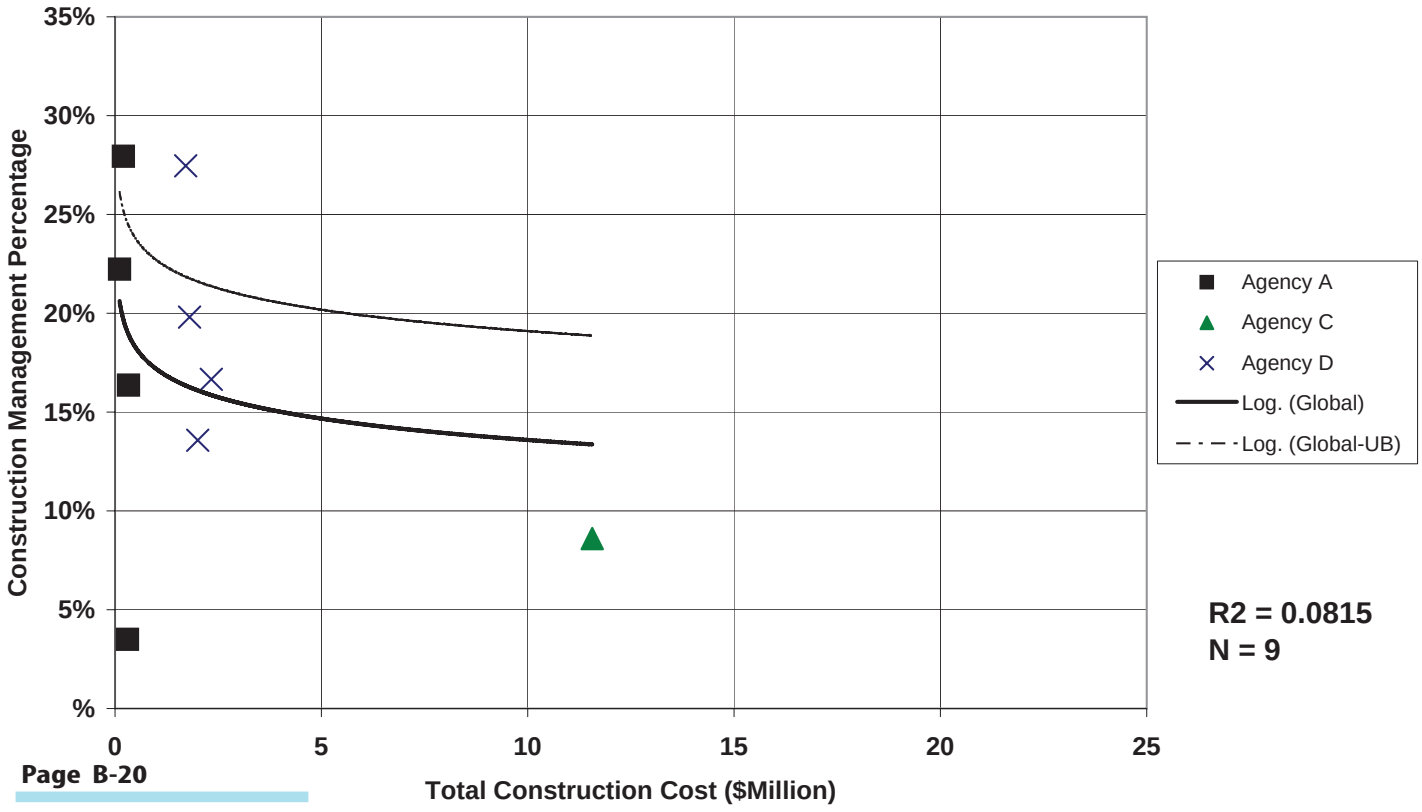


Streets - Widening/New/Grade Separation
Construction Management Percentage Versus Total Construction Cost



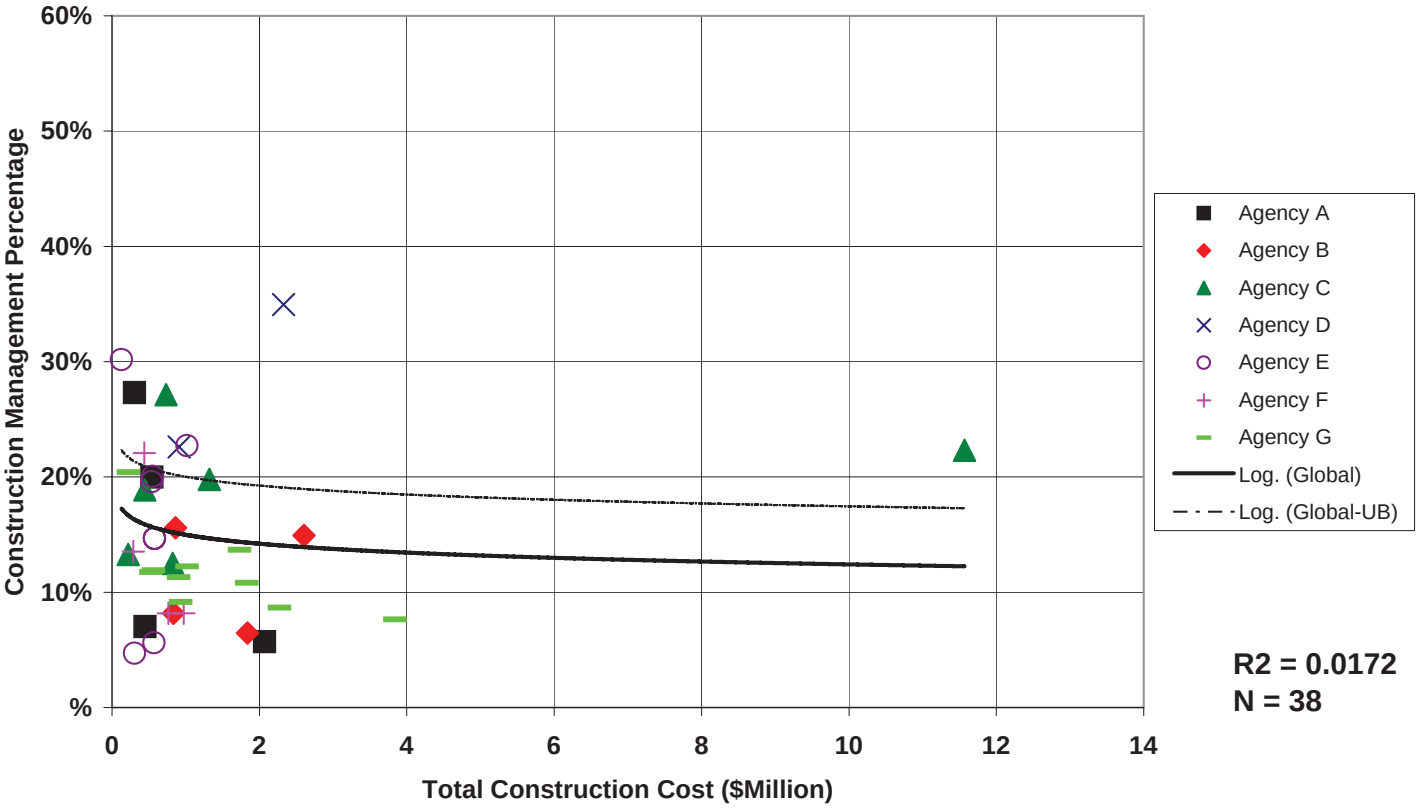
R2 = 0.0924
N = 23

Streets - Bridges (New/Retrofit)
Construction Management Percentage Versus Total Construction Cost



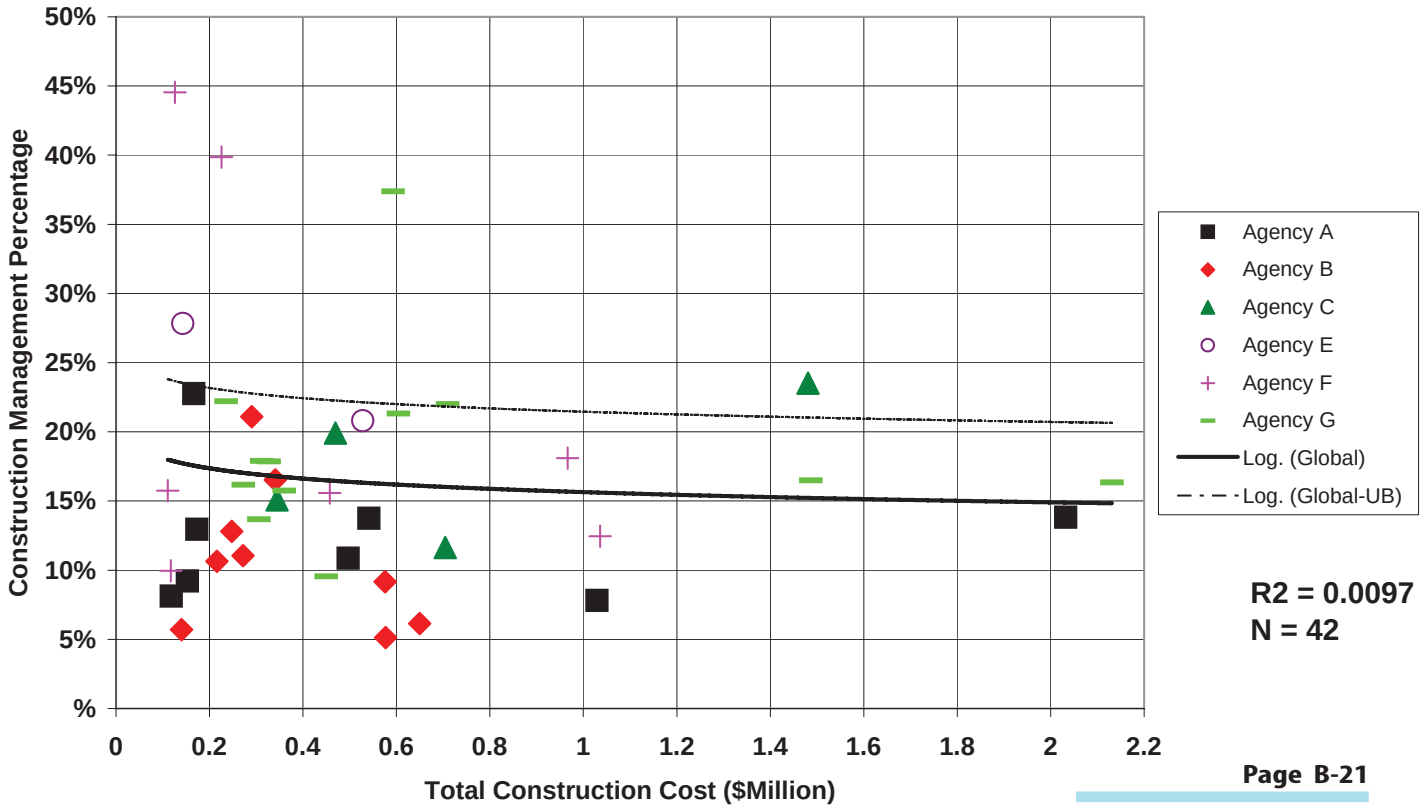
R2 = 0.0815
N = 9

Streets - Reconstruction
Construction Management Percentage Versus Total Construction Cost



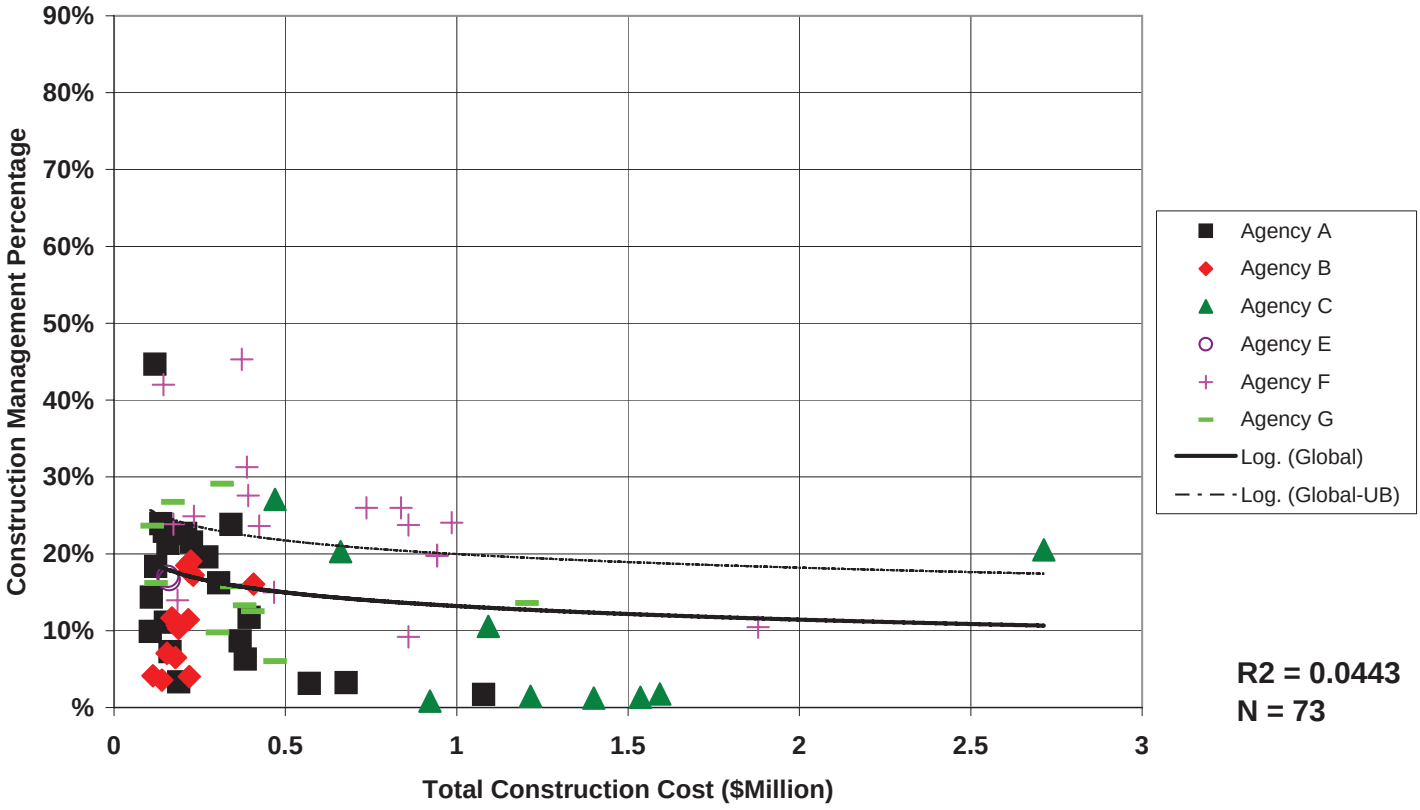
R2 = 0.0172
N = 38

Streets - Bike/Pedestrian/Streetscapes
Construction Management Percentage Versus Total Construction Cost

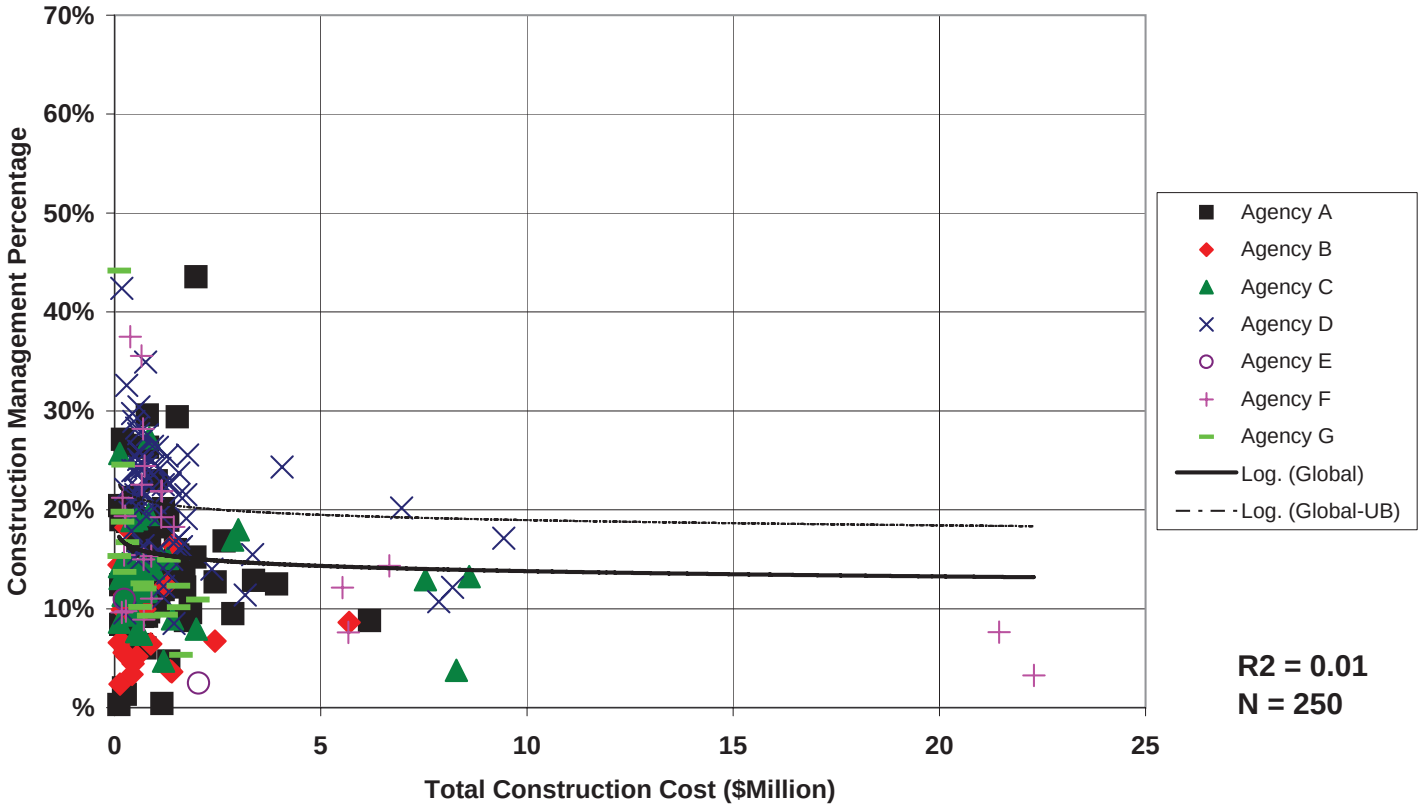


R2 = 0.0097
N = 42

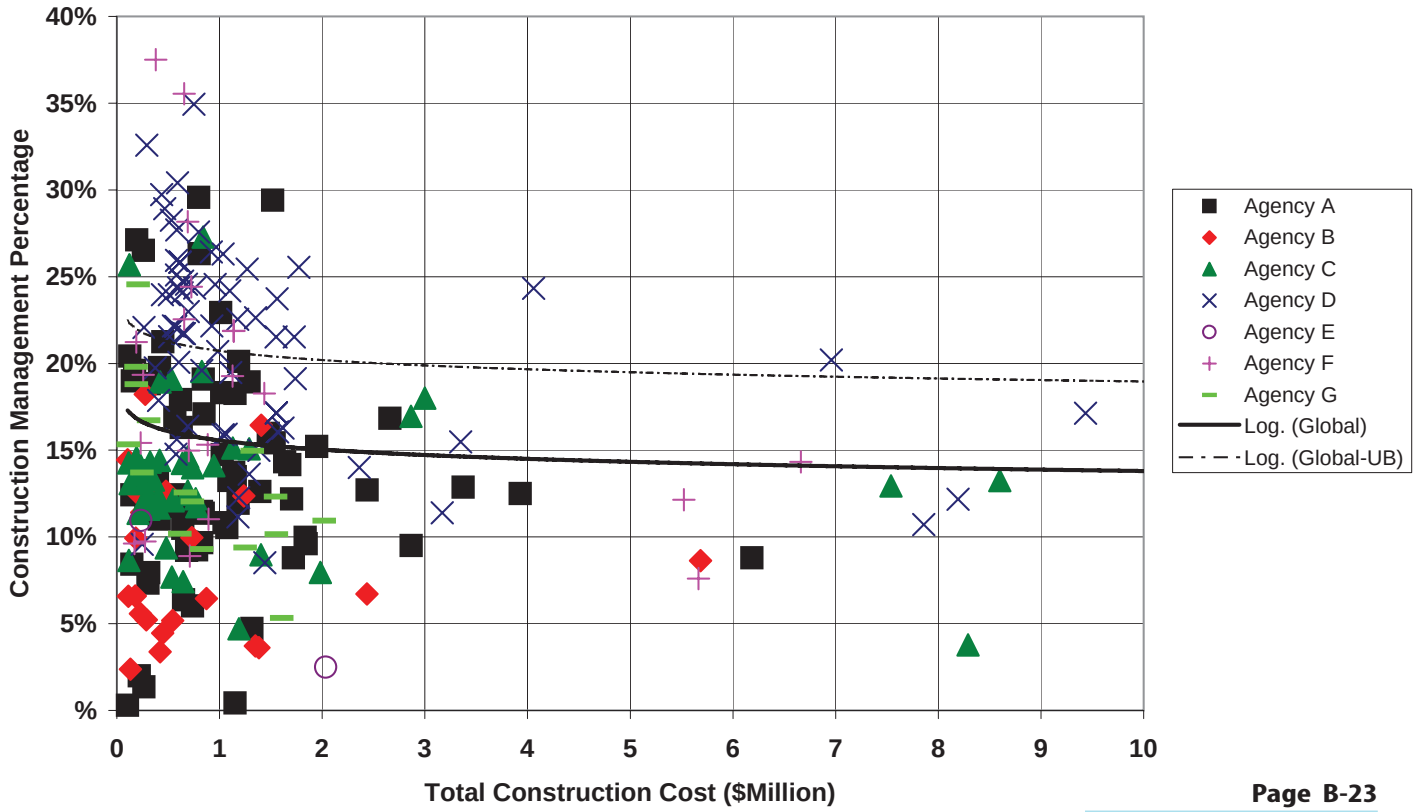
Streets - Signals
Construction Management Percentage Versus Total Construction Cost



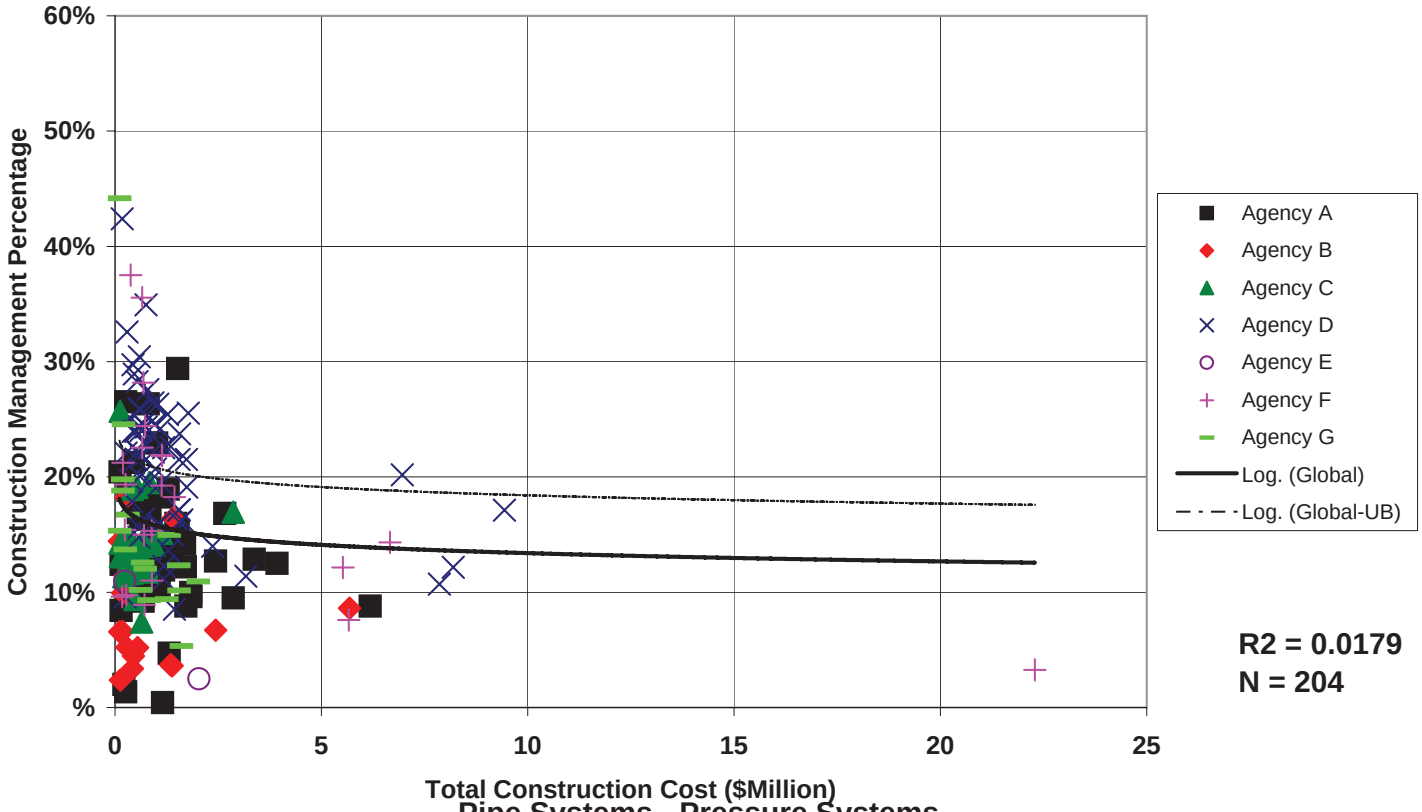
Pipe Systems – All Classifications
Construction Management Percentage Versus Total Construction Cost
Full Analysis



Pipe Systems – All Classifications
Construction Management Percentage Versus Total Construction Cost
Zoomed View

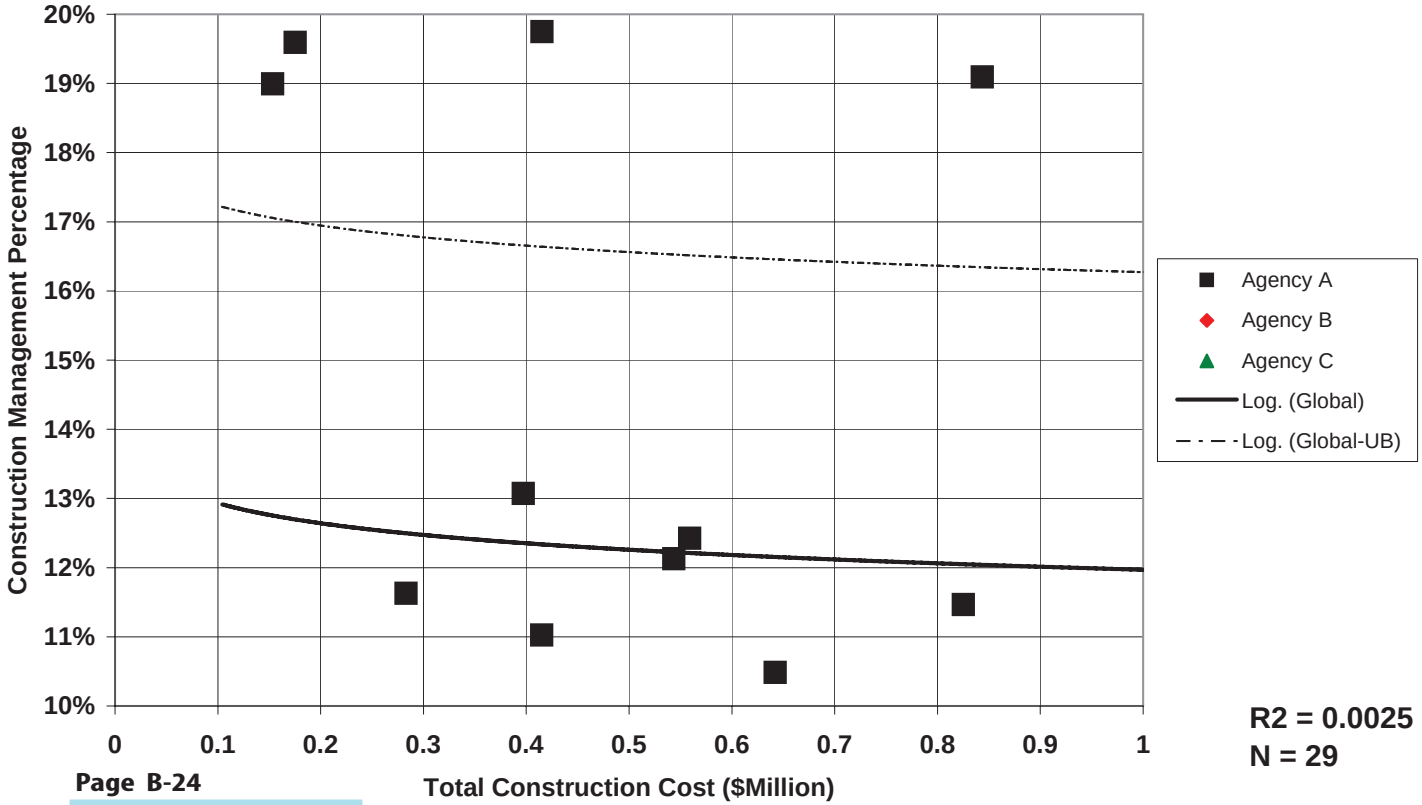


Pipe Systems - Gravity System (Storm Drains/Sewers)
Construction Management Percentage Versus Total Construction Cost



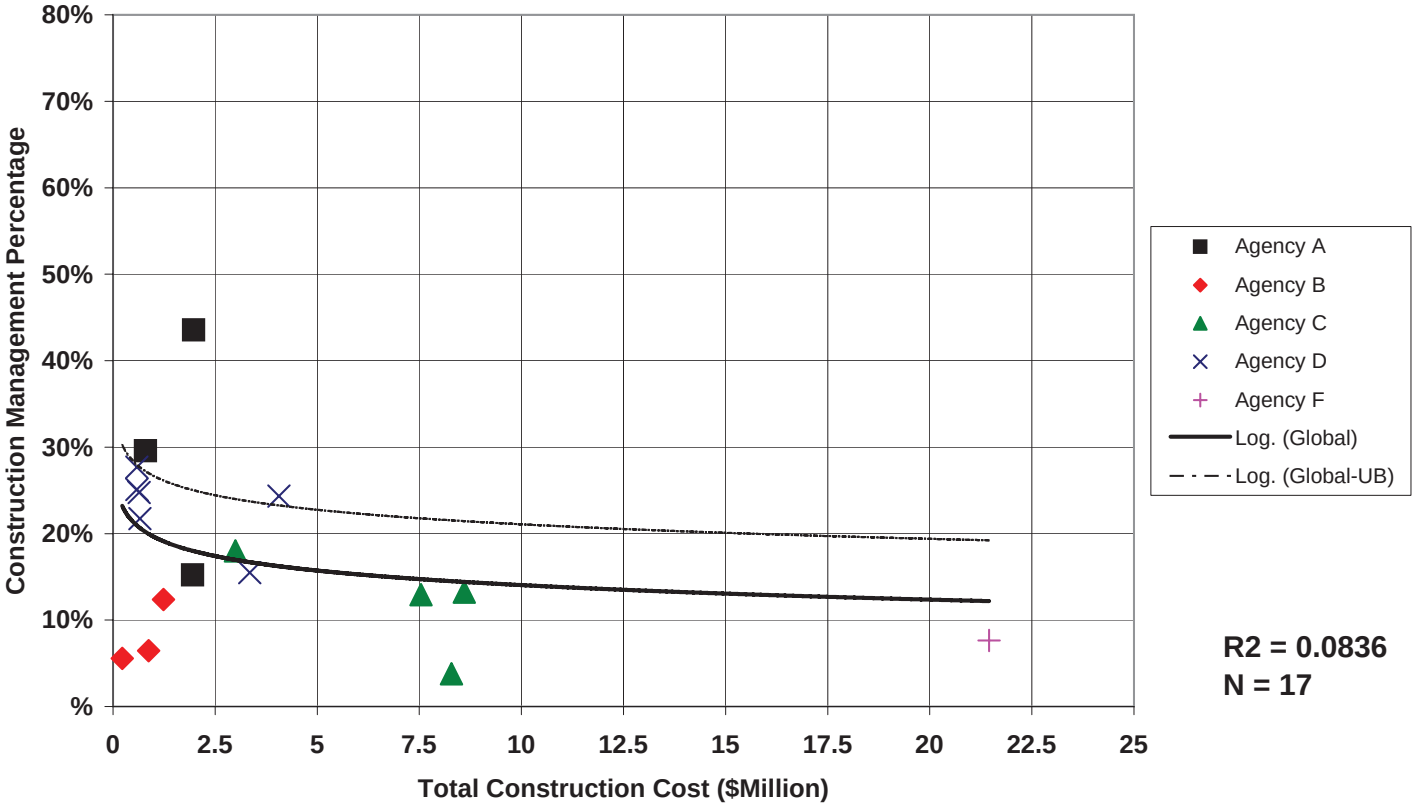
R2 = 0.0179
N = 204

Pipe Systems - Pressure Systems
Construction Management Percentage Versus Total Construction Cost

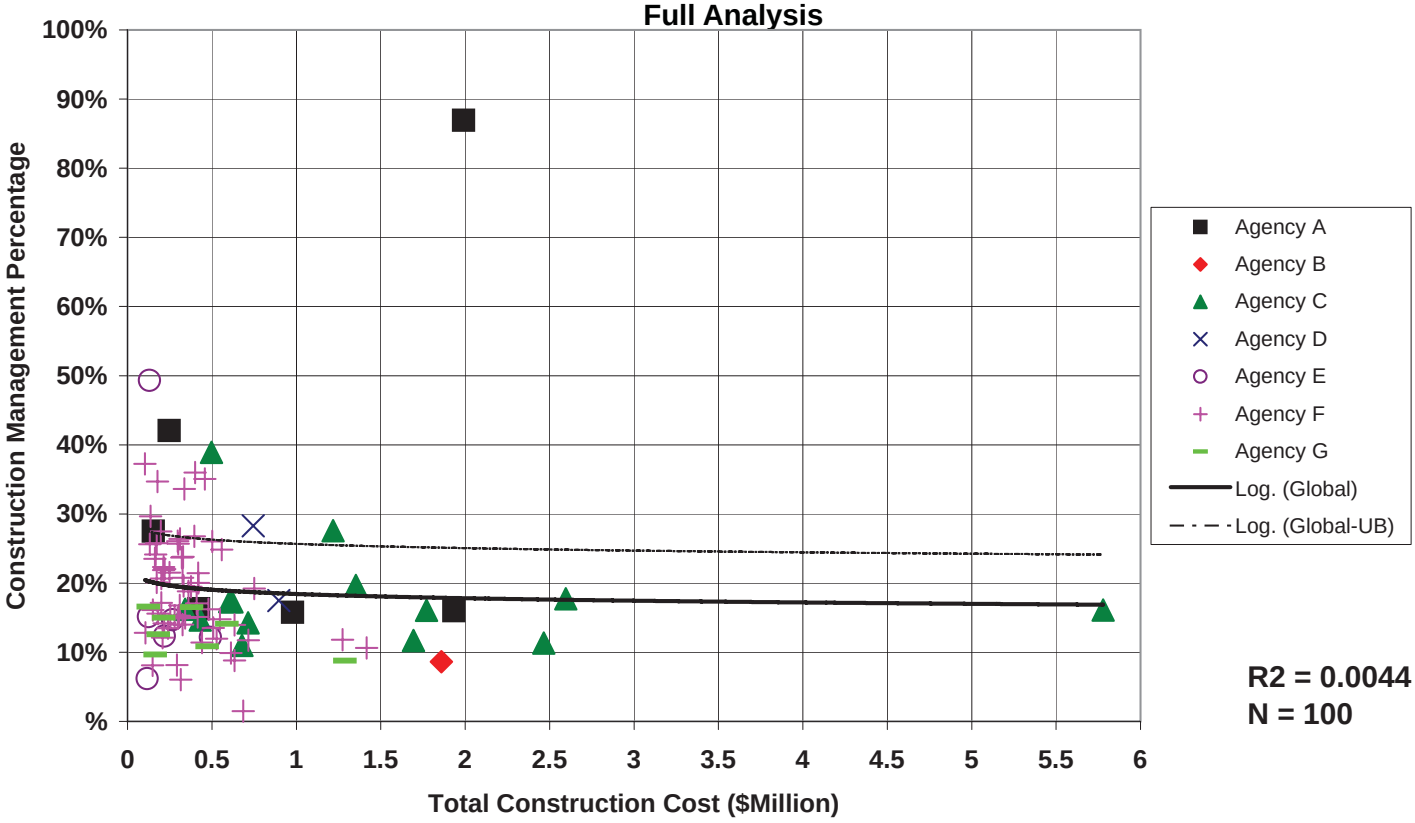


R2 = 0.0025
N = 29

Pipe Systems - Pump Stations
Construction Management Percentage Versus Total Construction Cost

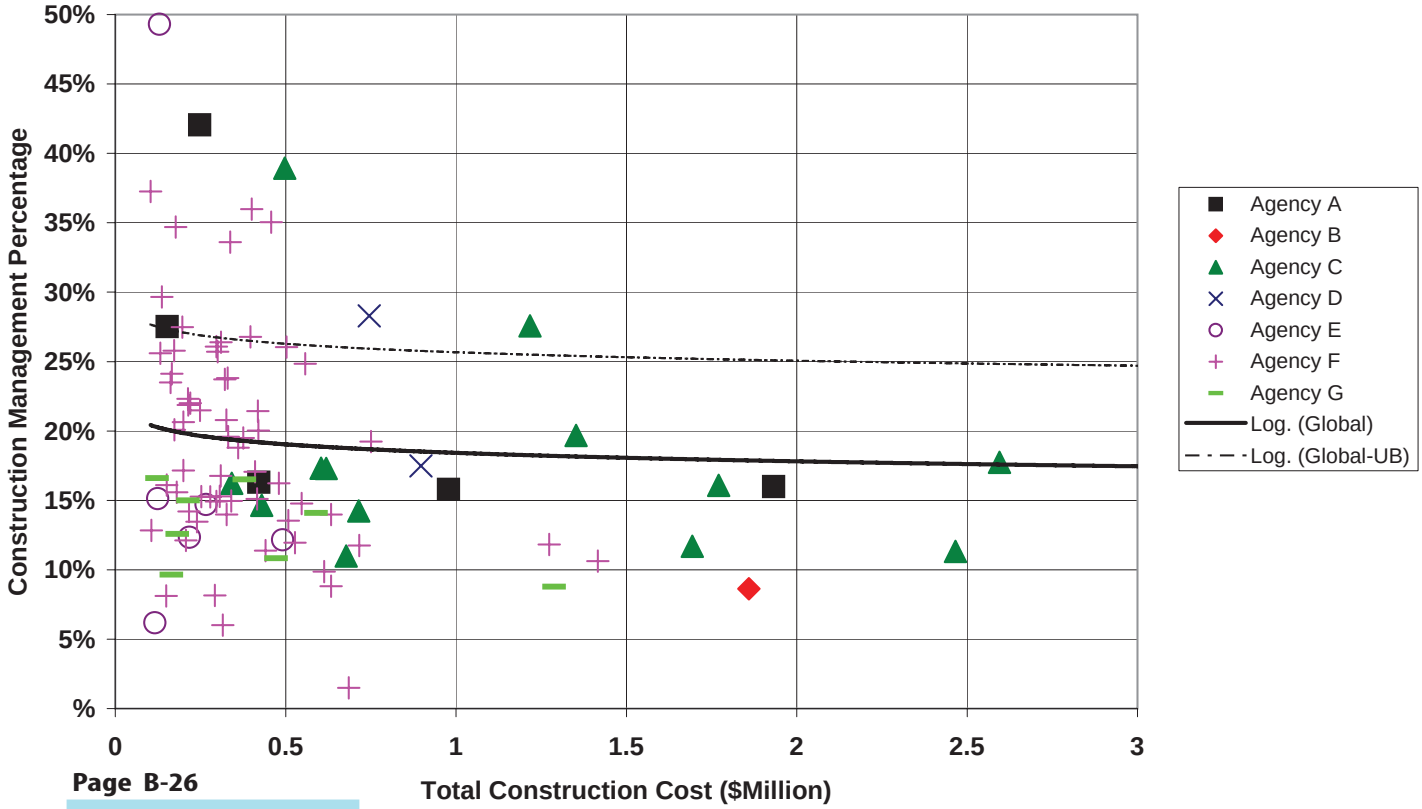


Parks – All Classifications
Construction Management Percentage Versus Total Construction Cost
Full Analysis

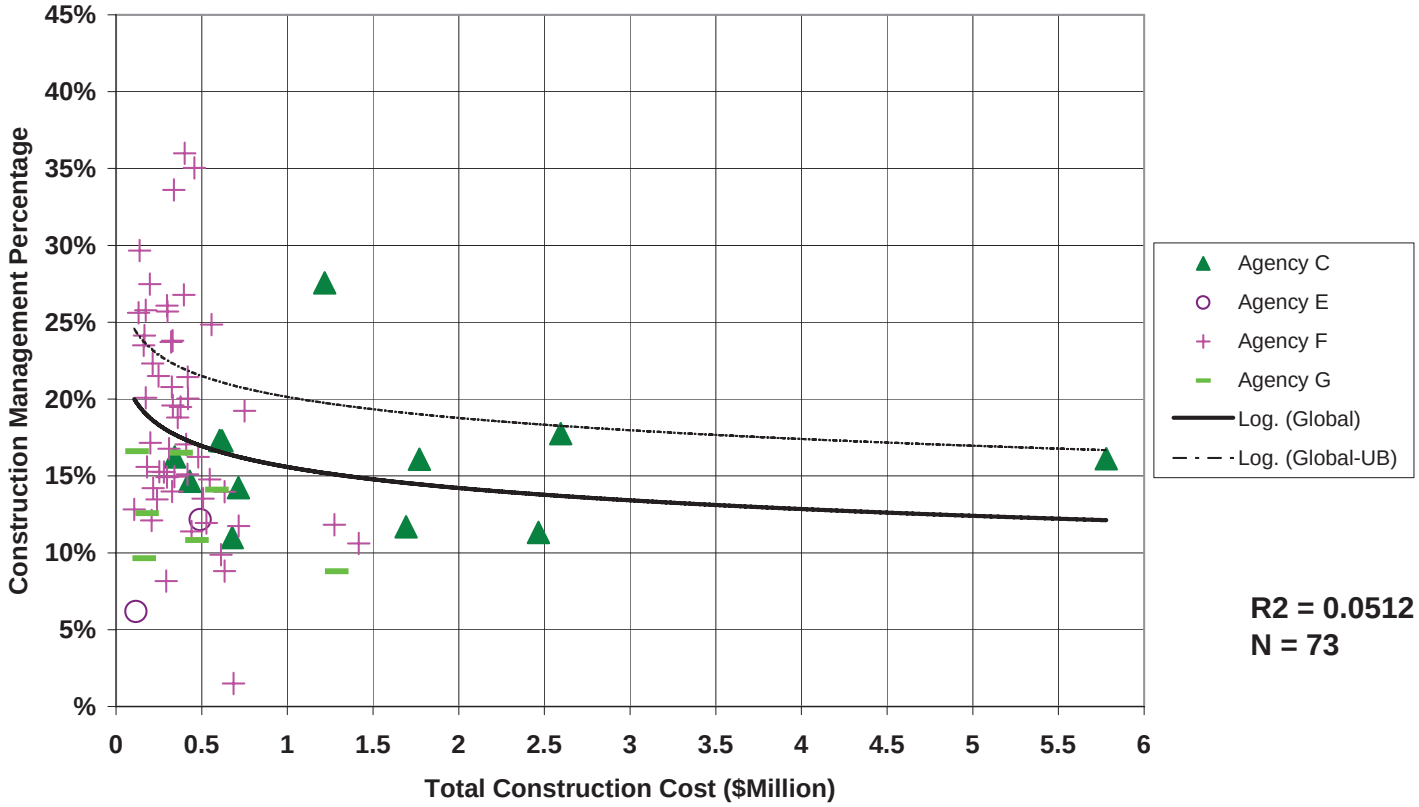


R2 = 0.0044
N = 100

Parks – All Classifications
Construction Management Percentage Versus Total Construction Cost
Zoomed View

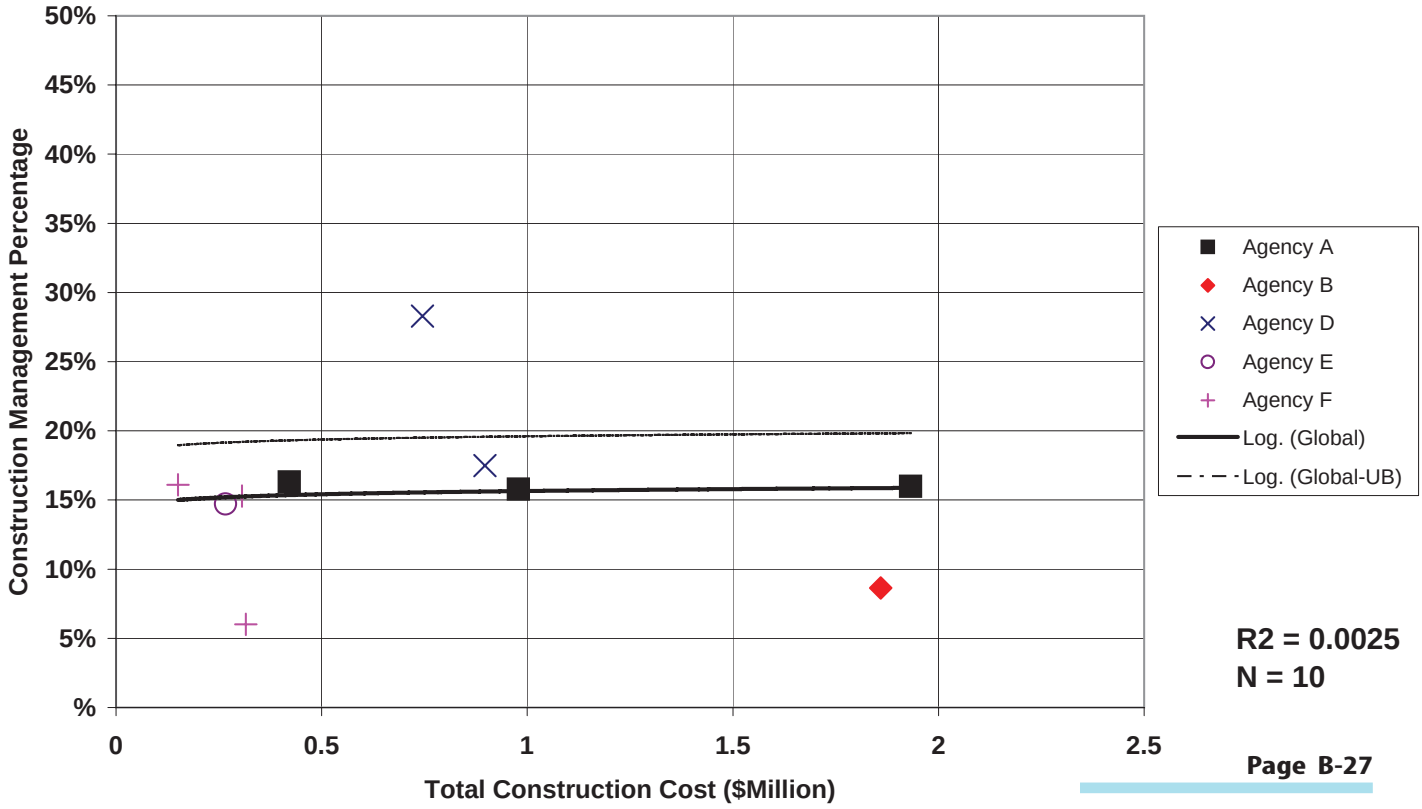


Parks - Playgrounds
Construction Management Percentage Versus Total Construction Cost



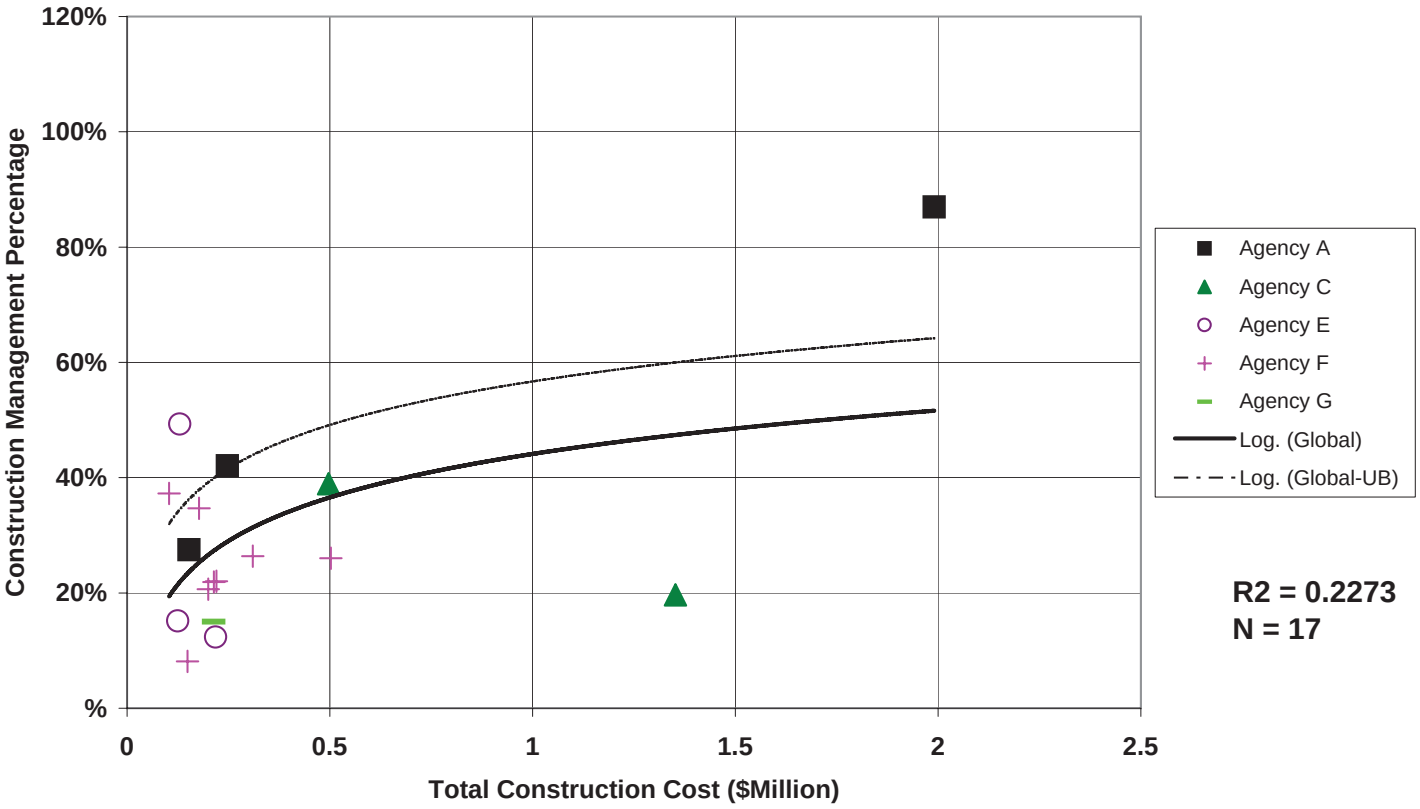
R2 = 0.0512
N = 73

Parks - Sportfields
Construction Management Percentage Versus Total Construction Cost



R2 = 0.0025
N = 10

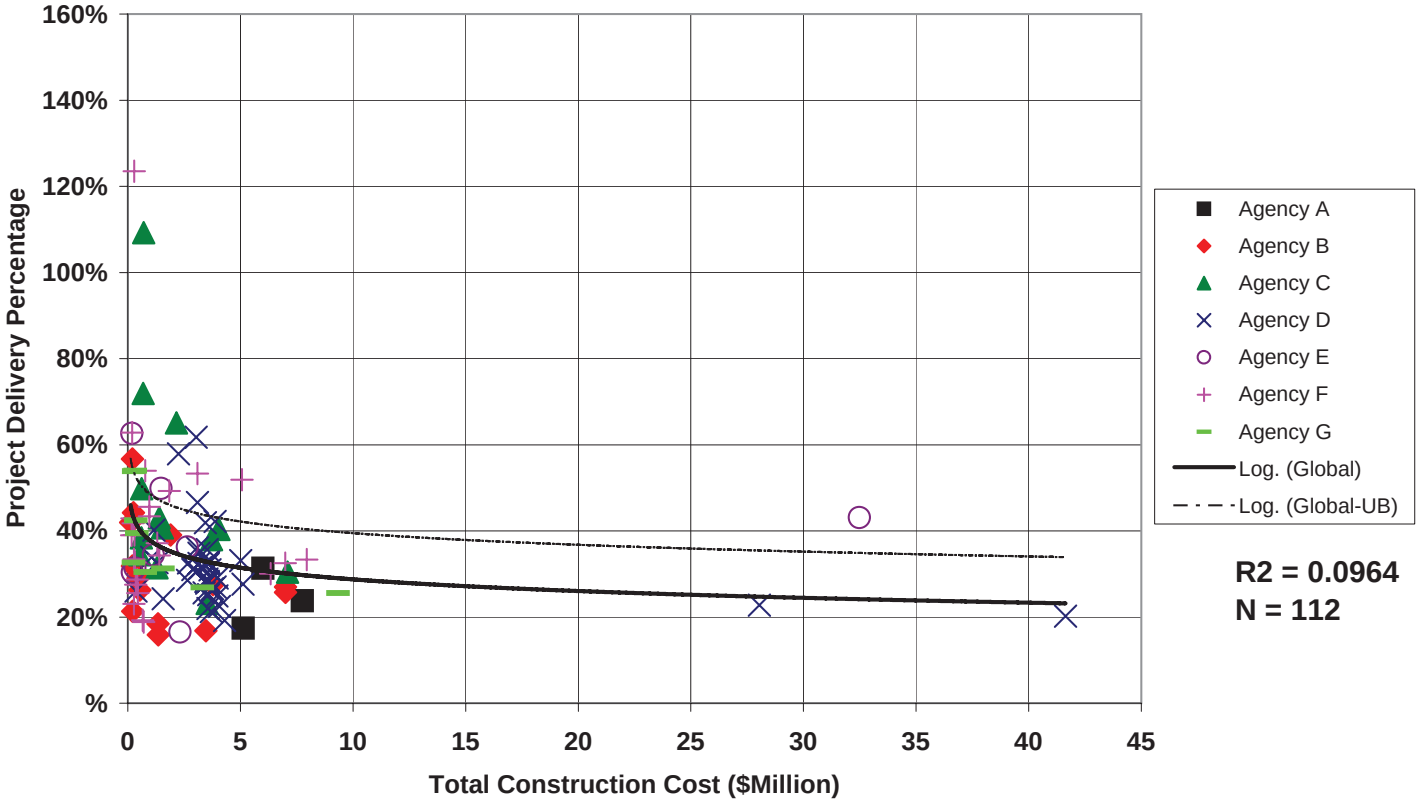
Parks - Restrooms
Construction Management Percentage Versus Total Construction Cost



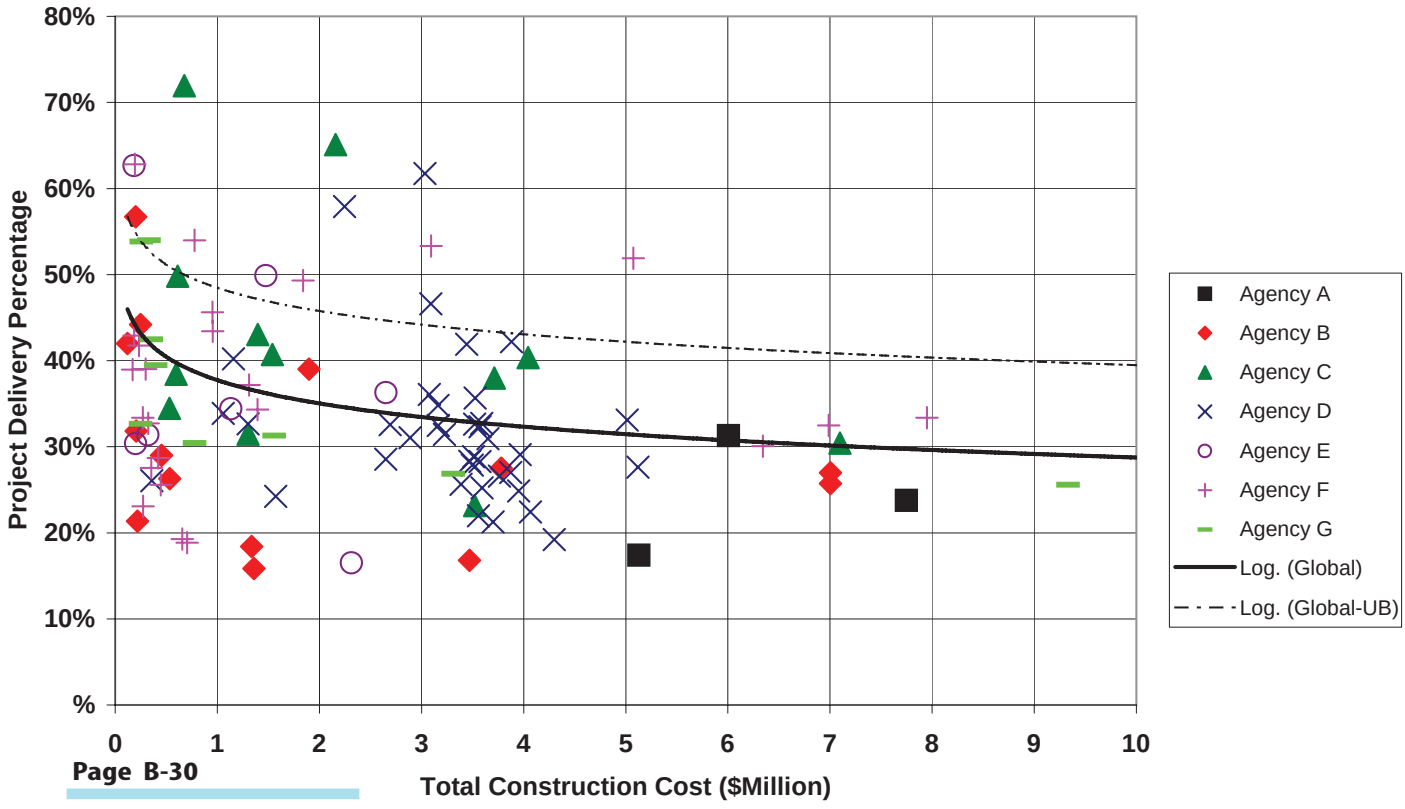
CURVES GROUP 3

Project Delivery as Percentage of Total Construction Cost vs. Total Construction Cost

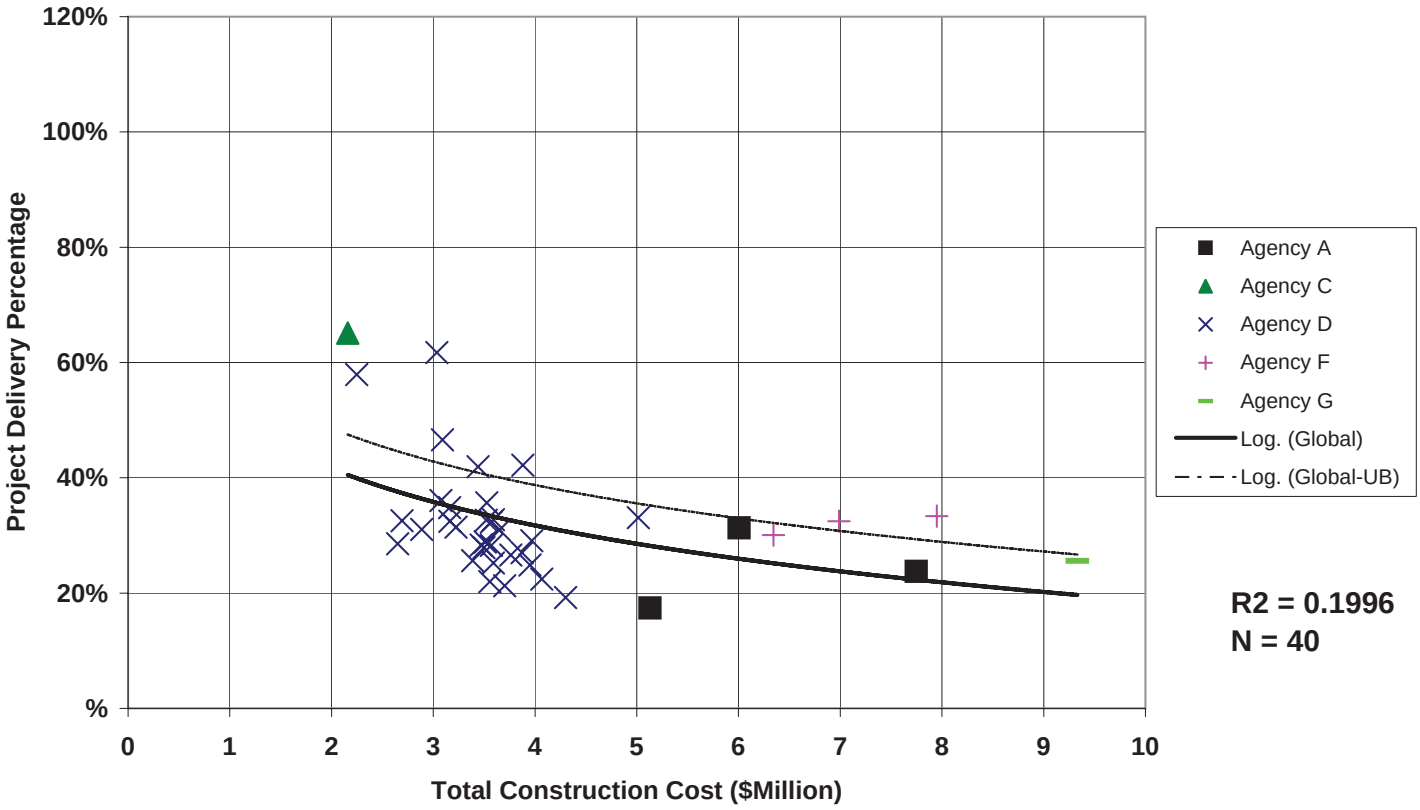
Municipal Facilities – All Classifications
Project Delivery Percentage Versus Total Construction Cost
Full Analysis



Municipal Facilities – All Classifications
Project Delivery Percentage Versus Total Construction Cost
Zoomed View

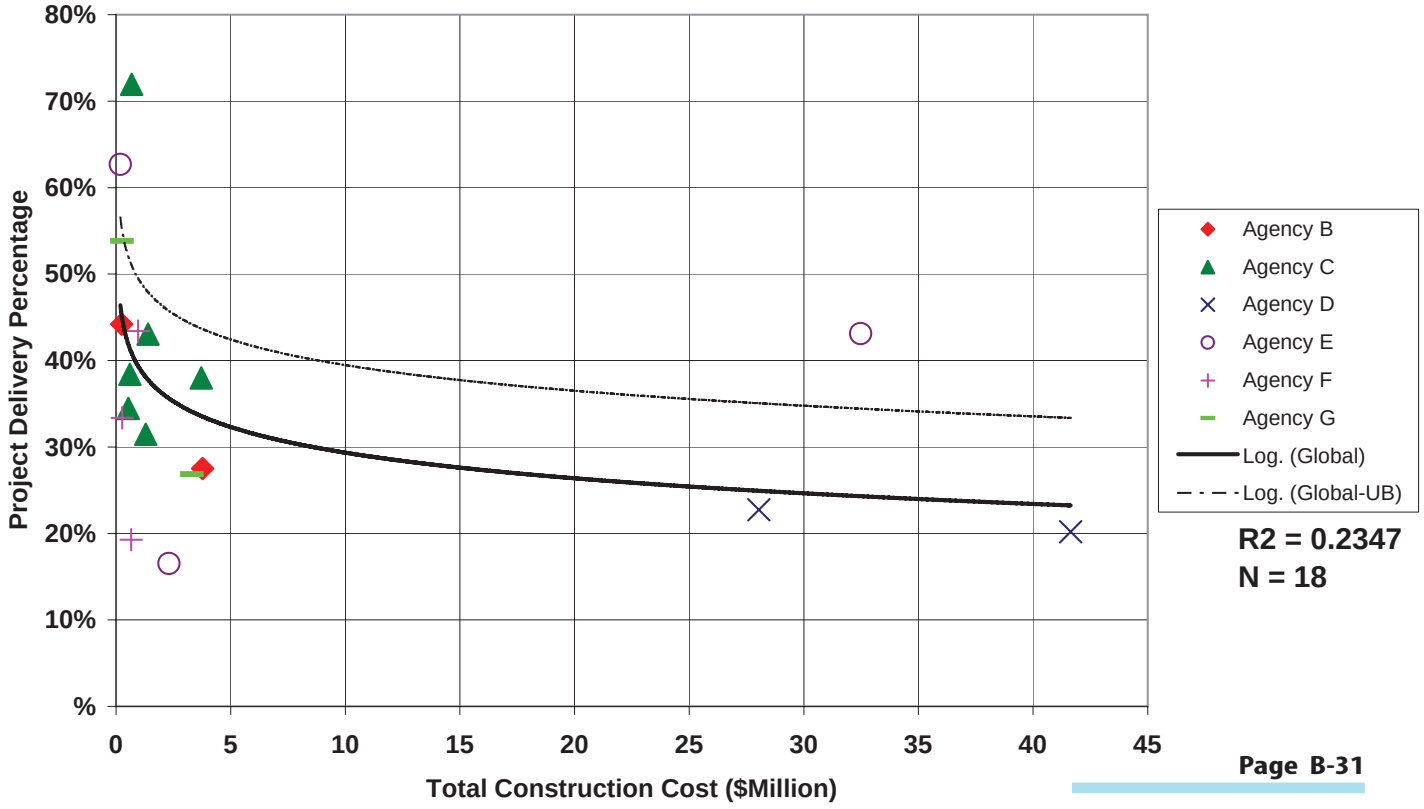


Municipal Facilities - Libraries
Project Delivery Percentage Versus Total Construction Cost



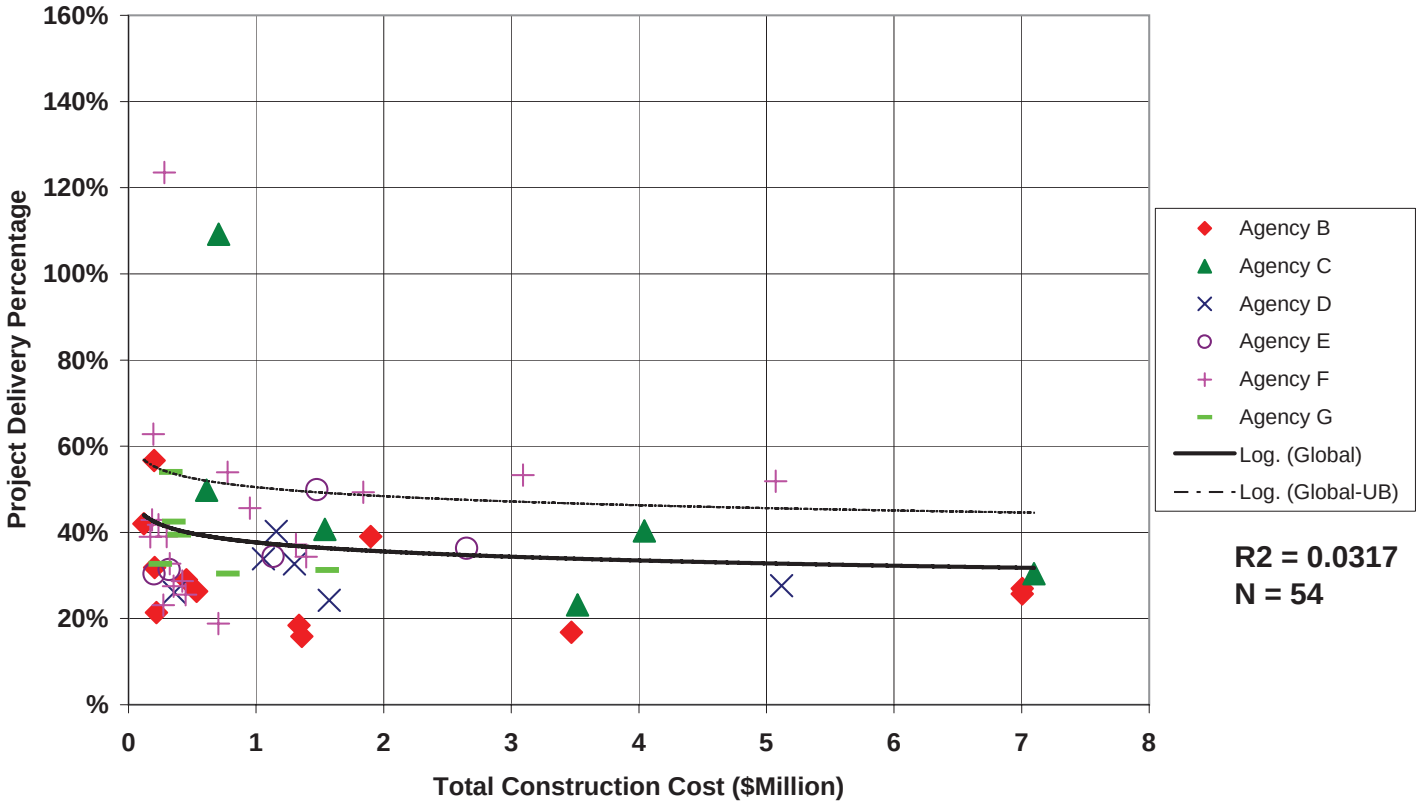
R2 = 0.1996
N = 40

Municipal Facilities - Police/Fire Station
Project Delivery Percentage Versus Total Construction Cost

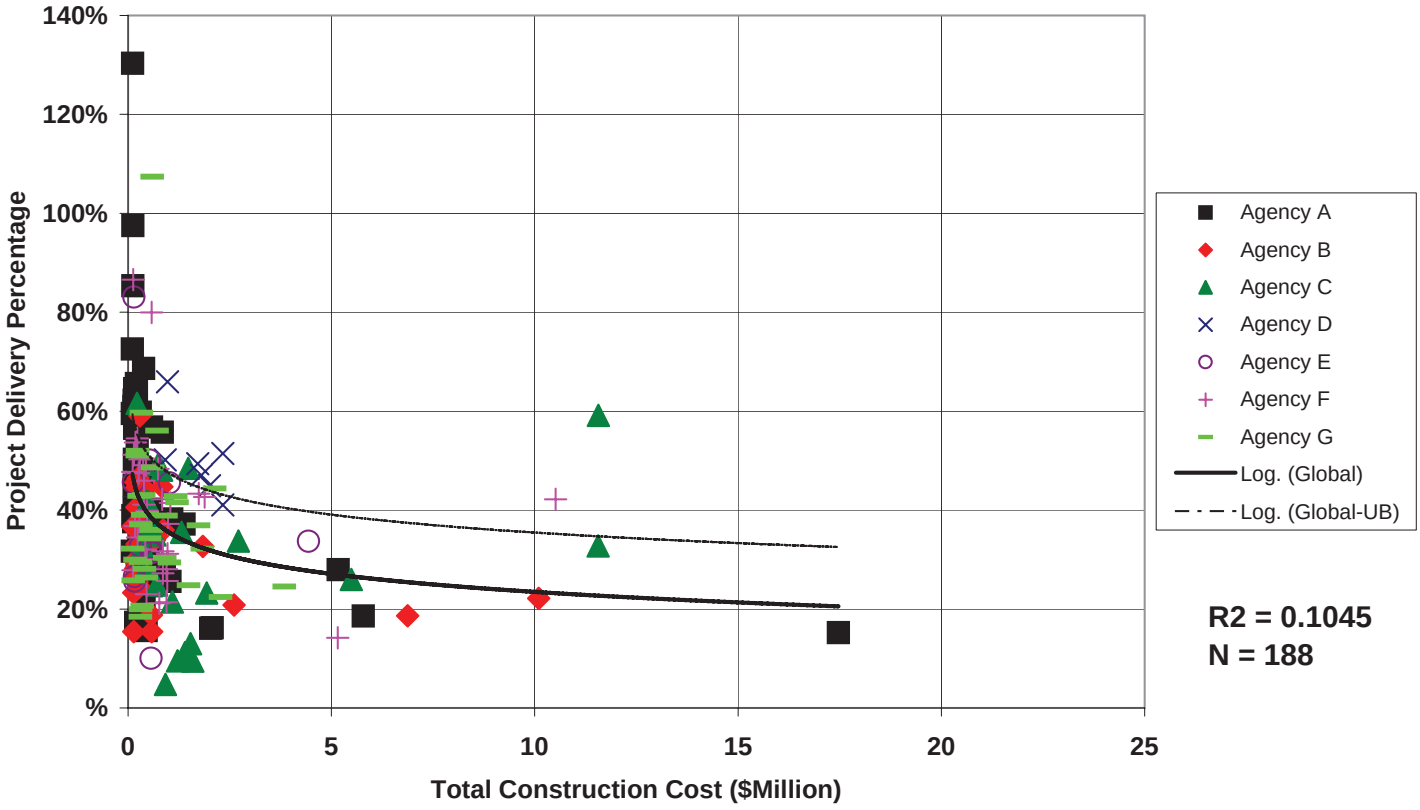


R2 = 0.2347
N = 18

Municipal Facilities - Comm./Rec. Center/Child Care/Gym
Project Delivery Percentage Versus Total Construction Cost

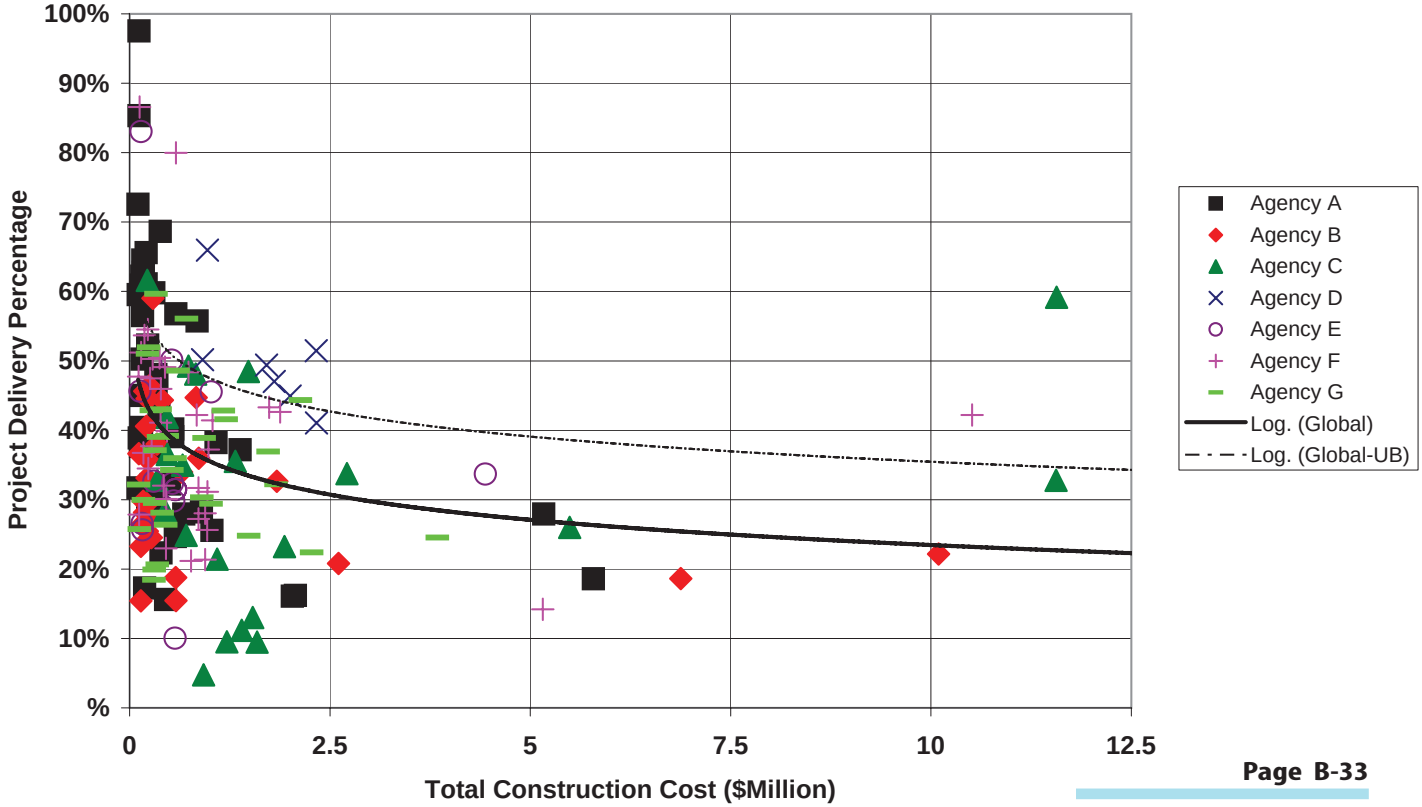


Streets – All Classifications
Project Delivery Percentage Versus Total Construction Cost
Full Analysis

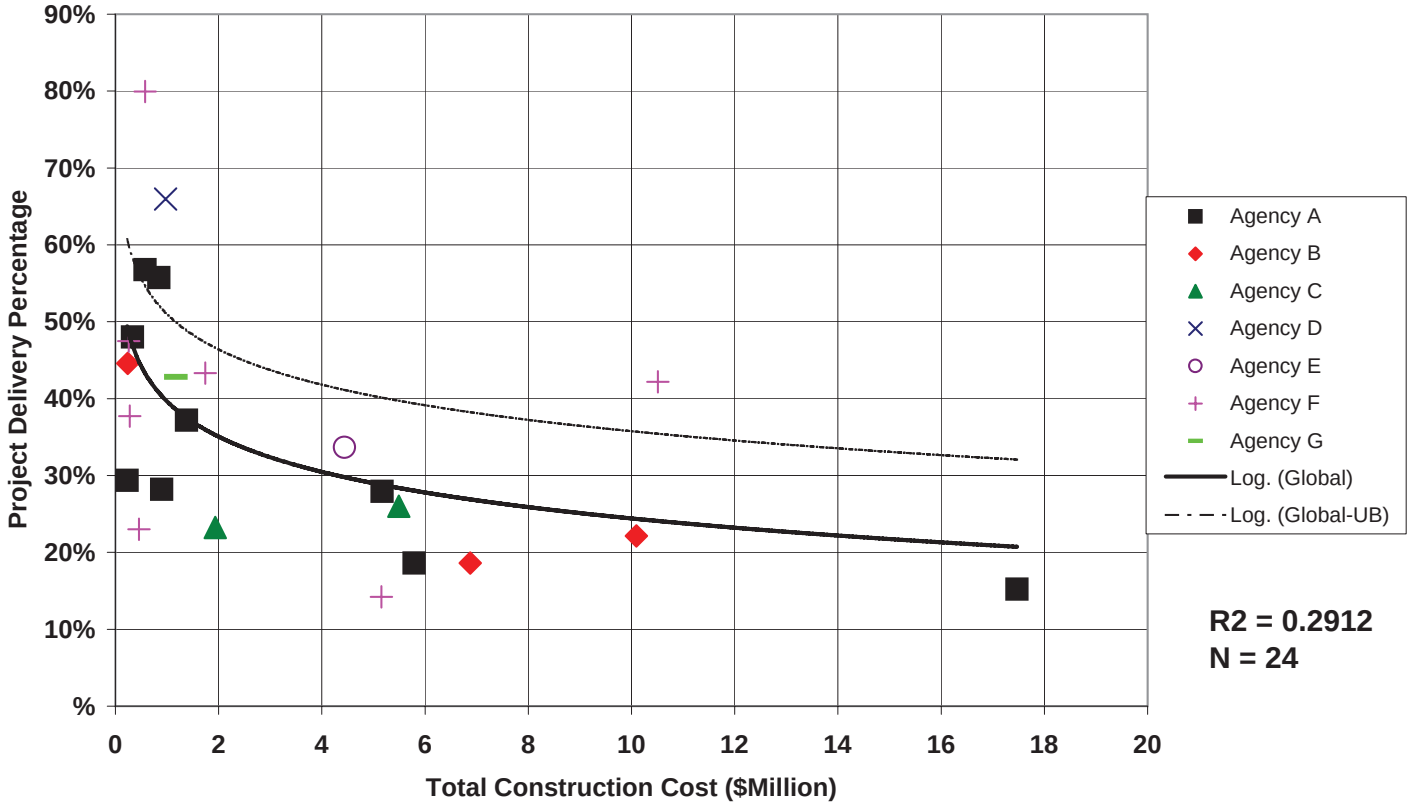


R2 = 0.1045
N = 188

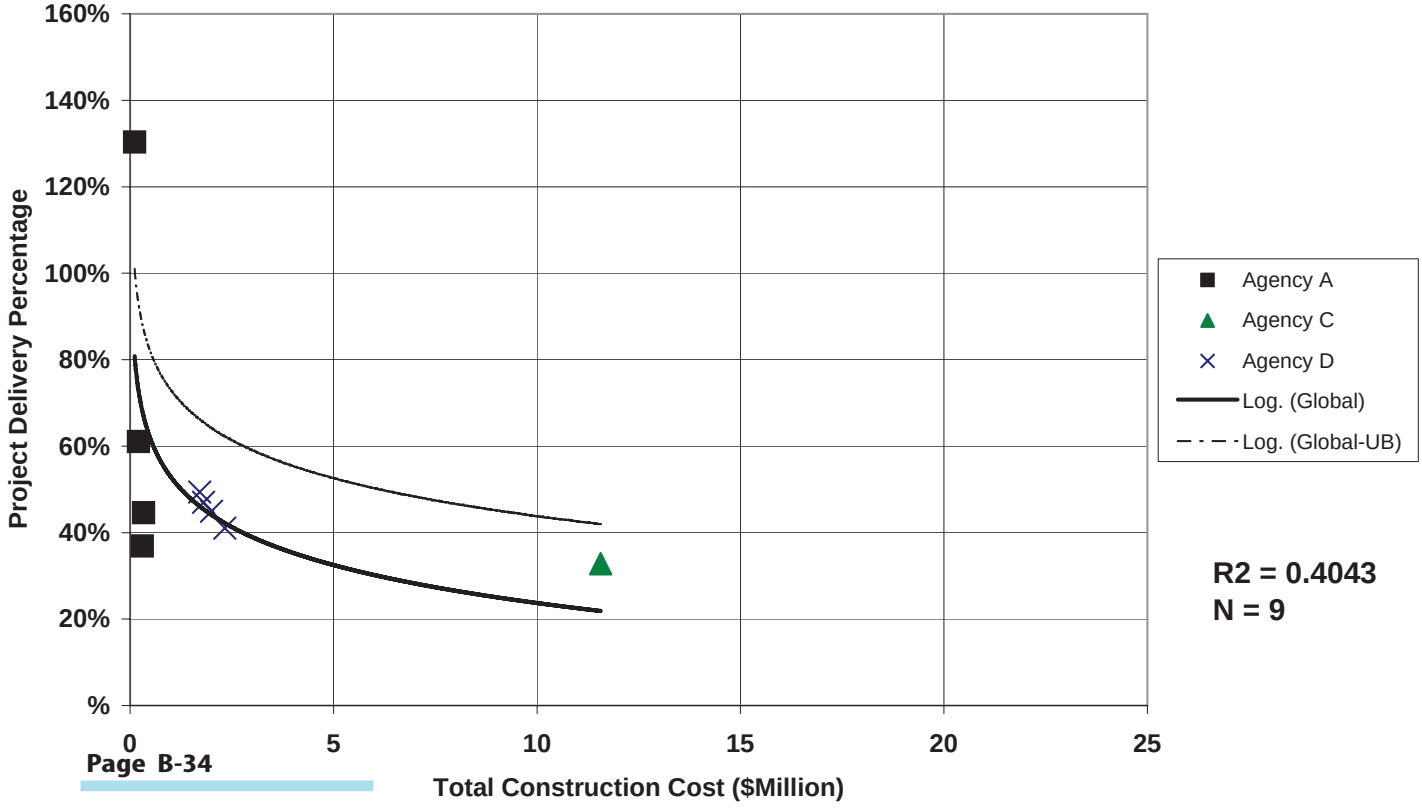
Streets – All Classifications
Project Delivery Percentage Versus Total Construction Cost
Zoomed View



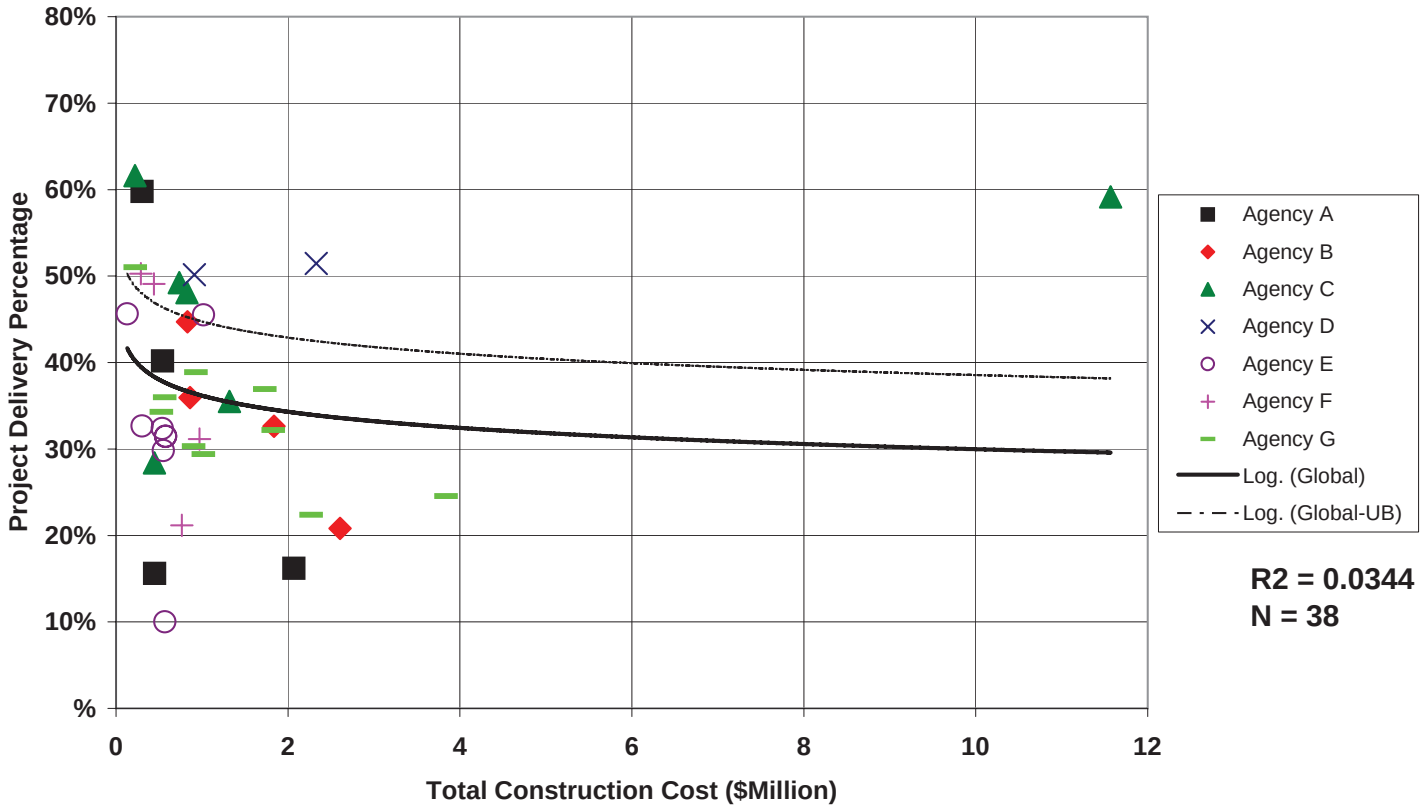
Streets - Widening/New/Grade Separation
Project Delivery Percentage Versus Total Construction Cost



Streets - Bridges (New/Retrofit)
Project Delivery Percentage Versus Total Construction Cost

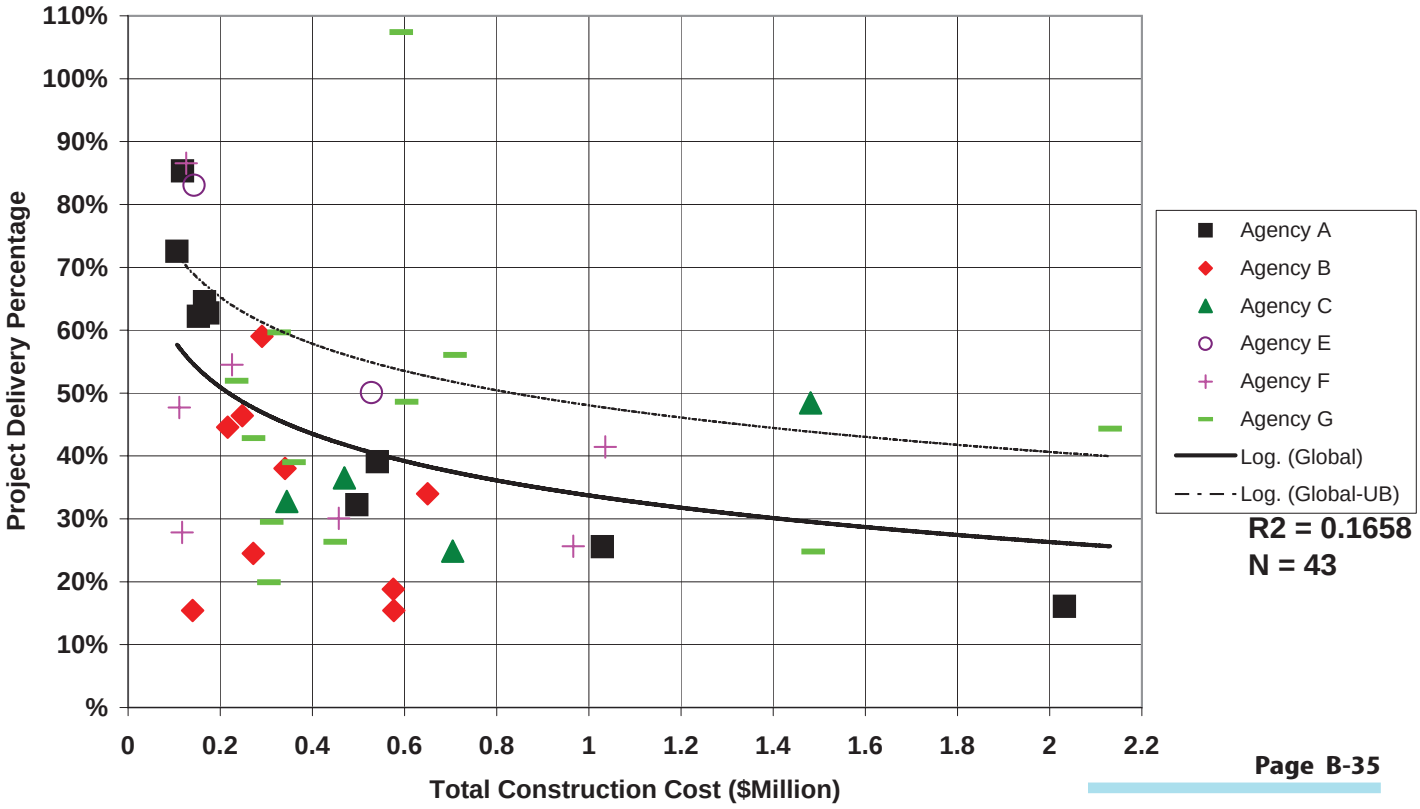


Streets - Reconstruction
Project Delivery Percentage Versus Total Construction Cost



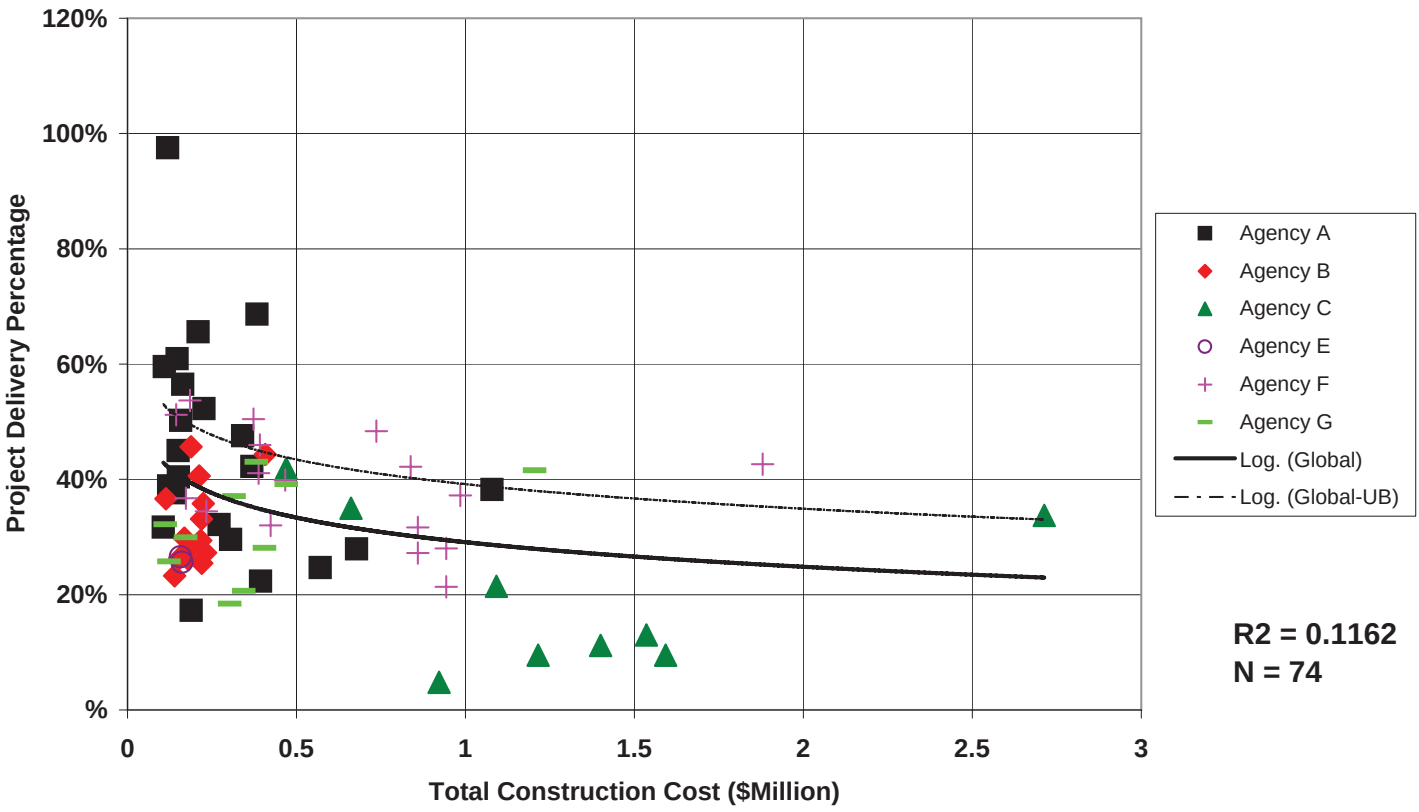
R2 = 0.0344
N = 38

Streets - Bike/Pedestrian/Streetscapes
Project Delivery Percentage Versus Total Construction Cost

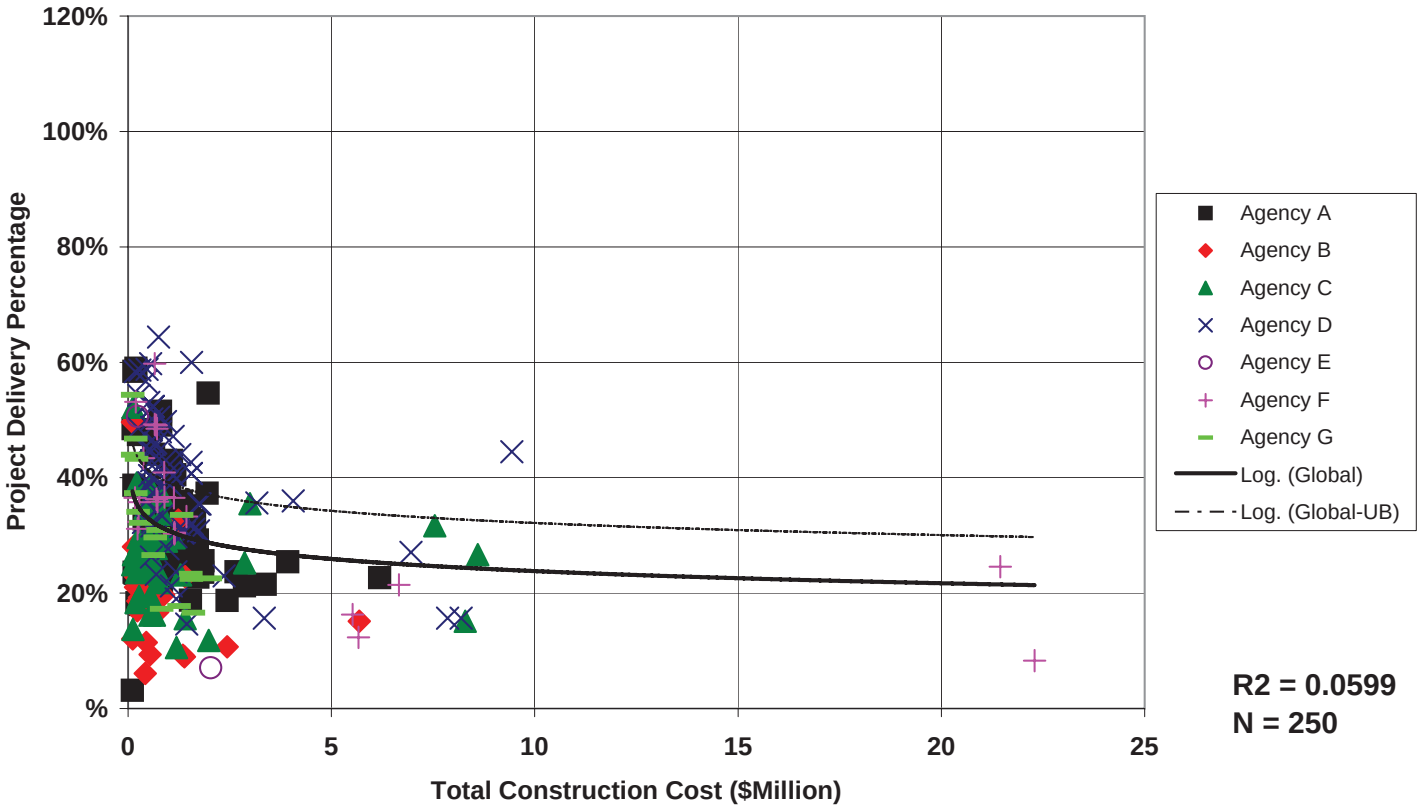


R2 = 0.1658
N = 43

Streets - Signals
Project Delivery Percentage Versus Total Construction Cost

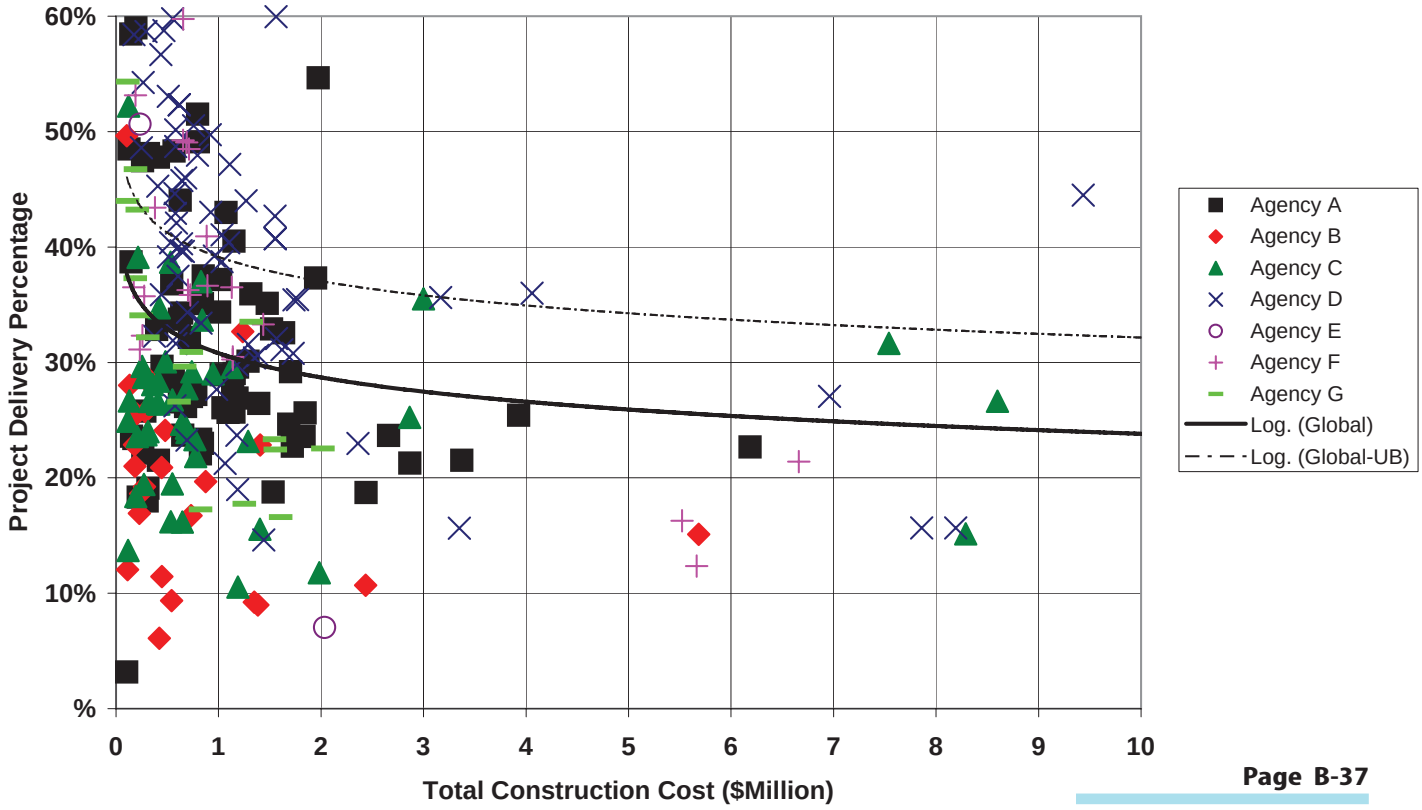


Pipe Systems – All Classifications
Project Delivery Percentage Versus Total Construction Cost
Full Analysis

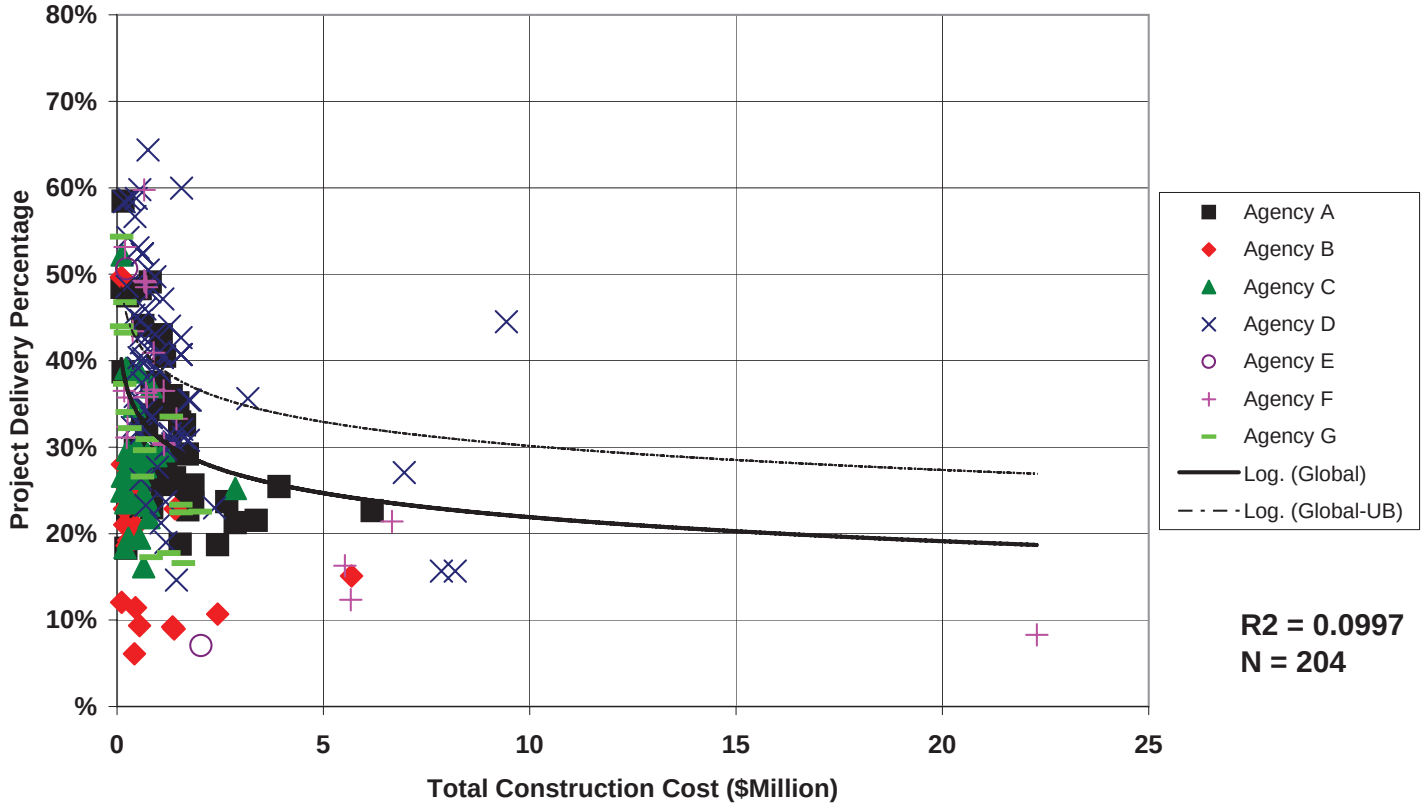


R2 = 0.0599
N = 250

Pipe Systems – All Classifications
Project Delivery Percentage Versus Total Construction Cost
Zoomed View

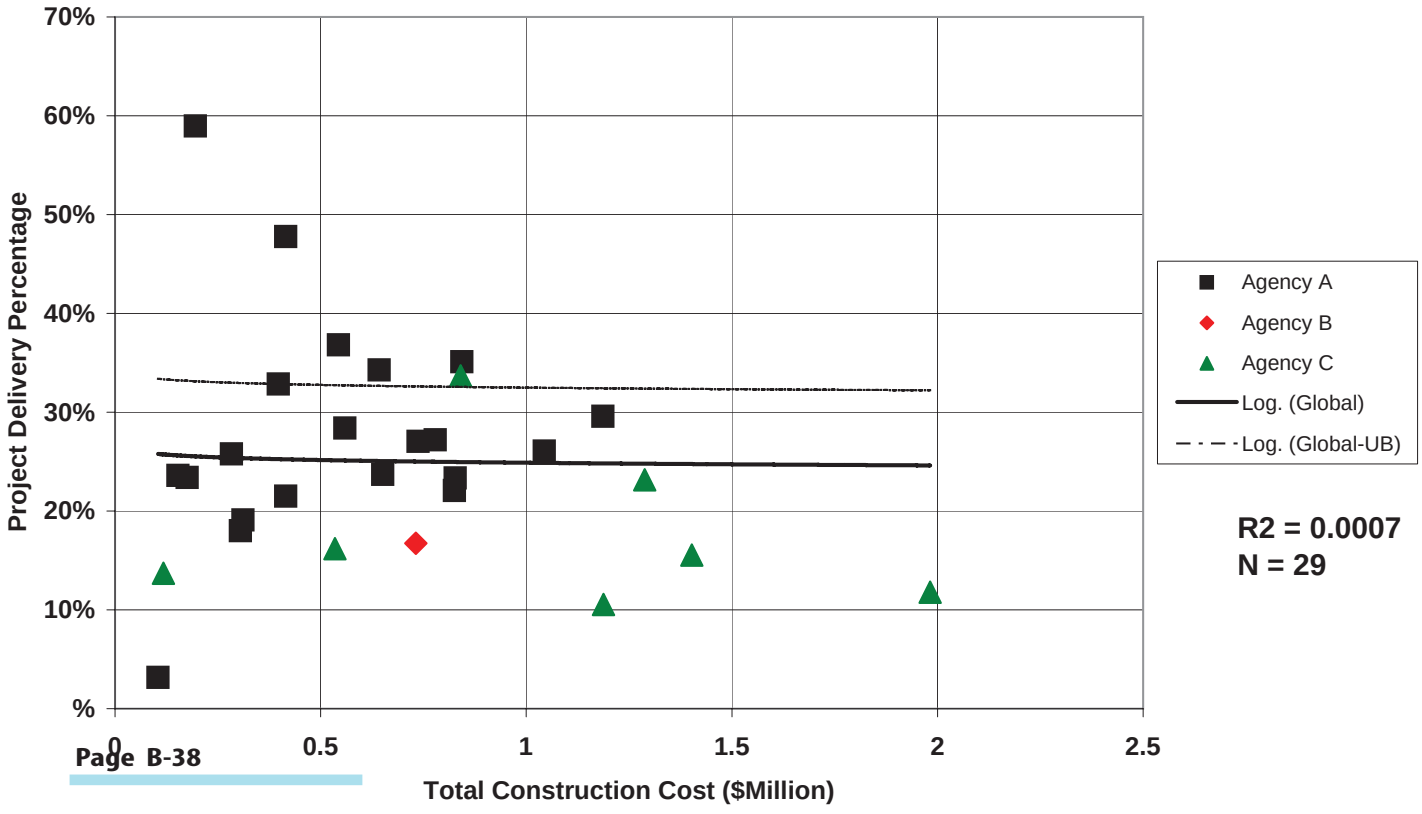


Pipe Systems - Gravity System (Storm Drains/Sewers)
Project Delivery Percentage Versus Total Construction Cost



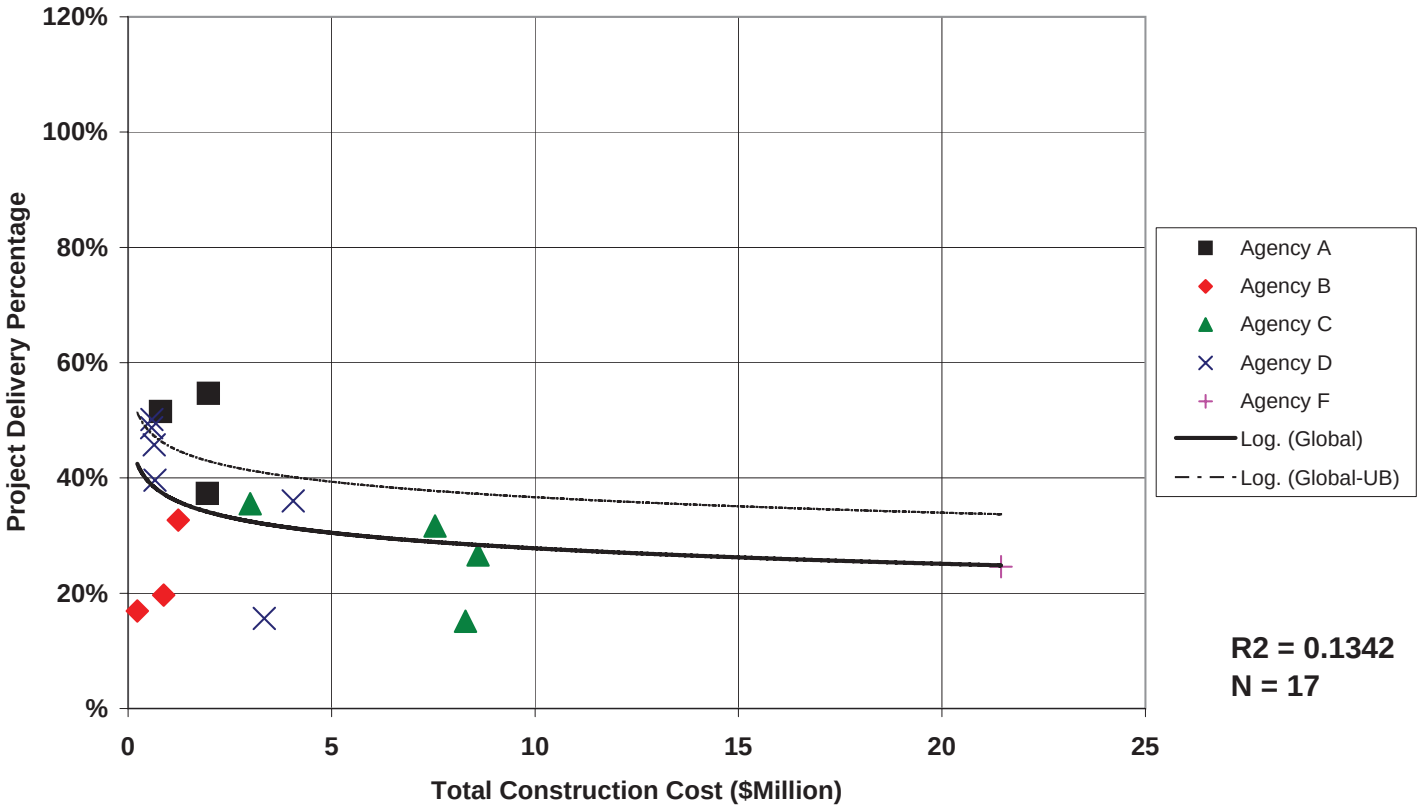
R2 = 0.0997
N = 204

Pipe Systems - Pressure Systems
Project Delivery Percentage Versus Total Construction Cost

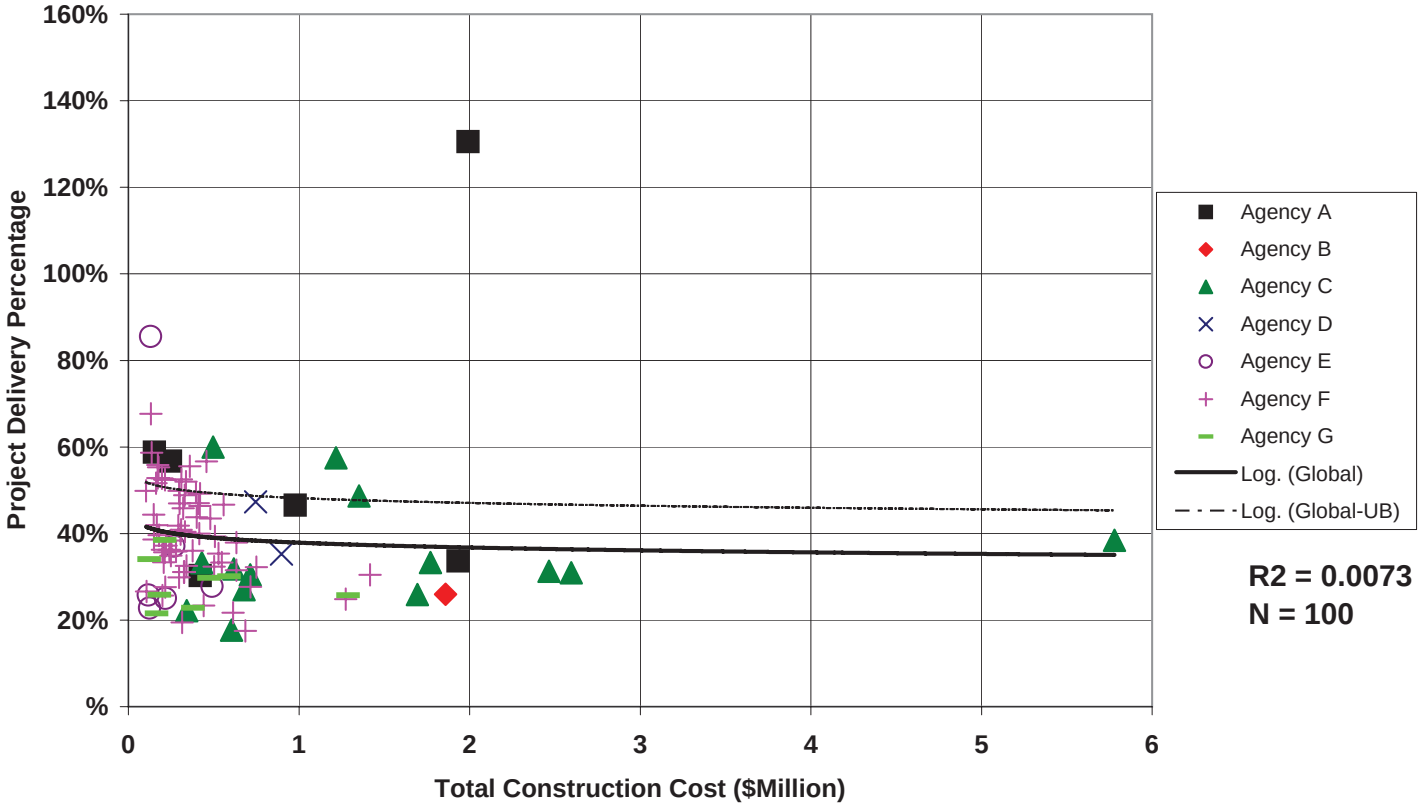


R2 = 0.0007
N = 29

Pipe Systems - Pump Stations
Project Delivery Percentage Versus Total Construction Cost

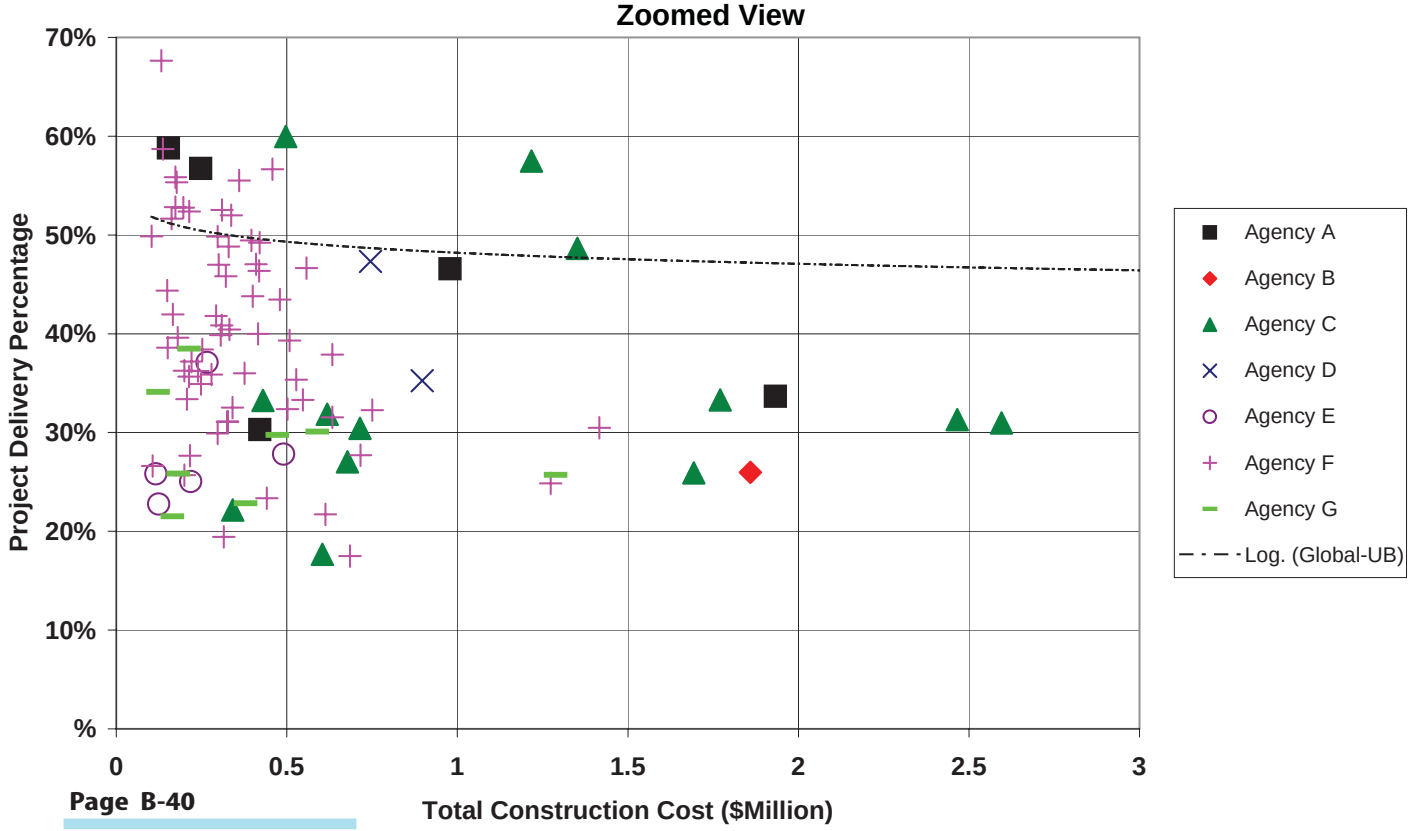


Parks – All Classifications
Project Delivery Percentage Versus Total Construction Cost
Full Analysis

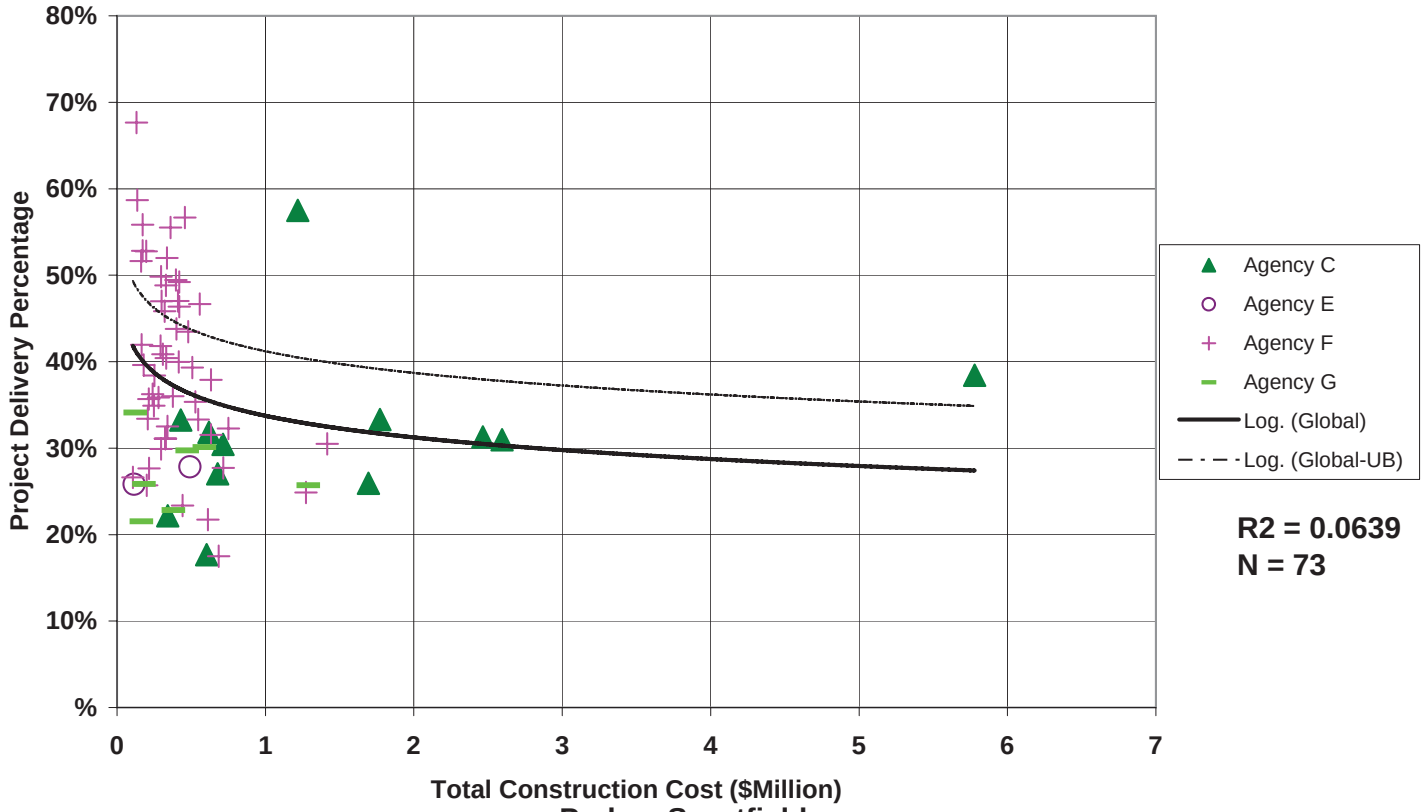


R2 = 0.0073
N = 100

Parks – All Classifications
Project Delivery Percentage Versus Total Construction Cost
Zoomed View

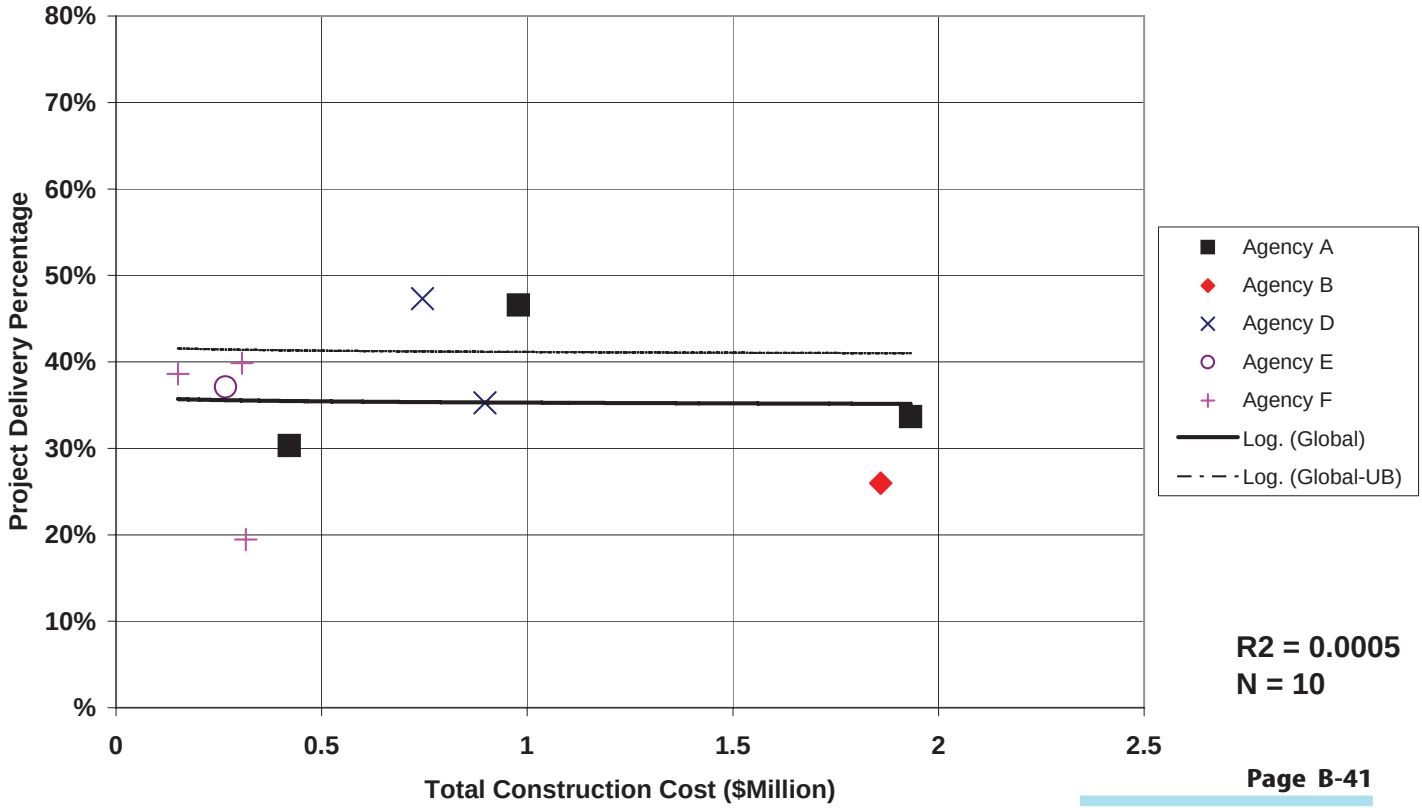


Parks - Playgrounds
Project Delivery Percentage Versus Total Construction Cost



R2 = 0.0639
N = 73

Parks - Sportfields
Project Delivery Percentage Versus Total Construction Cost



R2 = 0.0005
N = 10

Parks - Restrooms
Project Delivery Percentage Versus Total Construction Cost

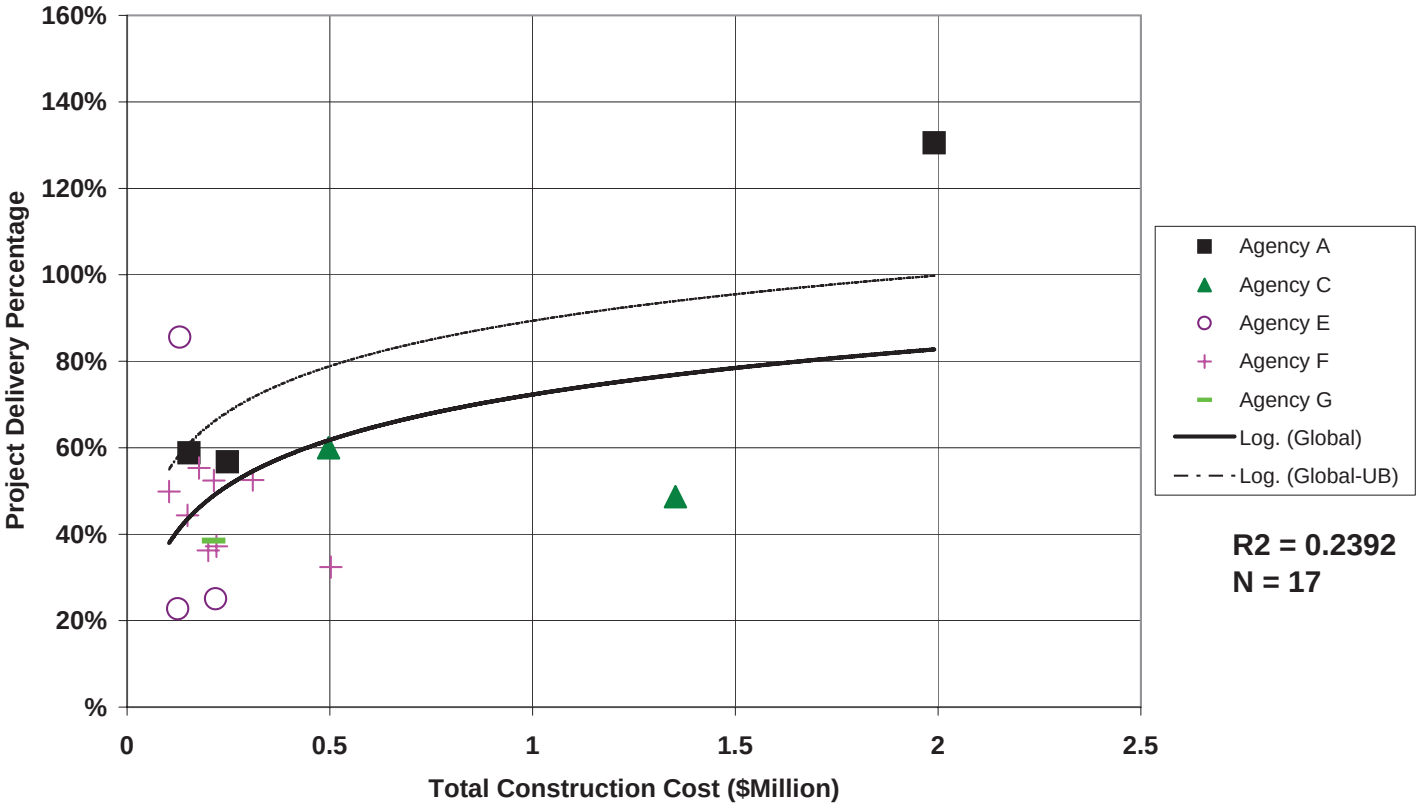


Table B-1 Coefficients of Determination (R^2-Values)

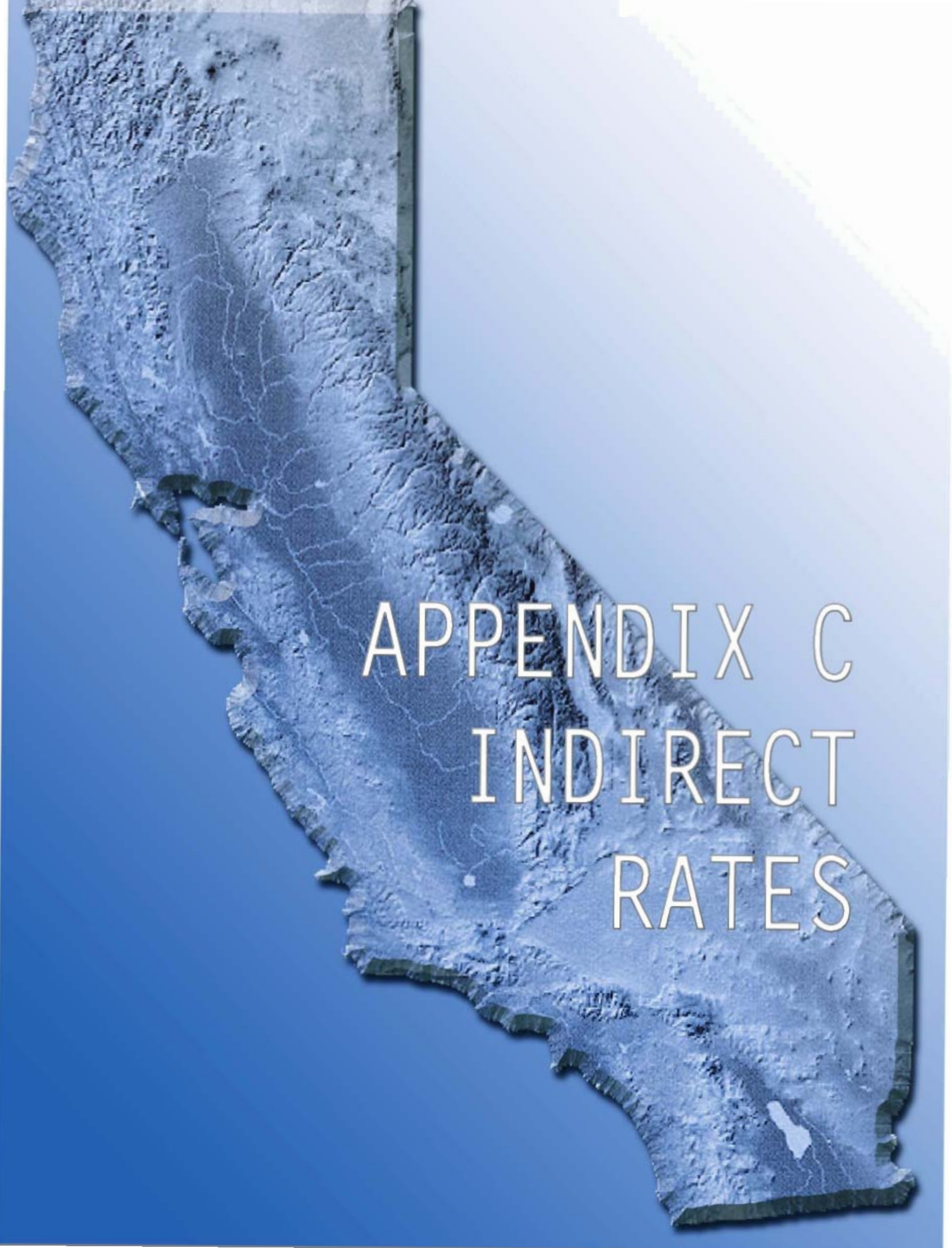
PROJECT TYPE AND CLASSIFICATION	DESIGN % VS TCC[1]	CONSTRUCTION MANAGEMENT % VS TCC	PROJECT DELIVERY % VS TCC
Municipal Facilities	0.06	0.03	0.1
Libraries	0.02	0.33	0.2
Police/Fire Station	0.21	0.18	0.23
Community Building / Recreation Center / Child Care Center / Gymnasium	0.01	0.02	0.03
Streets	0.07	0.05	0.1
Widening / New / Grade Separation	0.28	0.09	0.29
Bridge (New / Retrofit)	0.37	0.08	0.4
Reconstruction	0.02	0.02	0.03
Bike / Pedestrian / Streetscapes	0.22	0.01	0.17
Signals	0.06	0.04	0.12
Pipe Systems	0.07	0.01	0.06
Gravity System (Storm Drains / Sewers)	0.11	0.02	0.1
Pressure Systems	0.000	0.003	0.001
Pump Station	0.09	0.08	0.13
Parks	0.01	0.004	0.01
Playgrounds	0.03	0.05	0.06
Sportfields	0.01	0.003	0.001
Restrooms	0.1	0.23	0.24

Note:
[1]TCC=Total Construction Cost (Including net Change Orders)
Shaded values indicate poor R^2 values below 0.10.

Table B-2 Statistical Significance (P-Values)

PROJECT TYPE AND CLASSIFICATION	DESIGN % VS TCC[1]	CONSTRUCTION MANAGEMENT % VS TCC	PROJECT DELIVERY % VS TCC
Municipal Facilities	0.17	0.19	0.05
Libraries	0.85	0.000	0.03
Police/Fire Station	0.16	0.42	0.21
Community Building / Recreation Center / Child Care Center / Gymnasium	0.82	0.25	0.22
Streets	0.09	0.02	0.01
Widening / New / Grade Separation	0.01	0.13	0.01
Bridge (New / Retrofit)	0.45	0.3	0.32
Reconstruction	0.49	0.69	0.44
Bike / Pedestrian / Streetscapes	0.02	0.67	0.04
Signals	0.09	0.06	0.01
Pipe Systems	0.003	0.01	0.000
Gravity System (Storm Drains / Sewers)	0.000	0.01	0.000
Pressure Systems	0.27	0.64	0.31
Pump Station	0.57	0.11	0.12
Parks	1	0.9	0.93
Playgrounds	0.59	0.19	0.24
Sportfields	0.76	0.82	0.74
Restrooms	0.07	0.01	0.01

Note:
[1]TCC=Total Construction Cost (including net Change Orders)
Shaded values indicate that the result does not pass the test of statistical significance (i.e., the resulting p-value > 0.10).



APPENDIX C
INDIRECT RATES

CIP Benchmarking Study

Table C-1 Indirect Rates Applied to Capital Projects

Agency	Fringe Benefits	Compensated Time Off	City Overhead	Department Overhead	Agency Overhead	Indirect Rate Factor[1]	Receive General Fund Support For CIP
City of Long Beach							
Department of Public Works	38.60%	19.40%	4.40%	11.90%	72.70%	147%	YES
City of Los Angeles							
Department of Public Works							
Bureau of Engineering	29.44%%	18.41%	32.86%	20.60%	53.24%	154.55%	YES
City of Oakland							
Public Works Agency	60.39%	21.53%	22.05%	9.62%	13.82%	137.20%	NO
City of Sacramento							
Department of General Services	30.00%	18.70%	40.95%	6.67%	75.15%	194.44%	
Department of Transportation	30.00%	18.70%	14.51%	11.39%	79.75%	159.95%	
Department of Utilities	39.60%	18.70%			55.69%	113.99%	NO
City of San Diego							
Architectural Engineering and Contract Services	44.38%	20.35%	0%	0%	70.75%	181%	
Transportation Engineering Division	44.74%	18.45%	0%	0%	72.45%	157%	
Water and Wastewater Facilities Division	47.57%	18.44%	0%	0%	56.15%	159%	NO
City and County of San Francisco							
Department of Public Works							
Bureau of Engineering							
Bureau of Construction Management							
Bureau of Architecture	19.88%	26.28%	17.47%[2]	40.95%	80.89%	168.00%	NO
City of San Jose							
Department of Public Works	27.85%	25.00%	27.77%	1.58%	Included	120%	NO

Note:
[1] This value may be different from the sum of overhead values. The compounding formula may vary by agency.
2 Not included in the Indirect Rate.

CIP Benchmarking Study

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

http://eng.lacity.org/techdocs/cabm/