CIP Benchmarking Study

California Multi-Agency CIP Benchmarking Study

Annual Report - Update 2009







Department of PUBLIC WORKS

OAKLAND PUBLIC WORKS AGENCY

CITY OF SAN JOSE

CITY OF LONG BEACH

September 2009

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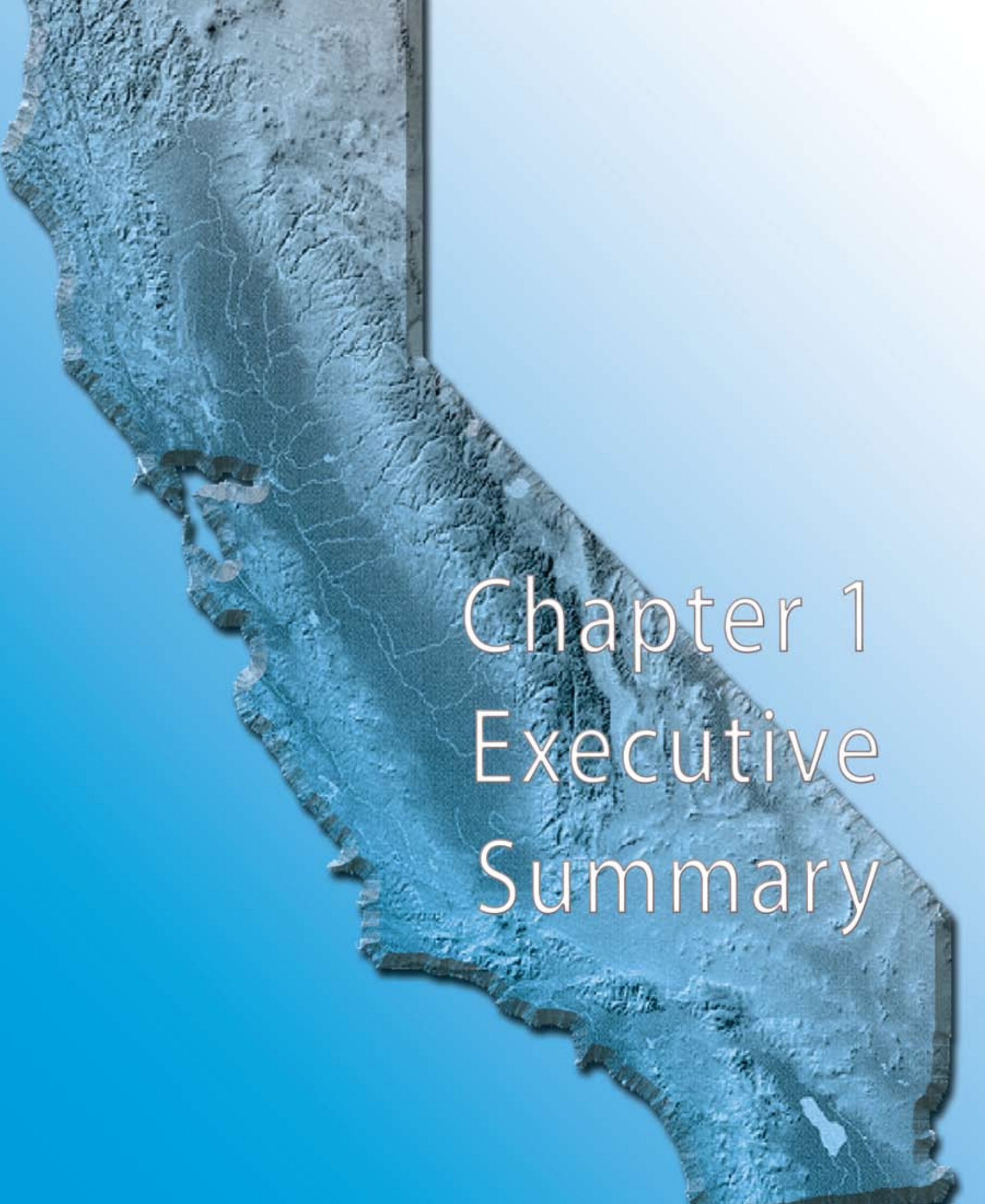


Chapter 1 Executive Summary

CHAPTER 1 Executive Summary

A. INTRODUCTION

During these highly challenging economic times, the *California Multi-Agency CIP Benchmarking Study (Study)* has continued its unparalleled effort to share the collective Capital Improvement Project implementation experiences of seven out of the eight largest cities in California for the eighth consecutive year. 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, they have obtained a better understanding of the changing capital project delivery process.

This year, the participating agencies spent a substantial amount of effort sharing approaches to continue to provide high value implementation of their capital programs in the most efficient manner possible in the face of unprecedented fiscal hardships. The *Study* provides a forum for the Agencies to share information amongst themselves via: quarterly meetings with a focus on current issues, an online portal where topics for discussion can be posed and challenges addressed, and a database that serves as both, a repository of the Agencies' projects and a tool for data analysis. Through these acts of collaboration, often times an optimum solution is found that can be translated into a Best Management Practice (BMP) for the group.

The sharing of best ideas amongst the *Study* participants has benefitted the agencies and owners who can turn to one another to gather insight on how to address challenges that might be new to them, but which others have already faced.

In this eighth year of the *Study*, the Update 2009 participants have continued to pursue on-going endeavors, as well as taken on new ones:

- Addition of the "Special Topic" roundtable discussion forums at Quarterly Meetings to explore areas of potential positive impact in relation to the current fiscal challenges;
- Improved online discussion forum for efficient information sharing;
- Continued improvement to the modeling methodology of the performance models;
- Continue to improve the quality of the performance data and the functionality of the database;
- Track the adoption of BMPs; and
- Create new BMPs targeted to common issues.

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 and consultant costs associated with project planning, design, bid, award, construction management, and closeout activities. The *Update 2009* performance curves have been developed from data on projects completed on or after January 1, 2004.

Performance Model

Table 1-1 summarizes the number of projects included in the database and in the analyses. The 5-year database used for the current analysis contains 729 projects. This total excludes project data older than five years or projects identified as outliers. Projects identified as outliers are not included in the performance data analysis but are retained in the performance database. Outlier analysis was performed using statistical techniques to ensure consistency in the selection of outlier data points. This methodology was first implemented during Update 2008 and the agencies recognize the merits of a scientific approach for outlier elimination. Some of the projects classified as outliers in previous *Study* years have been included in the performance data analysis, and vice-versa.

This is an improved practice when compared to prior *Study* years where project data points were classified as outliers based on a combination of statistical parameters and subjective judgments by the Project Team. Previously, projects identified as outliers during one *Study* phase were kept as outliers in subsequent *Study* phases.

Table 1-1 shows that as the rules for project selection were refined, non-representative and projects with total construction cost (TCC) less than $100K have decreased in number. In addition, only 14 projects have been excluded as outliers in the Update 2009 *Study* as compared to the elimination of 147 projects in Update 2007 and 113 projects in Update 2006.

Table 1-1
Growth of Database

Study Phase[1]	Submitted	Deleted		Count After Deletions	Excluded		Net
	(a) Total	(b) TCC <$100K	(c) Non-Repre-sentative[2]	(d)=(a)-(b)-(c)	(e) Project Completion Date < 2004	(f) Outliers[3]	Projects in Analyses (g)= (d)-(e)-(f)
I	237	25	44	168	168	0	0
II	285	0	35	250	250	0	0
III	262	0	29	233	230	0	3
IV	170	17	21	132	36	4	92
V	182	0	3	179	19	3	157
VI	189	0	0	189	3	2	184
VII	158	1	0	157	7	3	147
VIII	151	2	0	149	1	2	146
Total	**1,634**	**45**	**132**	**1,457**	**714**	**14**	**729**

Notes:
[1] Study Phase indicates action taken on the count of projects corresponding to Study Years I = 2002, II = 2003, III = 2004, IV = 2005, V = 2006, VI = 2007, VII = 2008, and VIII = 2009.
[2] Projects that do not fit Study criteria for project classifications and minimum TCC of $100K were removed from the database.
[3] Outliers are identified based on statistical analysis.

Performance Model Selection

During Update 2008, a significant amount of time and effort was expended on improving the accuracy of the performance model. A linear trendline was selected to replace the logarithmic relation between the project delivery costs and the TCC. These efforts yielded positive results by eliminating auto-correlation in the modeling methodology and by producing significant improvements in the performance model results yielding R^2 values of significantly higher magnitudes.

Although the participating agencies acknowledged the merits of a refined performance model using a linear trend line, it does not completely reflect the agencies' observations that on a percentage basis, projects with lower TCCs are more expensive to deliver than projects with higher TCCs. At the request of the participating agencies, during Update 2009 the *Study* Team evaluated five types of curves (logarithmic, exponential, polynomial, power, and linear) to determine the best-fit curve for the regression model.

Logarithmic and exponential curves resulted in poor R^2 values and generally fit poorly to the data points. Although polynomial curves exhibited good R^2 values, they did not model real world results. Power curves generated good R^2 values and represented a good fit for the project data. In all the cases, the resulting power curves were almost linear in nature. However, the associated expression used to calculate the project delivery percentage was mathematically complex. Linear trendlines generated good R^2 values and represented a good fit for the project data. In addition, the associated expression used to calculate the project delivery percentage was a simple mathematical relationship.

The findings of the best-fit analysis were reviewed by a statistics expert before being presented to the participating agencies during a quarterly meeting. The participating agencies agreed with the results of the analysis and approved the use of the linear trendline as the best-fit curve for the project data points, particularly with the enhancements made to the modeling methodology.

Modeling Methodology

To explore the agencies' observations that on a percentage basis, projects with lower TCCs are more expensive to deliver than projects with higher TCCs, the *Study* Team conducted additional investigations. The objective was to identify a subset of project size (in terms of TCC) that represented what was generally considered as the smaller projects. A statistical analysis of the distribution of the projects in the database revealed that generally 80 percent of the projects lay between a TCC ranging from $100,000 to $2 Million. Regressions were then undertaken to determine if delivery costs for this subset behaved in a different fashion than for the full range of projects. The statistical tests generally produced favorable results and it was concluded that this subset of projects were representative of the characteristics of smaller projects.

Therefore, it was decided to analyze the projects data in the following two ranges:

1. Full range of TCC

2. Smaller project subset of TCC (first 80 percent of the project distribution)

Preliminary results of such an evaluation using the Update 2008 projects database were presented to the agencies during a quarterly meeting. The results conformed to the agencies' practical experiences. After reviewing the results, the agencies directed the *Study* Team to analyze the Update 2009 projects data in the two ranges discussed above. The characteristics of the data in the performance model database are presented in the following paragraphs.

Characteristics of Data Analyzed

Project performance data were analyzed using the custom database application at both the Project Type level and the Project Classification level.

Project Count and Project Delivery by Completion Year

Table 1-2 summarizes characteristics of the 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. The median value is the value at which 50% of the values are above and 50% of the values are below.

Table 1-2
Project Delivery Costs by Project Completion Year
(As % of Total Construction Cost)

Project Completion Date	Design Cost (% of TCC)	Construction Management Cost (% of TCC)	Total Project Delivery Cost (% of TCC)	Median TCC ($M)
2004	27%	18%	46%	$0.57
2005	23%	17%	40%	$0.66
2006	20%	17%	37%	$0.86
2007	23%	17%	40%	$0.70
2008	23%	17%	40%	$0.72
Average	23%	17%	40%	$0.65

Notes:
[1] Project Delivery percentages represent arithmetic averages of the individual projects and do not represent the results from the regression analyses.
[2] Project Delivery percentages vary from year to year based on the selection and the composition of the projects in the database.

As indicated in **Table 1-2**, project size (measured as median TCC), increased significantly between 2004 and 2006 with an increase of approximately 51 percent. Project size declined approximately 16 percent between 2006 and 2008. The average TCC also declined steadily between 2006 and 2008. Similarly, project delivery costs measured as a percentage of the TCC declined significantly between 2004 and 2006. The project delivery percentages have remained stable during 2007 and 2008 having increased slightly from 2006.

Project Delivery Costs by Project Type

Table 1-3 shows project delivery costs by each of the four project types in the *Study* for the full range of TCC. The project delivery percentage for a category is the arithmetic average of the project delivery percentages of the individual projects grouped under that category.

Table 1-3
Project Delivery Costs by Project Type (% of TCC) (Full Range of TCC)

Type	Design	Construction Management	Project Delivery (Total)	Median Total Construction Cost ($M)	Number of Projects (N)
Municipal Facilities	21%	16%	36%	3.08	116
Parks	23%	16%	39%	0.34	83
Pipe Systems	20%	17%	36%	0.71	267
Streets	27%	19%	46%	0.54	263
Average	23%	17%	40%	0.65	729

Notes:
[1] Project Delivery percentages represent arithmetic averages of the individual projects and do not represent the results from the regression analyses.
[2] Project Delivery percentages vary from year to year based on the selection and the composition of the projects in the database.

Projects belonging to the Pipes and the Municipal categories have the lowest average project delivery cost. The Pipes category has the maximum number of projects (n = 267) in the Update 2009 database. The Streets category also has a similar number of projects in the database (n = 263). The Streets category also exhibits the highest average project delivery cost. The influence of low project delivery cost from Pipes projects is balanced by the influence of high project delivery cost from Streets projects. The average project delivery percentage for the overall dataset is approximately 40 percent.

Over the course of the *Study*, the Agencies have observed that the relatively high average project delivery cost of Streets projects is probably due to increasing cost influences of right-of-way acquisition, community outreach requirements, environmental mitigation requirements, and the smaller median total construction cost of these projects.

Table 1-4 shows project delivery costs by each of the four project types in the *Study* for the smaller project subset of TCC. The trends in the project delivery costs for the projects in the smaller project subset of TCC follow that of the projects in the full range of TCC. As expected based upon the Agencies' practical experience, project delivery costs are higher for projects that fall in the smaller project subset of TCC.

Table 1-4
Project Delivery Costs by Project Type (% of TCC)
(Smaller Project Subset of TCC)

Type	Design	Construction Management	Project Delivery (Total)	Median Total Construction Cost ($M)	Number of Projects (N)
Municipal Facilities	22%	16%	39%	3.08	93
Parks	24%	17%	41%	0.34	66
Pipe Systems	21%	18%	39%	0.71	214
Streets	29%	20%	49%	0.54	208
Average	25%	18%	43%	0.65	581

Notes:
1 Project Delivery percentages represent arithmetic averages of the individual projects and do not represent the results from the regression analyses.
2 Project Delivery percentages vary from year to year based on the selection and the composition of the projects in the database.

Consultant Usage Analysis

Project delivery performance and consultant usage by agency are presented in **Table 1-5**. The table indicates that approximately 56 percent of the design work and approximately 82 percent of the construction management efforts are completed in-house by the participating agencies. Consultants account for approximately 32 percent of the total project delivery costs while in-house efforts by the participating agencies accounts for the remaining 68 percent of the project delivery costs. For the available data, a clear relationship between the level of in-house effort and project delivery costs cannot be established.

Regression Analysis Results

During Update 2008, several changes were made to improve the modeling methodology. These included developing a statistically-sound method for outlier analysis, using a linear trendline for modeling project costs relationships, and using the upper and lower bounds of a 90 percent confidence interval to estimate the range of the project delivery percentages. As a result of these improvements, the model relationships could be predicted with a higher degree of certainty as compared to previous *Study* years. During Update 2009, the modeling methodology was further refined by analyzing the data in two ranges of TCC.

Given all these improvements to the analysis of the data, the reader is advised that direct comparison of data between Update 2009 and previous years may be more difficult due to these improvements.

Table 1-5
Project Delivery Performance and Consultant Usage by Agency

AGENCY	DESIGN					CONSTRUCTION MANAGEMENT					PROJECT DELIVERY					TCC	
	In-House		Consultants			In-House		Consultants			In-House		Consultants				
	($M)	% of Design[1]	($M)	% of Design	Total % of TCC[2,3]	($M)	% of CM	($M)	% of CM	Total % of TCC	($M)	% of PD	($M)	% of PD	Total % of TCC	Average	Median
Agency A	31.5	47%	35.9	53%	27%	32.9	68%	15.2	32%	15%	64.4	56%	51.1	44%	42%	2.5	0.7
Agency B	12.2	47%	13.5	53%	18%	11.6	61%	7.6	39%	12%	23.8	53%	21.1	47%	30%	1.4	0.4
Agency C	25.3	93%	2.0	7%	17%	24.7	97%	0.8	3%	17%	50.0	95%	2.8	5%	34%	1.6	1.1
Agency D	62.2	53%	55.0	47%	22%	100.1	85%	17.6	15%	21%	162.3	69%	72.5	31%	43%	5.0	1.3
Agency E	3.4	30%	8.0	70%	19%	6.8	72%	2.6	28%	14%	10.3	49%	10.6	51%	33%	2.3	1.1
Agency F	38.5	61%	24.7	39%	25%	44.4	88%	5.9	12%	22%	82.9	73%	30.6	27%	47%	1.4	0.4
Agency G	13.3	60%	8.8	40%	25%	9.4	100%	0.0	0%	13%	22.7	72%	8.8	28%	38%	0.8	0.4
OVERALL	186.5	56%	147.9	44%	23%	230.0	82%	49.7	18%	17%	416.5	68%	197.6	32%	40%	2.2	0.6

Notes:

[1] In-House and Consultant costs are expressed as percentages of total agency Design, CM (Construction Management), and PD (Project Delivery) costs.

[2] Total Construction Cost (TCC) is the sum of construction contract award, change orders, utility relocation cost, and city forces construction cost.

[3] Design, CM, and PD costs are expressed as percentages of TCC and are unweighted, arithmetic averages of projects by agency.

The results of the regression analyses are discussed in the remainder of this section. The results of the regression analyses are summarized in **Table 1-6** and **Table 1-7**. **Table 1-6** summarizes the performance model results for the full range of TCC while **Table 1-7** summarizes the results for the smaller project subset of TCC. These tables also summarize the design, construction management, and project delivery costs expressed as a percentage of the TCC and the R^2 and the p-values for the different project types.

The plots depicting the regression relationships are shown in **Appendix B**. It should also be noted that while majority of projects are clustered near the origin of the graph, the slope of the trendline is predominantly governed by the data points scattered at relatively high TCC values. Since the slope of the trendline provides the design, construction management, or the project delivery costs as a percentage of the TCC for a group of projects, the results better reflect the properties of a program of projects rather than that of an individual project. Therefore, the reader must avoid budgeting individual projects based on these analyses.

In most cases, the results reflect the agencies' experience with the delivery of capital projects that on a percentage basis projects with lower TCCs are more expensive to deliver than projects with higher TCCs.

It is important to note that while the slopes of the linear regression models are an expression of the project delivery cost as a percentage of construction, the slopes are not equal to the average and median project delivery percentages. The project delivery percentages in **Table 1-2** represent arithmetic averages of the individual projects and do not represent the results for the regression analysis.

In addition, it should be noted that although the R^2 and p-values are higher than in previous *Study* phases, the reader is cautioned that this table only be used as a reference and not for future prediction of future performance. Readers are urged to review the curves in **Appendix B** in conjunction with using this table.

C. BEST MANAGEMENT PRACTICES

At the start of the *Study*, the agencies examined over 100 practices used in project delivery. Included in the *Study* are those practices that the *study* participants did not already commonly use, but believed should be implemented as BMPs. New BMPs are also added annually, and in some cases existing BMPs are reworked by the agencies to address specific challenges they encounter. BMPs are also added or modified to reflect new learnings by the participants. Agency implementation of these selected practices has been and will continue to be tracked during the *Study*.

Table 1-6
Summary of Performance Models (Full Range of TCC)

Project Type or Classification	Number of Projects (N)	Design Cost				Construction Management Cost				Project Delivery Cost			
		(% of TCC)	95% CI (% of TCC)	R^2	p-value	(% of TCC)	95% CI (% of TCC)	R^2	p-value	(% of TCC)	95% CI (% of TCC)	R^2	p-value
Municipal Projects	**116**	**17%**	**16%-19%**	**0.90**	**8.28E-59**	**18%**	**17%-19%**	**0.92**	**1.06E-65**	**35%**	**34%-38%**	**0.94**	**3.06E-71**
Libraries	23	16%	9%-16%	0.63	3.11E-7	12%	7%-15%	0.59	1.22E-5	28%	19%-28%	0.77	1.41E-9
Police/Fire Stations	31	17%	14%-22%	0.78	6.05E-11	16%	13%-21%	0.75	2.5E-10	33%	29%-41%	0.81	3.14E-12
Comm./Rec.Center/ Child Care/Gyms	50	17%	13%-18%	0.77	2.2E-17	11%	7%-11%	0.64	1.28E-13	28%	21%-28%	0.80	4.91E-20
Other Municipal	12	18%	15%-21%	0.94	1.5E-7	19%	18%-21%	0.99	1.82E-11	37%	34%-42%	0.98	6.48E-10
Streets Projects	**263**	**16%**	**14%-17%**	**0.63**	**1.26E-59**	**18%**	**17%-19%**	**0.94**	**5.7E-165**	**34%**	**32%-35%**	**0.91**	**8.4E-137**
Widening/New/ Grade Separations	33	13%	10%-14%	0.74	6.17E-13	19%	18%-20%	0.97	7.07E-26	32%	29%-33%	0.97	1.04E-27
Bridges	10	35%	18%-52%	0.73	1.62E-3	12%	10%-13%	0.98	3.18E-8	47%	31%-63%	0.85	1.58E-4
Reconstructions	69	24%	23%-31%	0.69	1.31E-9	17%	17%-21%	0.83	1.11E-28	41%	40%-51%	0.79	1.19E-25
Bike/Pedestrian/ Streetscapes	78	20%	15%-22%	0.53	1.91E-14	14%	10%-15%	0.62	6.52E-18	34%	25%-36%	0.62	9.52E-18
Signals	73	16%	10%-16%	0.43	3.29E-12	17%	13%-18%	0.61	6.69E-17	34%	25%-32%	0.75	2.22E-27
Pipes Projects	**267**	**9%**	**9%-10%**	**0.88**	**5.0E-125**	**10%**	**9%-10%**	**0.99**	**1.3E-307**	**19%**	**18%-19%**	**0.96**	**6.6E-193**
Gravity Mains	227	9%	9%-10%	0.88	5.7E-107	10%	9%-10%	1.00	5.9E-277	19%	18%-19%	0.96	1.5E-164
Pressure Systems	22	7%	0%-7%	0.00	7.28E-2	10%	4%-10%	0.46	7.52E-5	17%	5%-17%	0.23	1.35E-3
Pump Stations	13	14%	11%-17%	0.89	9.95E-07	10%	6%-12%	0.80	1.75E-05	24%	20%-25%	0.97	2.21E-10
Parks Projects	**83**	**25%**	**24%-29%**	**0.83**	**5.5E-33**	**10%**	**7%-11%**	**0.49**	**9.04E-15**	**35%**	**33%-38%**	**0.91**	**1.28E-43**
Playgrounds	65	21%	19%-22%	0.89	1.07E-32	15%	14%-17%	0.87	2.8E-29	36%	33%-38%	0.92	7.15E-37
Sportfields	12	30%	31%-46%	0.84	7.78E-07	4%	0%-3%	0.00	3.27E-1	34%	31%-47%	0.90	1.46E-6
Restrooms	6	38%	5%-111%	0.58	3.89E-2	18%	0%-31%	0.42	1.13E-1	55%	32%-110%	0.80	7.27E-3

Notes:

[1] TCC = Total Construction Cost; Des. = Design Cost; CM = Construction Management Cost, and PD = Project Delivery Cost. CI = Confidence Interval. The project delivery percentages indicated are the ranges corresponding to the 95 percent confidence intervals on the slope of the linear regression trendline. Caution and review of the report text are urged in using this information. Refer to Appendix B for the corresponding regression curves, R2 values, and N values for more details. Highlighted values indicate those for which R2 values were low (below 0.50).

[2] Other Pipes Projects are not included in this table due to a small number of projects (less than 5).

Table 1-7
Summary of Performance Models (Smaller Project Subset of TCC)

Project Type or Classification	Number of Projects (N)	Design Cost				Construction Management Cost				Project Delivery Cost			
		(% of TCC)	95% CI (% of TCC)	R^2	p-value	(% of TCC)	95% CI (% of TCC)	R^2	p-value	(% of TCC)	95% CI (% of TCC)	R^2	p-value
Municipal Projects	**93**	**17%**	**13%-17%**	**0.64**	**8.17E-23**	**14%**	**12%-15%**	**0.73**	**4.58E-28**	**31%**	**25%-32%**	**0.78**	**8.89E-33**
Libraries	18	18%	6%-23%	0.41	2.29E-3	12%	0%-9%	0.00	5.63E-1	30%	6%-27%	0.07	3.65E-3
Police/Fire Stations	25	14%	7%-13%	0.54	4.22E-7	14%	10%-15%	0.79	1.28E-9	28%	18%-28%	0.75	1.87E-09
Comm./Rec.Center/ Child Care/Gyms	40	19%	11%-22%	0.45	8.11E-7	14%	10%-16%	0.69	1.3E-11	34%	23%-35%	0.66	3.14E-11
Other Municipal	10	17%	14%-22%	0.93	3.25E-6	10%	3%-12%	0.52	7.04E-3	26%	20%-31%	0.93	5.7E-6
Streets Projects	**208**	**27%**	**22%-30%**	**0.44**	**7.85E-28**	**19%**	**15%-20%**	**0.50**	**6.97E-33**	**46%**	**39%-49%**	**0.61**	**1.05E-44**
Widening/New/ Grade Separations	26	26%	9%-29%	0.31	4.72E-4	17%	11%-21%	0.66	3.48E-7	43%	23%-47%	0.53	4.4E-6
Bridges	8	37%	7%-39%	0.26	1.29E-2	16%	5%-21%	0.65	6.43E-3	53%	19%-53%	0.50	2.18E-3
Reconstructions	55	23%	15%-28%	0.45	2.43E-8	14%	9%-14%	0.51	1.31E-10	37%	26%-40%	0.62	5.4E-13
Bike/Pedestrian/ Streetscapes	61	28%	15%-32%	0.34	3.36E-7	19%	14%-26%	0.44	5.56E-9	47%	32%-56%	0.48	9.46E-10
Signals	58	25%	15%-30%	0.39	1.31E-7	21%	7%-25%	0.17	6.25E-4	46%	29%-50%	0.50	1.99E-10
Pipes Projects	**214**	**17%**	**11%-16%**	**0.31**	**3.36E-21**	**17%**	**14%-18%**	**0.60**	**1.75E-44**	**35%**	**26%-34%**	**0.54**	**2.61E-39**
Gravity Mains	182	17%	11%-16%	0.32	6.47E-19	18%	15%-19%	0.59	7.38E-37	35%	27%-34%	0.55	3.87E-34
Pressure Systems	18	11%	4%-15%	0.48	1.07E-3	14%	11%-17%	0.85	5.52E-8	25%	17%-30%	0.79	7.35E-7
Pump Stations	10	21%	8%-26%	0.62	2.05E-3	22%	16%-29%	0.89	4.34E-5	43%	27%-51%	0.86	6.61E-5
Parks Projects	**66**	**21%**	**11%-23%**	**0.30**	**5.54E-7**	**14%**	**6%-14%**	**0.23**	**2.68E-6**	**35%**	**19%-34%**	**0.40**	**3.8E-10**
Playgrounds	52	23%	13%-24%	0.44	2.01E-8	14%	4%-13%	0.09	1.09E-3	36%	19%-35%	0.42	4.96E-9
Sportfields	10	12%	0% - 24%	0.26	1.5E-1	10%	0%-12%	0.00	2.31E-1	21%	0%-31%	0.00	2.17E-1
Restrooms	5	11%	0% - 23%	0.00	5.77E-1	25%	10%-49%	0.86	1.68E-2	36%	2%-65%	0.78	4.38E-2

Notes:

[1] TCC = Total Construction Cost; Des. = Design Cost; CM = Construction Management Cost, and PD = Project Delivery Cost. CI = Confidence Interval. The project delivery percentages indicated are the ranges corresponding to the 95 percent confidence intervals on the slope of the linear regression trendline. Caution and review of the report text are urged in using this information. Refer to Appendix B for the corresponding regression curves, R2 values, and N values for more details. Highlighted values indicate those for which R2 values were low (below 0.50).

[2] Other Pipes Projects are not included in this table due to a small number of projects (less than 5).

In Update 2009, the Project Team added one new BMP under a new category called Sustainable Development to the BMP Implementation tracking list. This BMP was developed to address the growing need to incorporate environmental sustainability in engineering design and construction practices. The agencies felt that this new category should be added to Best Management Practices. The BMP was worded as:

- 7.a.2009 - To quantify the environmental benefits of the project at the time of award.

This BMP is believed to influence the cost of either design or construction management and, ultimately, project delivery efficiency. This BMP also has an intangible benefit through its positive long range effect on our environment.

D. ONLINE DISCUSSION FORUM

The following discussion topics are summarized in the Chapter 5 Online Discussion Forum.

- Infrastructure and Fixed Assest Capitalization Policies
- Permeable and Pervious Pavements
- Separate Section for Estimating and Scheduling
- Resource Level Scheduling
- Qualification Based Consultant Selection (QBCS) Policy/Procedure
- Materials Testing Laboratory Services
- Project Labor Agreement
- Covered Pedestrian Walkways
- Job Order Contracting

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

E. CONCLUSIONS

I. Performance Benchmarking

This year's *Study* focused on refining the modeling methodology used to develop relationships between the different components that constitute project delivery costs and the TCC. Statistical studies to determine the best-fit curve for the projects in the database revealed that the linear trendline was the best-fit curve amongst the five types of curves (logarithmic, exponential, polynomial, power, and linear) selected for evaluation. Improvements to the model also resulted in good R^2 and p-values indicating good relationships between the project delivery components and the TCC.

In order to incorporate the agencies' observations that on a percentage basis, projects with lower TCCs are more expensive to deliver than projects with higher TCCs, the *Study* Team conducted investigations with an objective to identify a subset of project size (in terms of TCC) that represented what was generally considered as the smaller projects. Regressions and statistical tests for the smaller projects revealed that the delivery costs for the smaller projects were higher than for the full range of projects. Therefore, in Update 2009, project data was analyzed in two ranges of TCC. The results of this analysis conformed to the agencies' practical experiences.

Although the results of the performance analyses are based on historical data provided by the participating agencies, there are several factors that affect project delivery and are not captured in the performance model. These external factors include personnel turnover in the agencies, competitive bids etc which impact project delivery. The reader is cautioned that the improved results of the regression analyses only be used as a reference and not for prediction of future performance.

Due to the current economic conditions, agencies are receiving bids that are significantly lower than the engineer's estimates. Therefore, it should be noted that project data collected over the next few *Study* cycles may exhibit higher project delivery costs as a percentage of the TCC as a result of the low construction bids due to the current economic crisis. It is recommended that the reader use best judgment while using the *Study* results for planning and budgeting.

Project delivery percentages (arithmetic averages) for the Update 2009 *Study* varied between the following values for the full range and the smaller project subset of TCC respectively:

Municipal Projects: 36% - 39%

Parks Projects: 39% - 41%

Pipes Projects: 36% - 39%

Streets Projects: 46% - 49%

II. Best Management Practices

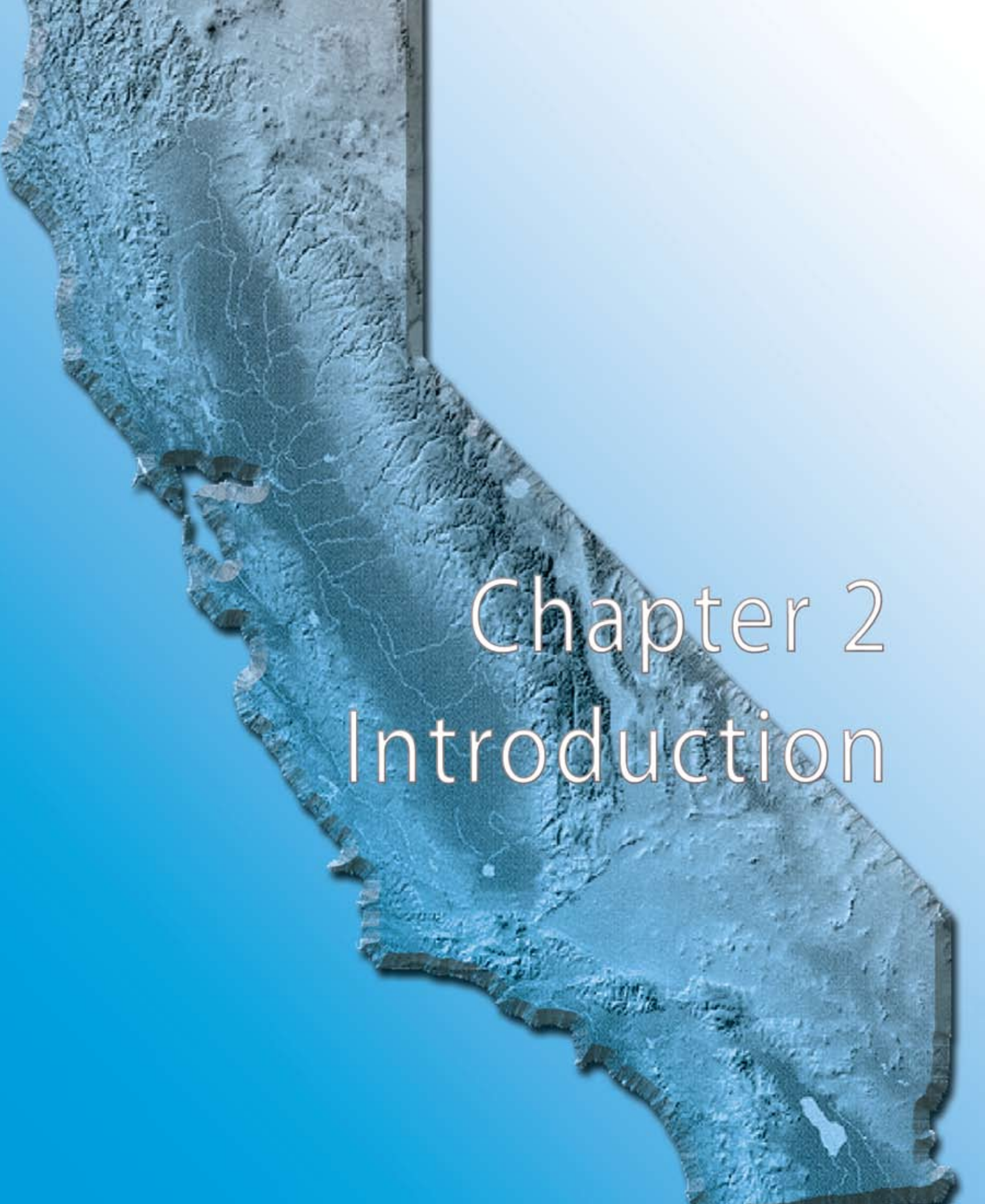
The agencies have continued to fully implement selected BMPs. Given the current state of the economy and due to staff reductions, furloughs, and the management's increased involvement in resolving budgetary issues, progress on fully implementing BMPs has been impacted. The agencies have focused their efforts on tracking BMPs that have been implemented and which continue to provide efficiencies in project delivery processes for participating departments. As of Update 2009, the agencies have fully implemented about 72 percent of all BMPs. Many more have been partially implemented with the goal of complete implementation over the next two years.
In Update 2009, the Project Team added one new BMP under a new category called Sustainable Development to the BMP Implementation tracking list. This BMP was developed to address the growing need to incorporate environmental sustainability in engineering design and construction practices. This BMP also has an intangible benefit through its positive long range effect on our environment. BMPs in the other areas will be discussed and developed during future *Study* phases.

As the BMPs are implemented, participating agencies should begin to realize project delivery efficiencies including but not limited to reduction in delivery times, reduced change orders, and overall project cost reductions.

III. Online Discussion Forum

In Update 2009, the Agencies transitioned from using emails to an online portal for collaboration on project delivery issues. There are several benefits of this transition one of which is the ability to archive all topics of discussion in a single location which is easily accessible. The use of the online portal also ensures that communication is not lost when a member leaves the Project Team.

The Online Discussion Forum continues to be an increasingly important feature for *Study* participants, with active exchanges occurring frequently and important issues addressed with changes to policy, approach, or BMP implementation. 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. The continued sharing of challenges and solutions through the Online Discussion Forum remains a remarkable advantage to all participants.



Chapter 2
Introduction

CHAPTER 2

Introduction

During these highly challenging economic times, the *California Multi-Agency CIP Benchmarking Study (Study)* has continued its unparalleled effort to share the collective Capital Improvement Project implementation experiences of seven out of the eight largest cities in California for the eighth consecutive year. 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, they have obtained a better understanding of the changing capital project delivery process.

This year, the participating agencies spent a substantial amount of effort sharing approaches to continue to provide high value implementation of their capital programs in the most efficient manner possible in the face of unprecedented fiscal hardships. The *Study* provides a forum for the Agencies to share information amongst themselves via: quarterly meetings with a focus on current issues, an online portal where topics for discussion can be posed and challenges addressed, and a database that serves as both, a repository of the Agencies' projects and a tool for data analysis. Through these acts of collaboration, often times an optimum solution is found that can be translated into a Best Management Practice (BMP) for the group.

The sharing of best ideas amongst the Study participants have benefitted the agencies and owners can turn to one another to gather insight on how to address challenges that might be new to them, but which others have already faced.

In this eighth year of the *Study*, the Update 2009 participants have continued to pursue on-going endeavors, as well as taken on new ones:

- Addition of the "Special Topic" roundtable discussion forums at Quarterly Meetings to explore areas of potential positive impact in relation to the current fiscal challenges;
- Improved online discussion forum for efficient information sharing;
- Continued improvement to the modeling methodology of the performance models;
- Continue to improve the quality of the performance data and the functionality of the database;
- Track the adoption of BMPs; and
- Create new BMPs targeted to common issues.

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 eight 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 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, Department of Engineering and Construction
- 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 and City Manager's Office

Table 2-1 summarizes some of general characteristics of the participating agencies and/or of specific departments.

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.

Table 2-1
Agencies' Overall Information

Information	Population[2]	Area (sq. mi.)	Website	Government Form
Long Beach	492,682	50	http://www.longbeach.gov	Council-Manager-Charter[1]
Los Angeles	4,065,585	469	http://eng.lacity.org	Mayor-Council
Oakland	425,068	66	www.oaklandnet.com	Mayor-Council-Administrator
Sacramento	481,097	99	http://www.cityofsacramento.org	Council-Manager
Dept. of General Services				
Dept. of Transportation				
Dept. of Utilities				
San Diego	1,353,993	342	http://www.sandiego.gov	Mayor-Council
San Francisco	845,559	47	http://www.sfdpw.com	Mayor-Board of Supervisors (11 members)
San Jose	1,006,892	178	http://www.sanjoseca.gov	Mayor-Council-Manager

Notes:
[1] Mayor has veto power.
[2] Source: California Department of Finance Population Estimates for Cities, Counties, and the State.

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:

- The City of San Jose continues to benefit by having ready access to the performance data and BMPs of the largest cities in California. This has assisted their decision-making process regarding policy and procedural improvements, especially with regard to newer topics that impact capital project delivery such as LEED [Leadership in Energy and Environmental Design] and "green building" initiatives and alternative contracting

methods (e.g., design-build). San Jose also offers: "What is great is that we learn new things at every meeting that lead to ways we can challenge ourselves to improve our processes and procedures. The online forum has also proved to be a very valuable tool between meetings and has generated some very informative discussions on a broad range of topics."

- "The City and County of San Francisco uses the Benchmarking Study in working with other City agencies using our services. Design costs initially quoted by outside consultants may not reflect the final design costs associated with occupied facilities, seismic retrofits, and rehabilitation (especially involving corrosion, dry rot and hazardous material abatement). Presenting seven cities' data is far more persuasive than presenting our estimates and past data alone. International prices for steel, cement, and petroleum-based products have been volatile over the past 5 years. Since the mortgage lending and auto company economic crisis, the bidding environment has been even more unpredictable. Having the larger sample size of information afforded by the Benchmarking Study is essential to forecasting pricing trends with any degree of certainty. The online forum has helped us provide elected officials accurate information quickly regarding other cities' practices on accepting streets and structures for maintenance, and how maintenance work is funded."

- The City of Los Angeles has stated that "in addition to the general benefits that we have described in past years and continue to receive from participation in the benchmarking group, there was one very notable additional benefit this *study* year in that it was very helpful in dealing with the challenges resulting from the sharp downturn in the economy. We found that many of the agencies were experiencing somewhat similar challenges, but were dealing with them in slightly different ways. For instance, many agencies had either implemented furloughs, or were planning to in the near future. It was very helpful to hear how the agencies were handling tasks such as construction management and inspection within their furlough programs. Responses ranged from declaring the furlough days non-working days to staggering staff furlough days so that construction projects would stay on the original schedule."

- The City of Long Beach offers this comment: "In an unprecedented period of budget reductions, cost reallocations, changing bid environment, increasing public awareness and scrutiny, and the ever growing green movement, having the ability to compare notes on project delivery with other agencies in California has moved from being a luxury to a necessity. When every dollar spent on delivering a project needs to be justified and

accounted for, it becomes extremely important for cities to be able share project delivery successes and failures in a cooperative unthreatening environment. By doing so, the successes can be rapidly duplicated statewide, and hopefully, future failures avoided, thus saving time and money if each agency were to have to discover these project delivery methods on their own. Participation in the statewide benchmarking process has allowed the City of Long Beach to share and acquire such knowledge allowing the City to meet head on the current challenges of project delivery."

- According to the City of Sacramento, "the benefits of our continued participation in the *Study* have increased geometrically each year we have participated. Our data collection and tracking have evolved to mirror the *Study* format, making it much easier for us to directly correlate the results of our work and effort with that of our industry peers. As we continue to implement new BMPs each year, our project management and delivery standards have improved greatly over where we were just a few years ago. We have also found that the online discussion forum is an invaluable resource when we are researching a new policy or practice, as all of the participating agencies are very generous in sharing their own knowledge, standards, and practices."

- The City of San Diego "finds the *Study* extremely useful in validating our Engineering Department's performance and in setting benchmarks and goals, especially after our implementation of our Business Process Reengineering. Participation in the quarterly meetings allows us to share information on new processes that we or the other agencies are implementing, and we always get new or better ideas to improve our project delivery. The discussion forum is a great way to keep the momentum between meetings and to share detail information on processes."

- According to the City of Oakland "the *Study* has been an invaluable resource to help the City of Oakland deliver its CIP. It has provided hard data from seven out of the eight largest California cities on the costs of planning, designing and constructing projects ranging from small restroom remodels to multimillion dollar street, sewer and building projects. It also has allowed comparison of BMPs used by each City to deliver projects; and provided a mechanism to obtain instant responses from each City to questions about how to improve their processes. The *Study* has greatly improved Oakland's ability to deliver projects better, cheaper and faster."

C. STUDY FOCUS

Improving the accuracy and the functionality of the performance models has been a continuous goal of the *Study*. During Update 2008, the regression models were refined and the resultant R^2 values (a measure of goodness-of-fit of the trendline) typically increased tenfold. Although these activities resulted in an improved performance model and laid the foundations for this year's *Study*, the model did not fully capture the Agencies' practical experiences in the delivery of capital projects where it was generally observed that smaller projects normally cost more to deliver when the project delivery costs are expressed as a percentage of the TCC.

Therefore, this year special attention was given to refine the modeling methodology to incorporate the Agencies' experiences. As part of the model refinements, statistical evidence was used to reconfirm the selection of a linear regression as the best-fit curve for the project data points. Using the linear model, it was possible to determine the benefits of evaluating the performance data considering two ranges of construction costs. This analysis revealed that an economy of scale exists in the delivery of capital projects reflecting the experiences of the Agencies. Details regarding the changes to the regression model are presented in **Chapter 3 Performance Benchmarking**.

In addition, the focus of the Quarterly Meetings was adjusted to include a "Special Topic" roundtable discussion forum. This forum explored areas of potential positive impact in relation to current events and fiscal challenges. Topics were identified prior to each meeting allowing time for each agency to prepare and participate meaningfully in the discussions.

D. STUDY GOALS

The *Study* method 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 2009* the agencies made progress on several goals:

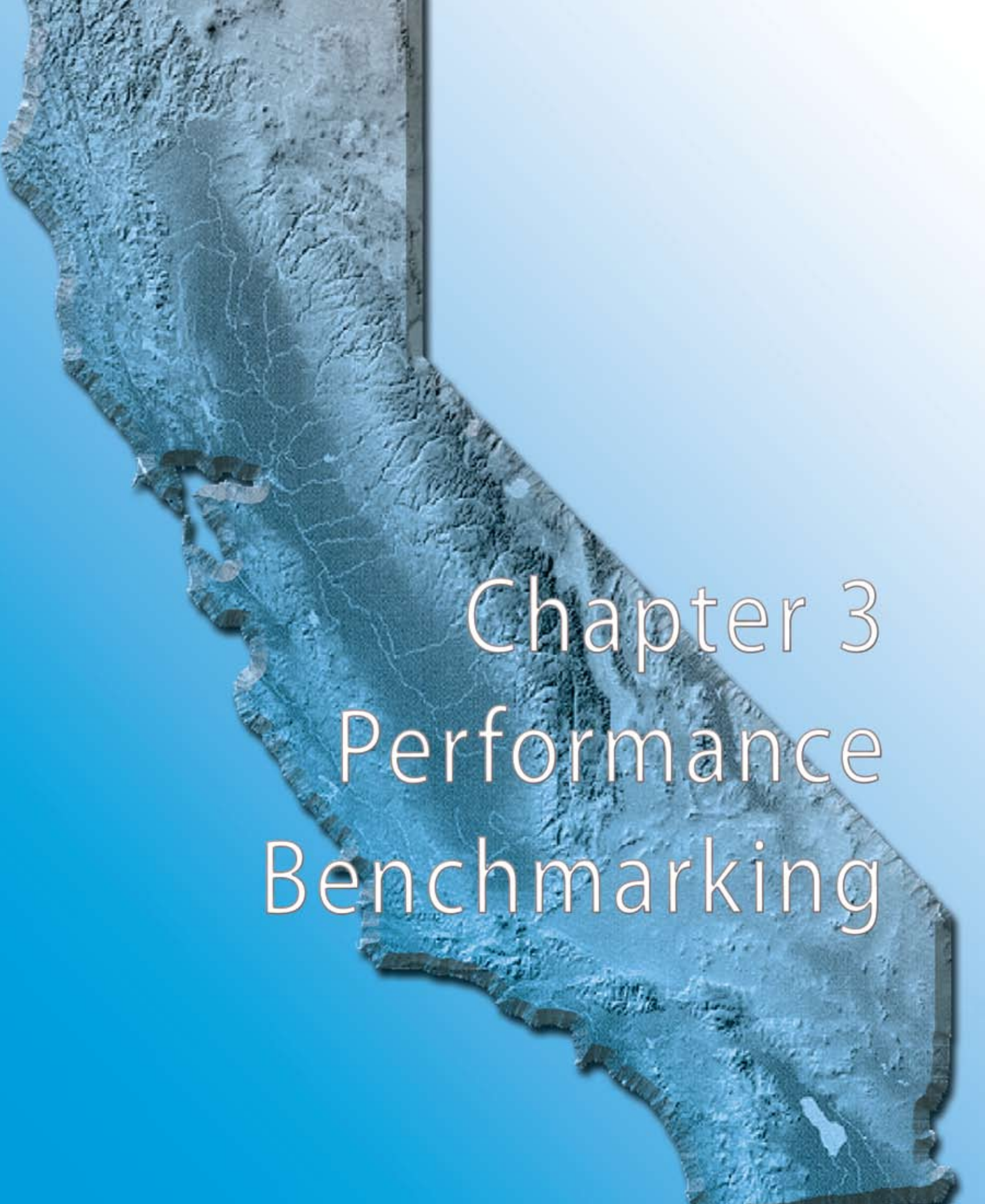
1. **Improve the modeling methodology to incorporate practical project delivery considerations.** Improving the performance models has been a continuous goal of the *Study*. This year special attention was given to refine the modeling methodology to reflect an economy of scale in the delivery of capital projects. The modeling methodology was refined to evaluate projects under two ranges of construction costs. The results from this evaluation provided support to the Agencies' experience that an economy of scale exists in the delivery of capital projects.

2. **Conduct roundtable discussions on Special Topics.** This year during each quarterly meeting roundtable discussions were held on current events. These sessions included discussions on innovative project delivery issues, the preparedness of the agencies to receive economic stimulus funding and the challenges posed by the current economic crisis towards efficient project delivery, and quality assurance and quality control of design and construction projects in the current fiscal crisis.

3. **Track the adoption of BMPs.** The *Study* Team continued to track the implementation of BMPs in order to link these practices to project delivery performance improvement over time in order to encourage their implementation.

4. **Create new BMPs targeted to address commonly held problem areas.** 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. One new BMP was adopted by the Project Team for implementation and added to the BMP implementation list. This BMP involved the estimation of environmental benefits in concert with the project award process.

5. **Continue efficient information sharing with one another through the online discussion forum.** In Update 2009, the Project Team utilized an online portal for discussing issues and challenges. The use of the online portal allows for efficient archiving of discussion topics and ease of access. The Project Team uses the discussion forum to share information; survey current processes and policies; and collaborate on implementing new processes and policies.



Chapter 3
Performance Benchmarking

CHAPTER 3 Performance Benchmarking

Performance benchmarking involves collecting documented project costs and plotting the component costs of project delivery against the total construction cost (TCC). The objective of this exercise is to develop relationships between these variables. As explained later in this Chapter (see **Section D and Section E**), the adoption of statistical techniques for model selection and vast improvements in the modeling methodology have significantly improved the model results in Update 2009 as compared to the results obtained in previous *Study* years.

The project costs data are collected from the agencies using a Performance Questionnaire created in Microsoft Excel®. Data are then compiled from the questionnaires 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 2009* performance benchmarking analyses:

- **Total Construction Cost** – 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. The participating agencies use fully-loaded (direct and indirect) costs for project delivery tasks. They have also agreed that land acquisition costs and environmental impact mitigation costs should be excluded from the TCC calculation.

- **Completion Date** – Projects included in the *Study* analyses were completed on or after January 1, 2004. Projects with earlier completion dates were kept in the database, but excluded from the analyses.

- **Outlier Elimination** – Statistical elimination was used to identify outliers in the performance model. The total project delivery percentage of each project in the database was evaluated against all other projects in the same classification. An outlier was identified as a project whose total project delivery percentage was outside the range expressed by the following equation:

  $y=m + 3\sigma$, where;

  m represents the mean of the project delivery percentages and σ represents the standard deviation of the project delivery percentages for all projects in the same classification.

  It should be noted that this approach, which was first adopted in Update 2008, allows for the inclusion of more data than in previous years where other methods including visual inspection were used for the elimination of outlier data points. This change was in part allowed by the improved modeling techniques that will be described in more detail in subsequent subsections.

  Projects confirmed as outliers by this statistical technique 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 method. Projects delivered using other project delivery methods are not included in this *Study* at this time.

- **Change Order Classification** – To support meaningful change order analyses, the Project Team reported change orders in accordance with the following classifications:

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

- Project Classifications – Sixteen project classifications grouped into four project types are used in this *Study*. In Update 2008, two new project classifications, "Other Municipal Facilities" and "Other Pipes" were added to the Municipal and the Pipes projects categories respectively. No projects were submitted by the agencies for the "Other Pipes" category in Update 2008. In Update 2009, five projects were submitted for the "Other Pipes" category. These two classifications will include projects that do not fall under the existing Municipal and Pipes classifications but are representative of the Municipal and the Pipes categories. The agencies will continue to collect data for these classifications for future analyses. 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 • Other Municipal Facilities[1]
Streets	• Widening, New, and Grade Separation • Bridges • Reconstruction • Bike Ways, Pedestrian Ways, and Streetscapes • Signals
Pipe Systems	• Gravity Systems • Pressure Systems • Pump Stations • Other Pipes
Parks	• Playgrounds • Sportfields • Restrooms

Notes:
[1] Projects include design and/or construction activities for parking structures, yards, soil anchors, docks, animal shelters, reservoirs, water treatment plants, piers, and animal services centers.

B. DATA COLLECTION AND CONFIRMATION

To obtain meaningful results from the performance model, it is essential that the data collected from the agencies are accurate and conform to the *Study* criteria. The agencies recognize the importance of quality input data and are committed 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 and consultant costs associated with project planning, design, bid, award, construction management, and closeout activities. Examples of specific activities included in each phase of project delivery are presented in **Table 3-2**.

For the Update 2009 *Study*, the agencies completed the questionnaires with comparable, complete, and accurate values. The agencies also review and compare their data collection and confirmation techniques on a regular basis. For example, in a quarterly meeting during Update 2008, each agency delivered a presentation describing how it compiles the project delivery data for the Performance Questionnaire. The presentations and the subsequent discussions helped clarify any inconsistencies in the data collection methodologies of the agencies. Such discussions ensure that inconsistencies in the data collection and confirmation process are identified and addressed. This also ensures that input data is vetted before projects are submitted for analysis.

Table 3-2
Project Cost Categories

Category and Phase	Description
1) Design Costs:	The design phase (and associated costs) begins with the initial concept development, 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:
Planning	• 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 • Qualify bidders • Manage the pre-bid conference • Evaluate bids • 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 costs associated with construction management, 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 and 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 Project Delivery Costs:	This is the total cost of delivering a capital improvement project, equal to 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 descriptions of the following types of change orders: • Changed/unforeseen conditions - This type of change is necessitated by discovery of actual job site conditions that differ from those shown on the contract plans or described in the specifications. These are conditions a designer could not have reasonably been expected to know about during the design of the project. • Changes to Bid Documents - This type of change is necessitated by a mistake or oversight in the original contract documents and is required to correct the plans and specifications. • Client-Initiated Changes - This type of change results from additions, deletions or revisions to the physical work.
5)Total Construction Cost (TCC):	This is the direct construction cost, including all change orders during the construction phase (from the issuance of Notice to Proceed to Notice of Completion). The following costs are associated with construction and are included in the TCC: • 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

C. PERFORMANCE DATABASE

The projects data submitted by the agencies are complied in a customized Microsoft Access® database. This database not only serves as a repository for the data collected since the inception of the *Study*, but also allows for data analysis using built-in functions. The database also provides customized reports and tables for easy data interpretation. Each year, the projects database is updated with the inclusion of projects data submitted for that *Study* year. The analysis and the reporting features of the database are also updated.

Table 3-3 summarizes the number of projects included in the database and in the analyses. The 5-year database used for the current analysis contains 729 projects. This total excludes project data older than five years or projects identified as outliers. Projects identified as outliers are not included in the performance data analysis but are retained in the performance database. As explained under subsection A *Study* Criteria of this chapter, outlier analysis was performed using statistical techniques to ensure consistency in the selection of outlier data points. This methodology was first implemented during Update 2008 and the agencies recognize the merits of a scientific approach for outlier elimination. Some of the projects classified as outliers in previous *Study* years have been included in the performance data analysis, and vice-versa.

This is an improved practice when compared to prior *Study* years where project data points were classified as outliers based on a combination of statistical parameters and subjective judgments by the Project Team. Previously, projects identified as outliers during one *Study* phase were kept as outliers in subsequent *Study* phases.

Table 3-3 shows that as the rules for project selection got refined, non-representative projects and projects with TCC less than $100K have gone down. In addition, only 14 projects have been excluded as outliers in the Update 2009 *Study* as compared to the elimination of 147 projects in Update 2007 and 113 projects in Update 2006.

Table 3-3
Growth of Database

Study Phase[1]	Submitted	Deleted		Increase	Excluded		Net
	(a) Total	(b) TCC <$100K	(c) Non-Repre-sentative[2]	(d)=(a)-(b)-(c)	(e) Project Completion Date <2002	(f) Outliers[3]	Projects in Analyses (h)= (d)-(e)-(f)-(g)
I	237	25	44	168	168	0	0
II	285	0	35	250	250	0	0
III	262	0	29	233	230	0	3
IV	170	17	21	132	36	4	92
V	182	0	3	179	19	3	157
VI	189	0	0	189	3	2	184
VII	158	1	0	157	7	3	147
VIII	151	2	0	149	1	2	146
Total	**1,634**	**45**	**132**	**1,457**	**714**	**14**	**729**

Notes:
[1] Study Phase indicates action taken on the count of projects corresponding to Study Years I = 2002, II = 2003, III = 2004, IV = 2005, V = 2006, VI = 2007, and VII = 2008.
[2]Projects that do not fit Study criteria for project classifications and minimum TCC of $100K were removed from the database.
[3]Outliers are identified based on statistical analysis and visual elimination.

As previously indicated, there are 4 project types (Municipal Facilities, Streets, Pipe Systems, and Parks) and 16 project classifications included in this *Study*. **Table 3-4** summarizes the distribution of projects included in the *Update 2009* analyses.

In the *Study 2002* report, it was recommended that at least 10 projects per classification and a minimum data set of 2,000 projects distributed evenly among classifications, ranges of TCC, and agencies are necessary to achieve statistically-significant results.

Although the requirement for the minimum number of projects per classification has been met for most project categories, more data needs to be collected to ensure an even distribution of projects amongst all classifications.

The agencies acknowledged that it is vital to the success of the *Study* to continue increasing the size of the data set, 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	5	36	12	11	10	8	34	**116**
Libraries	0	10	0	0	3	1	9	**23**
Police/Fire Stations	1	9	1	6	4	2	8	**31**
Comm./Rec. Center/ Child Care/Gyms	1	15	10	4	1	4	15	**50**
Other Municipal Facilities[2]	3	2	1	1	2	1	2	**12**
Streets	9	16	42	55	44	39	58	**263**
Widening/New/ Grade Separations	0	6	0	11	5	2	9	**33**
Bridges (New/Retrofit)	0	4	0	2	1	0	3	**10**
Reconstructions	7	4	18	4	4	22	10	**69**
Bike/Pedestrian/	1	2	18	27	11	5	14	**78**
Streetscapes	1	0	6	11	23	10	22	**73**
Signals	2	87	34	36	36	32	40	**267**
Pipe Systems	2	82	34	27	21	26	35	**227**
Gravity Systems (Storm Drains/Sewers)	0	0	0	6	8	6	2	**22**
Pressure Systems	0	1	0	2	7	0	3	**13**
Pump Stations	0	4	0	1	0	0	0	**5**
Parks	2	8	26	2	1	9	35	**83**
Playgrounds	2	3	20	1	1	9	29	**65**
Sportfields	0	5	4	1	0	0	2	**12**
Restrooms	0	0	2	0	0	0	4	**6**
Total[1]	**18**	**147**	**114**	**104**	**91**	**88**	**167**	**729**

Notes:

[1] Total refers to the projects included in the Update 2009 analyses only.

[2] Projects include design and/or construction activities for parking structures, yards, soil anchors, docks, animal shelters, reservoirs, water treatment plants, piers, and animal services centers.

D. PERFORMANCE MODEL SELECTION

Prior to discussing the model selection methodology for Update 2009, a brief overview of the relevant statistical terminology and their definitions is provided.

Regression Definitions

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

The regression trendline can be used as a starting point for evaluating the budget for a suite of projects. Caution and use of professional judgment is required if using the regression trendline to budget an individual project.

Confidence Interval

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.

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 whether the data set could be used to forecast 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 $p \leq 0.10$ is considered statistically significant. 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.

Model Selection

During Update 2008, a significant amount of time and effort was expended on improving the accuracy of the performance model. A linear trendline was selected to replace the logarithmic relation between the project delivery costs and the TCC. These efforts yielded positive results by eliminating auto-correlation in the modeling methodology and by producing significant improvements in the performance model results that yielded R^2 values of significantly higher magnitudes.

Although the participating agencies acknowledge the merits of a refined performance model using a linear trend line, it does not completely reflect the agencies' observations that on a percentage basis, projects with lower TCCs are more expensive to deliver than projects with higher TCCs. At the request of the participating agencies, during Update 2009 the *Study* Team evaluated five types of curves (logarithmic, exponential, polynomial, power, and linear) to determine the best-fit curve for the regression model.

Logarithmic and exponential curves resulted in poor R^2 values and generally fit poorly to the data points. Although polynomial curves exhibited good R^2 values, they did not model real world results. Power curves generated good R^2 values and represented a good fit for the project data. In all the cases, the resulting power curves were almost linear in nature. However, the associated expression used to calculate the project delivery percentage was mathematically complex. Linear trendlines generated good R^2 values and represented a good fit for the project data. In addition, the associated expression used to calculate the project delivery percentage was a simple mathematical relationship.

The findings of the best-fit analysis were reviewed by a statistics expert before being presented to the participating agencies during a quarterly meeting. The participating agencies agreed with the results of the analysis and approved the use of the linear trendline as the best-fit curve for the project data points, particularly with the enhancements made to the modeling methodology discussed in the next subsection.

E. MODELING METHODOLOGY

To explore the agencies' observations that on a percentage basis, projects with lower TCCs are more expensive to deliver than projects with higher TCCs, the *Study* Team conducted additional investigations. The objective was to identify a subset of project size (in terms of TCC) that represented what was generally considered as the smaller projects. A statistical analysis of the distribution of the projects in the database revealed that generally 80 percent of the projects lay between a TCC ranging from $100,000 to $2 Million. Regressions were then undertaken to determine if delivery costs for this subset behaved in a different fashion than for the full range of projects. The statistical tests generally produced favorable results and it was concluded that this subset of projects were representative of the characteristics of smaller projects.

Therefore, it was decided to analyze the projects data in the following two ranges:

1. Full range of TCC

2. Smaller project subset of TCC (first 80 percent of the project distribution)

Preliminary results of such an evaluation using the Update 2008 projects database were presented to the agencies during a quarterly meeting. The results conformed to the agencies' practical experiences. After reviewing the results, the agencies directed the *Study* Team to analyze the Update 2009 projects data in the two ranges discussed above. The characteristics of the project data in the performance database are presented in the following subsection.

F. CHARACTERISTICS OF DATA ANALYZED

Project performance data were analyzed using the custom database application at both the Project Type level and the Project Classification level (see **Table 3-1**).

Project Count and Project Delivery by Completion Year

Table 3-5 summarizes characteristics of the 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. The median value is the value at which 50% of the values are above and 50% of the values are below.

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)
2004	24	56	37	27	144	$2.99	$0.57	27%	18%	46%
2005	27	70	80	18	195	$1.74	$0.66	23%	17%	40%
2006	35	53	63	9	160	$2.68	$0.86	20%	17%	37%
2007	16	50	45	14	125	$2.58	$0.70	23%	17%	40%
2008	14	34	42	15	105	$2.36	$0.72	23%	17%	40%
Total	116	263	267	83	729	$2.21	$0.65	23%	17%	40%

Notes:
[1] Project Delivery percentages represent arithmetic averages of the individual projects and do not represent the results from the regression analyses.
[2] Project Delivery percentages vary from year to year based on the selection and the composition of the projects in the database.

As indicated in **Table 3-5**, project size (measured as median TCC), increased significantly between 2004 and 2006 with an increase of approximately 51 percent. Project size declined approximately 16 percent between 2006 and 2008. The average TCC also declined steadily between 2006 and 2008. Similarly, project delivery costs measured as a percentage of the TCC declined significantly between 2004 and 2006. The project delivery percentages have remained stable during 2007 and 2008 having increased slightly from 2006.

Project Delivery Costs by Project Type

Table 3-6 shows project delivery costs by each of the four project types in the *Study* for the full range of TCC. The project delivery percentage for a category is the arithmetic average of the project delivery percentages of the individual projects grouped under that category.

Although it is desirable for project delivery costs to decrease as agency efficiencies increase and BMPs are implemented, this can be confounded by other factors that change annually such as project size and market competition. For example, presently actual bid amounts have been depressed by competitive forces associated with the current recession. This will result in the rise of delivery cost as a percentage of TCC as TCC is depressed. The result may be noticed in the coming years as these projects are completed and reported into the database.

Table 3-6
Project Delivery Costs by Project Type (% of TCC) (Full Range of TCC)

Type	Design	Construction Management	Project Delivery (Total)	Median Total Construction Cost ($M)	Number of Projects (N)
Municipal Facilities	21%	16%	36%	3.08	116
Parks	23%	16%	39%	0.34	83
Pipe Systems	20%	17%	36%	0.71	267
Streets	27%	19%	46%	0.54	263
Average	23%	17%	40%	0.65	729

Notes:
[1] Project Delivery percentages represent arithmetic averages of the individual projects and do not represent the results from the regression analyses.
[2] Project Delivery percentages vary from year to year based on the selection and the composition of the projects in the database.

Projects belonging to the Pipes and the Municipal categories have the lowest average project delivery cost. The Pipes category has the maximum number of projects (n = 267) in the Update 2009 database. The Streets category also has a similar number of projects in the database (n = 263). The Streets category also exhibits the highest average project delivery cost. The influence of low project delivery cost from Pipes projects is balanced by the influence of high project delivery cost from Streets projects. The average project delivery percentage for the overall dataset is approximately 40 percent.

Over the course of the *Study*, the Agencies have observed that the relatively high average project delivery cost of Streets projects is probably due to increasing cost influences of right-of-way acquisition, community outreach requirements, environmental mitigation requirements, and the smaller median total construction cost of these projects.

Table 3-7 shows project delivery costs by each of the four project types in the *Study* for the smaller projects subset of TCC. The trends in the project delivery costs for the projects in the smaller project subset of TCC follow that of the projects in the full range of TCC. As expected based upon the Agencies' practical experience, project delivery costs are higher for projects that fall in the smaller project subset of TCC.

Table 3-7
Project Delivery Costs by Project Type (% of TCC)
(Smaller Project Subset of TCC)

Type	Design	Construction Management	Project Delivery (Total)	Median Total Construction Cost ($M)	Number of Projects (N)
Municipal Facilities	22%	16%	39%	3.08	93
Parks	24%	17%	41%	0.34	66
Pipe Systems	21%	18%	39%	0.71	214
Streets	29%	20%	49%	0.54	208
Average	25%	18%	43%	0.65	581

Notes:
[1] Project Delivery percentages represent arithmetic averages of the individual projects and do not represent the results from the regression analyses.
[2] Project Delivery percentages vary from year to year based on the selection and the composition of the projects in the database.

Consultant Usage Analysis

Project delivery performance and consultant usage by agency are presented in **Table 3-8**. The table indicates that approximately 56 percent of the design work and approximately 82 percent of the construction management efforts are completed in-house by the participating agencies. Consultants account for approximately 32 percent of the total project delivery costs while in-house efforts by the participating agencies accounts for the remaining 68 percent of the project delivery costs. For the available data, a clear relationship between the level of in-house effort and project delivery costs cannot be established.

G. REGRESSION ANALYSIS RESULTS

During Update 2008, several changes were made to improve the modeling methodology. These included developing a statistically-sound method for outlier analysis, using a linear trendline for modeling project costs relationships, and using the upper and lower bounds of a 90 percent confidence interval to estimate the range of the project delivery percentages. As a result of these improvements, the model relationships could be predicted with a high degree of certainty as compared to previous *Study* years. During Update 2009, the modeling methodology was further refined by analyzing the data in two ranges of TCC.

Table 3-8
Project Delivery Performance and Consultant Usage by Agency

AGENCY	DESIGN					CONSTRUCTION MANAGEMENT					PROJECT DELIVERY					TCC	
	In-House		Consultants			In-House		Consultants			In-House		Consultants				
	($M)	% of Design[1]	($M)	% of Design	Total % of TCC[2,3]	($M)	% of CM	($M)	% of CM	Total % of TCC	($M)	% of PD	($M)	% of PD	Total % of TCC	Average	Median
Agency A	31.5	47%	35.9	53%	27%	32.9	68%	15.2	32%	15%	64.4	56%	51.1	44%	42%	2.5	0.7
Agency B	12.2	47%	13.5	53%	18%	11.6	61%	7.6	39%	12%	23.8	53%	21.1	47%	30%	1.4	0.4
Agency C	25.3	93%	2.0	7%	17%	24.7	97%	0.8	3%	17%	50.0	95%	2.8	5%	34%	1.6	1.1
Agency D	62.2	53%	55.0	47%	22%	100.1	85%	17.6	15%	21%	162.3	69%	72.5	31%	43%	5.0	1.3
Agency E	3.4	30%	8.0	70%	19%	6.8	72%	2.6	28%	14%	10.3	49%	10.6	51%	33%	2.3	1.1
Agency F	38.5	61%	24.7	39%	25%	44.4	88%	5.9	12%	22%	82.9	73%	30.6	27%	47%	1.4	0.4
Agency G	13.3	60%	8.8	40%	25%	9.4	100%	0.0	0%	13%	22.7	72%	8.8	28%	38%	0.8	0.4
OVERALL	186.5	56%	147.9	44%	23%	230.0	82%	49.7	18%	17%	416.5	68%	197.6	32%	40%	2.2	0.6

Notes:

[1] In-House and Consultant costs are expressed as percentages of total agency Design, CM (Construction Management), and PD (Project Delivery) costs.

[2] Total Construction Cost (TCC) is the sum of construction contract award, change orders, utility relocation cost, and city forces construction cost.

[3] Design, CM, and PD costs are expressed as percentages of TCC and are unweighted, arithmetic averages of projects by agency.

Given all these improvements to the analysis of the data, the reader is advised that direct comparison of data between Update 2009 and previous years may be more difficult due to these improvements.

The results of the regression analyses are discussed in the remainder of this section. The results of the regression analyses are summarized in **Table 3-9** and **Table 3-10**. **Table 3-9** summarizes the performance model results for the full range of TCC while **Table 3-10** summarizes the results for the smaller project subset of TCC. These tables also summarize the design, construction management, and project delivery costs expressed as a percentage of the TCC and the R^2 and the p-values for the different project types.

The plots depicting the regression relationships are shown in **Appendix B**. It should also be noted that while majority of projects are clustered near the origin of the graph, the slope of the trendline is predominantly governed by the data points scattered at relatively high TCC values. Since the slope of the trendline provides the design, construction management, or the project delivery costs as a percentage of the TCC for a group of projects, the results better reflect the properties of a program of projects rather than that of an individual project. Therefore, the reader must avoid budgeting individual projects based on these analyses.

In most cases, the results reflect the agencies' experience with the delivery of capital projects that on a percentage basis projects with lower TCCs are more expensive to deliver than projects with higher TCCs. For projects belonging to the Pipes category, there is a significant increase (approximately 16 percent) in the project delivery percentages for projects evaluated in the smaller project subset of TCC. Similarly, project delivery percentages for projects belonging to the Streets category exhibit a 12 percent increase. Projects under the Municipal category exhibit a minor increase while projects under the Parks category show no change in their project delivery percentages for projects evaluated in the smaller project subset of TCC. Comparing the results summarized in T**able 3-9** and **Table 3-10** shows that an economy of scale exists in delivering projects with a higher TCC versus those with a lower TCC.

It is important to note that while the slopes of the linear regression models are an expression of the project delivery cost as a percentage of construction, the slopes are not equal to the average and median project delivery percentages shown in **Table 3-5**, **Table 3-6** and **Table 3-7**. The project delivery percentages in the tables represent arithmetic averages of the individual projects and do not represent the results for the regression analysis.

In addition, it should be noted that although the R^2 and p-values are higher than in previous *Study* phases, the reader is cautioned that this table only 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 3-9
Summary of Performance Models (Full Range of TCC)

Project Type or Classification	Number of Projects (N)	Design Cost				Construction Management Cost				Project Delivery Cost			
		(% of TCC)	95% CI (% of TCC)	R^2	p-value	(% of TCC)	95% CI (% of TCC)	R^2	p-value	(% of TCC)	95% CI (% of TCC)	R^2	p-value
Municipal Projects	**116**	**17%**	**16%-19%**	**0.90**	**8.28E-59**	**18%**	**17%-19%**	**0.92**	**1.06E-65**	**35%**	**34%-38%**	**0.94**	**3.06E-71**
Libraries	23	16%	9%-16%	0.63	3.11E-7	12%	7%-15%	0.59	1.22E-5	28%	19%-28%	0.77	1.41E-9
Police/Fire Stations	31	17%	14%-22%	0.78	6.05E-11	16%	13%-21%	0.75	2.5E-10	33%	29%-41%	0.81	3.14E-12
Comm./Rec.Center/ Child Care/Gyms	50	17%	13%-18%	0.77	2.2E-17	11%	7%-11%	0.64	1.28E-13	28%	21%-28%	0.80	4.91E-20
Other Municipal	12	18%	15%-21%	0.94	1.5E-7	19%	18%-21%	0.99	1.82E-11	37%	34%-42%	0.98	6.48E-10
Streets Projects	**263**	**16%**	**14%-17%**	**0.63**	**1.26E-59**	**18%**	**17%-19%**	**0.94**	**5.7E-165**	**34%**	**32%-35%**	**0.91**	**8.4E-137**
Widening/New/ Grade Separations	33	13%	10%-14%	0.74	6.17E-13	19%	18%-20%	0.97	7.07E-26	32%	29%-33%	0.97	1.04E-27
Bridges	10	35%	18%-52%	0.73	1.62E-3	12%	10%-13%	0.98	3.18E-8	47%	31%-63%	0.85	1.58E-4
Reconstructions	69	24%	23%-31%	0.69	1.31E-9	17%	17%-21%	0.83	1.11E-28	41%	40%-51%	0.79	1.19E-25
Bike/Pedestrian/ Streetscapes	78	20%	15%-22%	0.53	1.91E-14	14%	10%-15%	0.62	6.52E-18	34%	25%-36%	0.62	9.52E-18
Signals	73	16%	10%-16%	0.43	3.29E-12	17%	13%-18%	0.61	6.69E-17	34%	25%-32%	0.75	2.22E-27
Pipes Projects	**267**	**9%**	**9%-10%**	**0.88**	**5.0E-125**	**10%**	**9%-10%**	**0.99**	**1.3E-307**	**19%**	**18%-19%**	**0.96**	**6.6E-193**
Gravity Mains	227	9%	9%-10%	0.88	5.7E-107	10%	9%-10%	1.00	5.9E-277	19%	18%-19%	0.96	1.5E-164
Pressure Systems	22	7%	0%-7%	0.00	7.28E-2	10%	4%-10%	0.46	7.52E-5	17%	5%-17%	0.23	1.35E-3
Pump Stations	13	14%	11%-17%	0.89	9.95E-07	10%	6%-12%	0.80	1.75E-05	24%	20%-25%	0.97	2.21E-10
Parks Projects	**83**	**25%**	**24%-29%**	**0.83**	**5.5E-33**	**10%**	**7%-11%**	**0.49**	**9.04E-15**	**35%**	**33%-38%**	**0.91**	**1.28E-43**
Playgrounds	65	21%	19%-22%	0.89	1.07E-32	15%	14%-17%	0.87	2.8E-29	36%	33%-38%	0.92	7.15E-37
Sportfields	12	30%	31%-46%	0.84	7.78E-07	4%	0%-3%	0.00	3.27E-1	34%	31%-47%	0.90	1.46E-6
Restrooms	6	38%	5%-111%	0.58	3.89E-2	18%	0%-31%	0.42	1.13E-1	55%	32%-110%	0.80	7.27E-3

Notes:

[1] TCC = Total Construction Cost; Des. = Design Cost; CM = Construction Management Cost, and PD = Project Delivery Cost. CI = Confidence Interval. The project delivery percentages indicated are the ranges corresponding to the 95 percent confidence intervals on the slope of the linear regression trendline. Caution and review of the report text are urged in using this information. Refer to Appendix B for the corresponding regression curves, R2 values, and N values for more details. Highlighted values indicate those for which R2 values were low (below 0.50).

[2] Other Pipes Projects are not included in this table due to a small number of projects (less than 5).

Table 3-10
Summary of Performance Models (Smaller Project Subset of TCC)

Project Type or Classification	Number of Projects (N)	Design Cost				Construction Management Cost				Project Delivery Cost			
		(% of TCC)	95% CI (% of TCC)	R^2	p-value	(% of TCC)	95% CI (% of TCC)	R^2	p-value	(% of TCC)	95% CI (% of TCC)	R^2	p-value
Municipal Projects	**93**	**17%**	**13%-17%**	**0.64**	**8.17E-23**	**14%**	**12%-15%**	**0.73**	**4.58E-28**	**31%**	**25%-32%**	**0.78**	**8.89E-33**
Libraries	18	18%	6%-23%	0.41	2.29E-3	12%	0%-9%	0.00	5.63E-1	30%	6%-27%	0.07	3.65E-3
Police/Fire Stations	25	14%	7%-13%	0.54	4.22E-7	14%	10%-15%	0.79	1.28E-9	28%	18%-28%	0.75	1.87E-09
Comm./Rec.Center/ Child Care/Gyms	40	19%	11%-22%	0.45	8.11E-7	14%	10%-16%	0.69	1.3E-11	34%	23%-35%	0.66	3.14E-11
Other Municipal	10	17%	14%-22%	0.93	3.25E-6	10%	3%-12%	0.52	7.04E-3	26%	20%-31%	0.93	5.7E-6
Streets Projects	**208**	**27%**	**22%-30%**	**0.44**	**7.85E-28**	**19%**	**15%-20%**	**0.50**	**6.97E-33**	**46%**	**39%-49%**	**0.61**	**1.05E-44**
Widening/New/ Grade Separations	26	26%	9%-29%	0.31	4.72E-4	17%	11%-21%	0.66	3.48E-7	43%	23%-47%	0.53	4.4E-6
Bridges	8	37%	7%-39%	0.26	1.29E-2	16%	5%-21%	0.65	6.43E-3	53%	19%-53%	0.50	2.18E-3
Reconstructions	55	23%	15%-28%	0.45	2.43E-8	14%	9%-14%	0.51	1.31E-10	37%	26%-40%	0.62	5.4E-13
Bike/Pedestrian/ Streetscapes	61	28%	15%-32%	0.34	3.36E-7	19%	14%-26%	0.44	5.56E-9	47%	32%-56%	0.48	9.46E-10
Signals	58	25%	15%-30%	0.39	1.31E-7	21%	7%-25%	0.17	6.25E-4	46%	29%-50%	0.50	1.99E-10
Pipes Projects	**214**	**17%**	**11%-16%**	**0.31**	**3.36E-21**	**17%**	**14%-18%**	**0.60**	**1.75E-44**	**35%**	**26%-34%**	**0.54**	**2.61E-39**
Gravity Mains	182	17%	11%-16%	0.32	6.47E-19	18%	15%-19%	0.59	7.38E-37	35%	27%-34%	0.55	3.87E-34
Pressure Systems	18	11%	4%-15%	0.48	1.07E-3	14%	11%-17%	0.85	5.52E-8	25%	17%-30%	0.79	7.35E-7
Pump Stations	10	21%	8%-26%	0.62	2.05E-3	22%	16%-29%	0.89	4.34E-5	43%	27%-51%	0.86	6.61E-5
Parks Projects	**66**	**21%**	**11%-23%**	**0.30**	**5.54E-7**	**14%**	**6%-14%**	**0.23**	**2.68E-6**	**35%**	**19%-34%**	**0.40**	**3.8E-10**
Playgrounds	52	23%	13%-24%	0.44	2.01E-8	14%	4%-13%	0.09	1.09E-3	36%	19%-35%	0.42	4.96E-9
Sportfields	10	12%	0% - 24%	0.26	1.5E-1	10%	0%-12%	0.00	2.31E-1	21%	0%-31%	0.00	2.17E-1
Restrooms	5	11%	0% - 23%	0.00	5.77E-1	25%	10%-49%	0.86	1.68E-2	36%	2%-65%	0.78	4.38E-2

Notes:

[1] TCC = Total Construction Cost; Des. = Design Cost; CM = Construction Management Cost, and PD = Project Delivery Cost. CI = Confidence Interval. The project delivery percentages indicated are the ranges corresponding to the 95 percent confidence intervals on the slope of the linear regression trendline. Caution and review of the report text are urged in using this information. Refer to Appendix B for the corresponding regression curves, R2 values, and N values for more details. Highlighted values indicate those for which R2 values were low (below 0.50).

[2] Other Pipes Projects are not included in this table due to a small number of projects (less than 5).

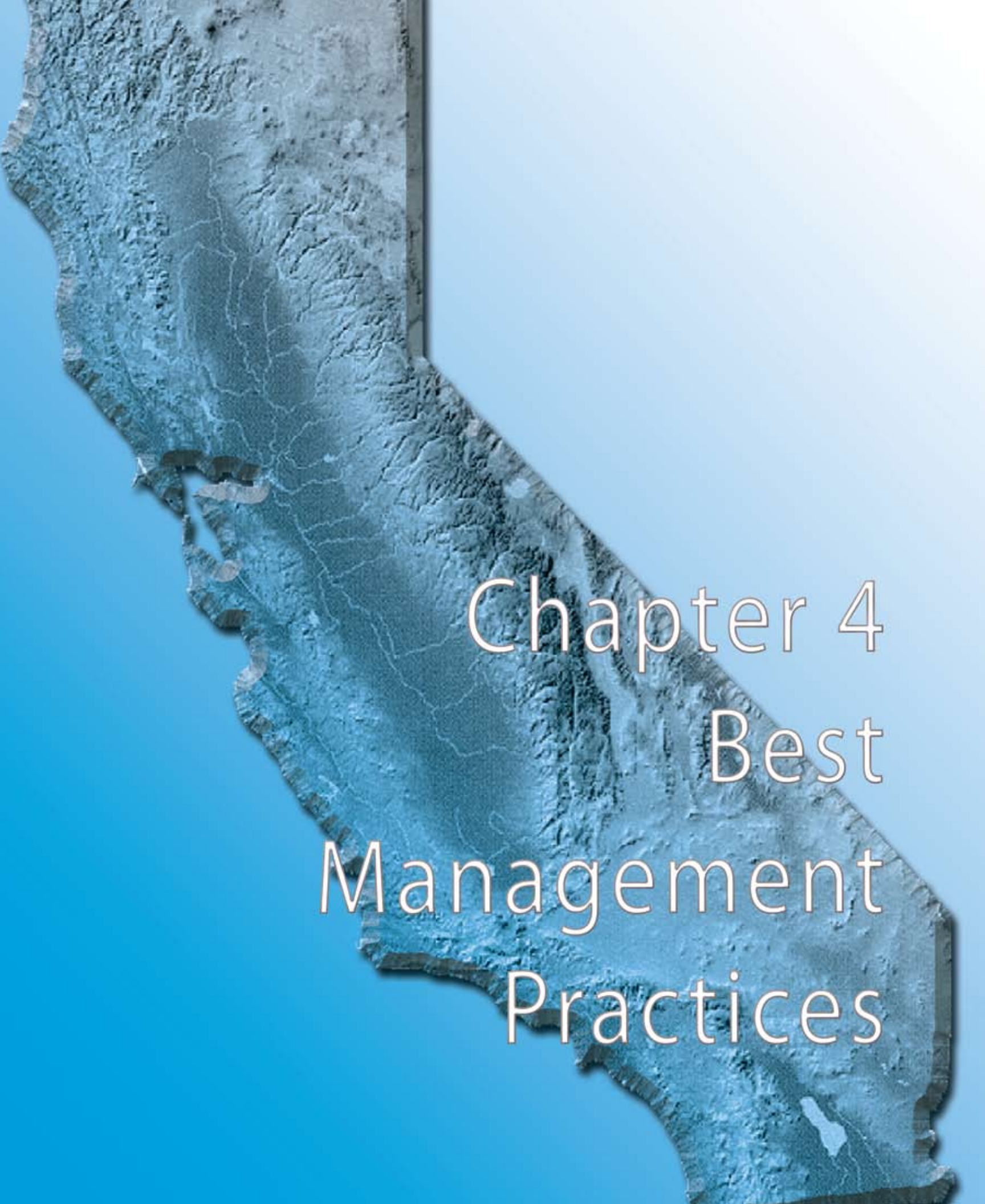
The elimination of auto-correlation in Update 2008 and the use of the linear trendline to describe the relationship between project delivery costs and the TCC have significantly improved the R^2 values as compared to the previous *Study* years.

For projects evaluated under the full range of TCC, Pipes and Municipal Facilities projects exhibit higher R^2 values as compared to Streets and Parks projects for the project delivery versus TCC regressions. This may be attributed to better definition of Pipes and Municipal Facilities projects 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.

It is observed that the R^2 values are lower for projects falling in the smaller project subset of TCC than for projects falling under the full range of TCC. This is explained due to the fact that there is greater scatter amongst the project data points evaluated under a smaller range of TCC than the full range of TCC. Project classifications with very few data points typically exhibit low R^2 values (less than 0.5).

The results of statistical significance tests also improved with the elimination of auto-correlation during Update 2008. Increasing the number of data points in models with p-values above 0.10 should improve (reduce) the p-values. For those models with p-values above 0.10, the model should not be used alone to forecast delivery costs for individual projects.

Increasing the size of the project database is a major challenge posed to the *Study* participants. This is primarily because of the 5-year rolling window criterion for project completion dates; even as new projects are added, old projects are excluded from analyses by the window of time. In addition, the agencies are also challenged to identify as many completed 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.



Chapter 4
Best Management Practices

CHAPTER 4 Best Management Practices

At the start of the *Study*, the agencies examined over 100 practices used in project delivery. Included in the *Study* are those practices that the study participants did not already commonly use, but believed should be implemented as BMPs. Each year new BMPs are added, and in some cases existing BMPs are reworked by the agencies to address specific challenges they encounter. BMPs are also added or modified to reflect relevant experiences by the participants. Agency implementation of these selected practices has been and will continue to be tracked during the *Study*. One new BMP was added to the list this year which started a new category, Sustainable Development. The BMPs discussed in this chapter are believed to influence the cost of either design or construction management and, ultimately, project delivery efficiency.

A. NEW BEST MANAGEMENT PRACTICES

In *Update 2009*, the Project Team added one new BMP and one new category to the BMP implementation tracking list. The BMP was developed to address the growing field of sustainable design and practices. The agencies felt that a new category, Sustainable Development, should be added to Best Management Practices. The new BMP is:

- 7.a.2009 - To quantify the environmental benefits of the project at the time of award.

This BMPs is believed to influence the cost of either design or construction management and, ultimately, project delivery efficiency. This BMP also has an intangible benefit through its positive long range effect on our environment.

B. DESCRIPTION OF BEST MANAGEMENT PRACTICES

The *Study 2002* report included descriptions of the BMPs that the Project Team felt were most critical to improving project delivery performance. These descriptions, presented in **Table 4-1**, have been updated to reflect changes in interpretation of those BMPs, as well as additions since 2002 to the BMP list.

Table 4-1
Description of Best Management Practices

Category	Ref:*	BMP	Description
Planning	1.a	Define capital projects well with respect to scope and budget including community and client approval at the end of the planning phase.	Changes in project scope or budget increase both total construction cost and the cost of project delivery. The later these changes occur in the life of the project, the greater the increase. Reaching and documenting consensus with the community and the client will reduce changes after the project delivery process begins.
	1.b	Complete Feasibility Studies on projects prior to defining budget and scope.	Feasibility studies should be completed early in the process so that issues are identified and either resolved or accommodated within the final definition of scope, budget, and project delivery schedule. This will also reduce overall project delivery costs. Early feasibility studies are particularly important on complex projects and projects with a construction budget greater than $5 million.
	1.d	Utilize a Board/Council project prioritization system.	Departments responsible for project delivery have limited resources. A system will ensure that resources are directed to meet the community's most critical needs.
	1.e	Resource load all CIP projects for design and construction.	The resources required to deliver projects according to the master CIP schedule mandated by the Board/Council should become part of the CIP. This will facilitate defining performance measures and ensure that there is a common understanding of the resources required to deliver the CIP.
	1.f	Include a Master Schedule in the CIP that identifies start and finish dates for projects.	A master schedule can be used to define resource needs and performance measures.
	1.g 2007	Make an early determination on which environmental document is required and incorporate into the schedule.	Completing the environmental assessment and permitting process influences project schedules and costs. Establish a checklist of potential environmental and permit requirements and examine each project scope against the list early in the planning process.
	1.i	Show projects on a Geographical Information System (GIS).	Entering and tracking planned projects into a GIS which is available to all private and public sector project planners will reduce the potential for conflicts and re-work.

Table 4-1
Description of Best Management Practices (cont'd)

Category	Ref:*	BMP	Description
Design	2.b	Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start.	Entering and tracking planned projects into a GIS which is available to all private and public sector project planners will reduce the potential for conflicts and re-work.
	2.f	Define requirements for reliability, maintenance, and operation prior to design initiation.	Design professionals will work more efficiently if given a clear scope when contracted to provide the design services. Clear scope and budget should be defined in advance and made a part of the design professional's contract if/when a consultant is used.
	2.i	Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc).	Reliability, maintenance, operational requirements, and standard materials and equipment should be clearly defined in advance, approved by the user/client, and included in the design professional's contract when a consultant is used.
	2.k 2003	Train in-house staff to use Green Building Standards.	Successful designs of fire stations, police facilities, maintenance facilities, pump stations, and many other projects should be re-used when possible. Site adaptations of successful designs may reduce design costs by half.
	2.l 2004	Limit Scope Changes to early stages of design.	Communities have a stake in the environment as well as in the cost of operating and maintaining public facilities. Utilizing "Green Building Standards" allows facilities to be built and operated with renewable resources and other environmentally sound practices.
	2.m 2004	Require scope changes during design to be accompanied by budget and schedule approvals.	It is well known within the industry that the later a change occurs in the construction process, the more costly the change is.
	2.n 2006	Implement a rotating Request for Quote process for contracting small projects to streamline the bidding and award process during construction. (Include criteria for exemptions from formal Council approval.)	Smaller projects cost more (as a percentage of construction cost) to deliver. One way of reducing the cost of project delivery on small projects is to shorten the bid and award process by setting a threshold amount under which the delivery team may solicit and receive quotes from qualified contractors and award contracts without getting Board/Council prior approval.
	2.o 2007	Establish criteria for obtaining independent cost estimates which take in consideration both project characteristics and volatility of the market.	Having to re-design and re-bid a project on which bids come in over budget can significantly impact project delivery cost. Accurate estimates at the end of each design phase, performed by unbiased, independent, qualified professionals with an understanding of local market conditions will reduce the potential for receiving unexpected bids.

Table 4-1
Description of Best Management Practices (cont'd)

Category	Ref:*	BMP	Description
	2.o 2007	Establish criteria for obtaining independent cost estimates which take in consideration both project characteristics and volatility of the market.	Having to re-design and re-bid a project on which bids come in over budget can significantly impact project delivery cost. Accurate estimates at the end of each design phase, performed by unbiased, independent, qualified professionals with an understanding of local market conditions will reduce the potential for receiving unexpected bids.
Design	2.p 2008	Establish criteria for responsible charge design approval such that it occurs at the lowest appropriate organizational level in order to expedite design completion.	Many times responsible charge design approval is set at a very high level. This can sometimes result in only one person with limited time who can approve all sheets in a design package. This leads to a bottleneck situation.
Quality Assurance / Quality Control	3.I.a	Develop and use a standardized Project Delivery Manual.	Standardized procedures streamline project design, bidding, and construction processes. Standardized design management procedures will reduce scope creep and delays in construction document preparation. During construction, standard procedures will reduce response times on RFIs, and add overall clarity and efficiency to the construction management process. Having a standard manual will also reduce the time necessary for project documentation training.
	3.II.b	Perform a formal Value Engineering Study for projects larger than $1 million.	Value Engineering identifies life cycle costs of design elements included in a project and certain alternatives. While the cost of the value engineering process may initially add costs to project delivery, overall project costs will be reduced.
	3.III.a	Use a formal Quality Management System.	Quality management should include all activities from the preparation of design documents through the closeout of construction. (Constructability reviews, independent cost estimates, classification and auditing of change orders, etc.) The implementation and tracking of quality control should be formalized on a checklist to ensure application.
	3.III.b	Perform and use post-project reviews to identify lessons learned.	Project Managers should develop formal post project reviews and identify lessons learned. These documents should be made available to PM's on projects of a similar scope and nature. This BMP will make future project management and delivery more efficient and cost effective.
	3.III.k 2007	Establish a Utility Coordinating Committee with members from public and private entities.	Regular meetings of a committee will establish a forum for ideas to improve the utility relocation process and thus improve project progress. Meetings will also be an opportunity for problem projects (relocations) to be discussed.
	3.III.l 2007	Designate a responsible person or group and establish a process of notifications and milestones for utility relocations.	Identifying a utility relocation specialist within the project delivery team who is familiar with the procedures and contacts within the public and private utility entities will improve communication and problem solving during design and construction.

Table 4-1
Description of Best Management Practices (cont'd)

Category	Ref:*	BMP	Description
Quality Assurance / Quality Control	3.III.m 2008	Maintain and regularly update electronic standard contract specifications and related documents, as well as technical/special provisions.	Standard contract specifications and technical special provisions need to be regularly maintained and updated in order to reduce the amount of time required to create contract bid documents. If a City implements new requirements, the standards should be modified for every project one time instead of each manager having to modify these documents of every project.
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.	Change order work should be authorized as soon as is practically possible in order to avoid potential delays to critical work. Scheduling a significant change order for review and authorization by the Board may delay project progress, even though it may be within the contingency amount allowed in the project budget. Authorization of the City Engineer/ Public Works Director to approve changes within the contingency budgeted for changes will ensure that critical changes are acted on promptly and that delays are minimized.
	4.I.m	Classify types of change orders.	Classification of change orders into categories such as changed conditions, unforeseen conditions, owner requests, or design changes for owner use improves understanding of the project and lessons learned from the data may improve project delivery on similar projects.
	4.II.a	Include a formal Dispute Resolution Procedure in all contract agreements.	Construction is acknowledged as a dispute prone industry. As such, it makes sense to provide options in the contract documents to avoid litigation and to expedite disputes resolution using alternatives to litigation.
	4.III.a	Use a team building process for projects greater than $5 million.	Partnering is a team-building process that has a proven record of improving working relationships and production, and reducing claims and disputes on construction projects. It is one of several team-building processes that should be used in the interest of reducing conflict and facilitating project delivery.
	4.IV.a	Involve the Construction Management Team prior to completion of design.	Experienced contractors and construction managers should be included in the design process to make designs more constructible and lower cost. Construction managers and contractors are frequently more experienced about the products and/or equipment as well as construction methods that are readily available. Their contributions to selections and decisions during the design process will facilitate construction procurement, means and methods.

Table 4-1
Description of Best Management Practices (cont'd)

Category	Ref:*	BMP	Description
Construction Management	4.V.a 2003	Delegate authority below Council to make contract awards under $1 million.	The time and costs of scheduling and presenting a Council or Board item can be saved and project starts can be expedited if awards on projects with budgets under $1 million can be awarded administratively.
	4.V.b 2003	Establish a pre-qualification process for contractors on large, complex projects.	Prequalification helps screen contractors for prior performance on similar projects, safety and financial capability thus reducing risk and, ultimately, project delivery cost.
	4.V.c 2003	Make bid documents available online.	Making bid documents available on line will reduce agency printing costs. It may also increase bidder participation by making documents easily available to a larger pool of potential bidders and subcontractors.
Project Management	5.I.f	Assign a client representative to every project.	Client (end user) representation during the life of the project will expedite decisions on submittals, substitutions, and changes. Their involvement will also help determine intent and streamline the commissioning and occupancy process.
	5.I.j 2003	Create in-house project management team for small projects.	It has been documented that the cost of project delivery of small projects is a higher percentage of the construction cost. Establishing a project management team that specializes in smaller projects may lead to economies such as grouping similar projects during permitting and bidding thus reducing project delivery cost.
	5.I.k 2004	Institutionalize Project Manager performance and accountability.	Recognize that professional project management requires specific education, training, and experience. Provide for PMI, CCM, or other formal training and certification and establish performance measures for project delivery personnel.
	5.II.a	Provide formal training for Project Managers on a regular basis.	Project Managers come to projects with varying degrees of skill and familiarity with agency procedures. Orientation and training will improve their ability to deliver the project on the intended schedule. It is also important that updated training is available at least on an annual basis.

Table 4-1
Description of Best Management Practices (cont'd)

Category	Ref:*	BMP	Description
Project Management	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 analysis, etc).	The success of a project is influenced significantly by the education and skills of the project manager. Agencies should verify that PM's know and use the tools available within an agency and that they are current with industry practices.
	5.III.a	Adopt and use a Project Control System on all projects.	A web-based project control system will improve collaboration and documentation during the design and construction process. Questions, answers, proposals, and decisions can be expedited using a collaborative system.
	5.III.e 2006	Implement a financial system that tracks expenditures by category to monitor project hard and soft costs during project delivery.	It is recommended that a system that identifies actual expenditures against planned budgets be made available to project managers to be used as a performance measurement tool.
	5.III.f 2006	Implement a Work Breakdown Structure (WBS) to measure progress on project deliverables.	Getting accurate data on the cost of project delivery depends upon being able to capture and classify expenses to the phases of construction on each project. Ideally, costs would be identified by each of five project delivery phases and coded to particular milestones or deliverables.
	5.III.g 2006	Monitor "earned value" versus budgeted and actual expenditures during project delivery.	Soft costs "burn rate" should be proportionate to percent complete during the design and construction phases. Using a program which measures and relates soft cost expenses to earned values permits better tracking and control during project delivery.
	5.III.h 2007	Include a fixed ROW acquisition milestone schedule and obtain commitments from participating City departments.	Prolonged ROW acquisition can be avoided if all stakeholders agree on milestones to complete the acquisitions.

Table 4-1
Description of Best Management Practices (cont'd)

Category	Ref:*	BMP	Description
Project Management	5.III.i 2008	Implement an electronic progress payment system to improve efficiency	Reduction in the length of time and inefficiencies in processing of progress payments through the use of electronic means.
	5.IV.a 2006	Bundle small projects whenever possible.	Bundling small projects so that they are designed, bid, and constructed together will reduce project delivery cost proportionately.
	5.IV.b 2007	Have a coordinator with expertise in the environmental process within the department delivering the engineering/ capital project.	Identifying an environmental specialist within the project delivery team who is familiar with procedures and contacts within the approving entities will reduce permit procurement time and costs.
Consultant Selection and Use	6.c.	Include a standard consultant contract in the RFQ/RFP with an indemnification clause.	The negotiation of the design contract can be expedited if the consultant understands and agrees to the conditions of the contract at the time a proposal is submitted.
	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.	Authorization for the Public Works Director/City Engineer to award consulting contracts ensures earlier start of design and construction management activities and will reduce consultant selection process costs.
	6.g.	Implement and use a consultant rating system that identifies quality of consultant performance.	The performance of consultants should be tracked so that those who deliver quality services at reasonable costs can be adequately considered for future awards.
	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.	Establishing an on-call list of qualified consultants with expertise in a variety of design disciplines will expedite the start of the design process.
Sustainable Development	7.a. 2009	Identify the environmental benefits of the project at the time of award.	Provide written, environmental benefits to the awarding authority on projects that use sustainable practices or aim to achieve LEED certification.

C. PROGRESS ON BEST MANAGEMENT PRACTICE IMPLEMENTATION

In *Update 2009*, 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. Agencies have started to review and update those BMPs that have been fully implemented for several years. Agencies continue to pursue full implementation of BMPs although many remain only partially implemented. Given the current state of the economy and due to staff reductions, furloughs, and the management's increased involvement in resolving budgetary issues, progress on fully implementing BMPs has been impacted. The agencies have focused their efforts on tracking BMPs that have been implemented and which continue to provide efficiencies in project delivery processes for participating departments. As of *Update 2009*, the agencies have fully implemented about 72 percent of all BMPs. Many of the remaining BMPs require multiple department involvement and are more complicated to implement than other BMPs.

To support the linking of BMPs to performance improvements, BMP implementation has been tracked and project completion dates have been collected on Performance Questionnaires.

BMPs targeted for future implementation and progress on actual BMP implementation since the Update 2008 are summarized below.

I. City of Los Angeles

Implemented from June 2008 to May 2009:	Targeted June 2009 Onward:
	• 4.V.c 2003 Make bid documents available online. • 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.III.h 2007 Include a fixed ROW acquisition milestone schedule and obtain commitments from participating City departments (partially implemented).

II. City of Long Beach

Implemented from June 2008 to May 2009:	Targeted June 2009 Onward:
	• 3.I.a. Develop and use a standardized Project Delivery Manual (partially implemented). • 3.III.a. Use a formal Quality Management System (partially implemented). • 3.III.b Perform and use post-project reviews to identify lessons learned. • 3.III.m.2008 Maintain and regularly update electronic standard contract specifications and related documents as well as technical/special provisions. • 6.g. Implement and use a consultant rating system that identifies quality of consultant performance (In Progress).

III. City of Oakland

Implemented from June 2008 to May 2009:	Targeted June 2009 Onward:
• 1.i. Show projects on a Geographical Information System. • 2.f. Define requirements for reliability, maintenance, and operation prior to design initiation. • 3.III.a. Use a formal Quality Management System.	

IV. City of Sacramento

Implemented from June 2008 to May 2009:	Targeted June 2009 Onward:
Department of Transportation • 4.V.c 2003 Make bid documents available online. • 5.1.f Assign a client representative to every project. • 5.III.e.2006 Implement verification procedures to ensure that PM training includes agency policies, procedures, forms, and standards of practice (scheduling, budgeting, claims avoidance, risk analysis, etc.). • 5.III.h 2007 Include a fixed ROW acquisition milestone schedule and obtain commitments from participating City departments. **Department of Utilities** • 2.p. 2008 Establish criteria for responsible charge design approval such that it occurs at the lowest appropriate organizational level in order to expedite design completion. • 3.III.m.2008 Maintain and regularly update electronic standard contract specifications and related documents as well as technical/special provisions. • 4.II.a. Include a formal dispute Resolution Procedure in all contract agreements. • 5.III.e 2006 Implement a financial system that tracks expenditures by category to monitor project hard and soft costs during project delivery. • 6.c. Include a standard consultant contract in the RFQ/RFP with an indemnification clause.	**Department of Transportation** • 5.I.k 2004 Institutionalize Project Manager performance and accountability. • 5.III.f 2006 Implement a Work Breakdown Structure (WBS) to measure progress on project deliverables. (partially implemented) • 5.III.g 2006 Monitor "earned value" versus budgeted and actual expenditures during project delivery. (partially implemented) **Department of Utilities** • 1.d Utilize a Board/Council project prioritization system. (partially implemented) • 4.V.c 2003 Make bid documents available online. (partially implemented) • 5.I.k 2004 Institutionalize Project Manager performance and accountability. (partially implemented) • 5.III.h Include a fixed ROW acquisition milestone schedule and obtain commitments from participating City departments. (partially implemented) • 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. (partially implemented)

V. City of San Diego

Implemented from June 2008 to May 2009:	Targeted June 2009 Onward:
• 1.a Define capital projects well with respect to scope and budget including community and client approval at the end of the planning phase. • 1.b Complete Feasibility Studies on projects prior to defining budget and scope. • 1.e. Resource load all CIP projects for design and construction. (partially implemented) • 1.f Include a Master Schedule in the CIP that identifies start and finish dates for projects. • 2.b Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start. • 3.I.a. Develop and use a standardized Project Delivery Manual. (partially implemented) • 5.I.k 2004 Institutionalize Project Manager performance and accountability. (partially implemented)	• 5.III.e 2006 Implement a financial system that tracks expenditures by category to monitor project hard and soft costs during project delivery • 5.III.g 2006 Monitor "earned value" versus budgeted and actual expenditures during project delivery. (partially implemented)

VI. City and County of San Francisco

Implemented from June 2008 to May 2009:	Targeted June 2009 Onward:
• 1.d Utilize a Board/Council project prioritization system. • 2.I. 2004 Limit Scope Changes to early stages of design. • 2.m. 2004 Require scope changes during design to be accompanied by budget and schedule approvals. • 2.o. 2007 Establish criteria for obtaining independent cost estimates which take in consideration both project characteristics and volatility of the market. • 5.I.j 2003 Create in-house project management team for small projects. (partially implemented) • 5.I.k 2004 Institutionalize Project Manager performance and accountability. (partially implemented)	• 1.e. Resource load all CIP projects for design and construction (partially implemented) • 1.f. Include a Master Schedule in the CIP that identifies start and finish dates for projects. • 4.V.c. 2003 Make bid documents available online. • 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 analysis, etc). • 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.

VII. City of San Jose

Implemented from June 2008 to May 2009:	Targeted June 2009 Onward:
	• 3.1.a Develop and use a standardized Project Delivery Manual • 3.III.a. Use a formal Quality Management System. • 3.III.l 2007 Designate a responsible person or group and establish a process of notifications and milestones for utility relocations (partially implemented). • 3.III.m.2008 Maintain and regularly update electronic standard contract specifications and related documents as well as technical/special provisions. • 5.I.k 2004 Institutionalize Project Manager performance and accountability. (partially implemented) • 5.II.a Provide formal training for Project Managers on a regular basis. (partially implemented) • 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 analysis, etc). • 5.III.f 2006 Implement a Work Breakdown Structure (WBS) to measure progress on project deliverables. (partially implemented) • 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.

Table 4-2 summarizes the BMPs that have been implemented by the participating agencies, as well as the planned implementation priorities.

Table 4-2
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 phase.	✓	✓	✓	✓	✓	✓	✓	✓	✓	SC DU: Community involved after project is better-defined, typically at 30% design.
	1.b.	Complete Feasibility Studies on projects prior to defining budget and scope.	✓	✓	✓	✓	✓	✓	✓	✓	✓	LB: When applicable SC DU: Only on complex projects that require a Feasibility Study SF: When applicable SJ: Some exceptions
	1.d.	Utilize a Board/Council project prioritization system.	✓	NI	PI, TBD	PI, 2008	✓	PI, 2009	✓	✓	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 SF: Capital plan developed City-wide and priorities set by City-wide committee of major department heads.
	1.e.	Resource load all CIP projects for design and construction.	✓	TBD	✓	✓	✓	NI	✓	✓	✓	LB: Software in development. SC DU: Estimate drafting only.

Key:
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, and SJ: San Jose
✓: 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.

Table 4-2
Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Planning	1.f.	Include a Master Schedule in the CIP that identifies start and finish dates for projects.	✓	TBD	✓	✓	✓	✓	✓	2010	✓	LB: Software in development. SC DU: Completion date only estimated, not determined by scheduling analysis.
	1.g 2007	Make an early determination on which environmental document is required and incorporate into the schedule.	✓	✓	✓	2008	✓	✓	✓	✓	✓	
	1.i.	Show projects on a Geographical Information System.	✓	✓	✓	✓	✓	✓	✓	✓	✓	LB: Infrastructure only
Design	2.b.	Provide a detailed clear, precise scope, schedule, and budget to designers prior to design start.	✓	✓	✓	✓	✓	✓	✓	✓	✓	SC DU: General scope only for simple projects.
	2.f.	Define requirements for reliability, maintenance, and operation prior to design initiation.	✓	✓	✓	PI, 2008	✓	NI	✓	✓	✓	SD: Some Divisions only

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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.

Table 4-2
Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Design	2.i.	Adapt successful designs to project sites, whenever possible (e.g. fire stations, gymnasiums, etc).	✓	✓	✓	✓	✓	✓	NI	✓	✓	SC DU: This is key to low delivery costs. Std special provisions are updated continuously for lessons learned, new requirements, changing technology, etc.
	2.k. 2003	Train in-house staff to use Green Building Standards.	✓	✓	✓	✓	NI	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.	✓	✓	✓	✓	✓	NI	✓	✓	✓	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.	✓	✓	✓	✓	✓	NI	✓	✓	✓	

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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.

Table 4-2
Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Design	2.n. 2006	Implement a rotating Request for Quote process for contracting small projects to streamline the bidding and award process during construction. (Include criteria for exemptions from formal Council approval.)	NI	✓	NI	✓	NI	NI	✓	✓	✓	SC DT: Maintains on-call consultant list for various engineering, traffic, landscape, architecture, and geotechnical services. SF: As-needed job order contracting (JOC)
	2.o 2007	Establish criteria for obtaining independent cost estimates which take in consideration both project characteristics and volatility of the market.	TBD	PI, TBD	TBD	TBD	2009	TBD	TBD	✓	TBD	LA will likely implement this in some fashion, but is still working out the details. We are considering only implementing this on projects over $10M. SF: Establishing estimating database
	2.p 2008	Establish criteria for responsible charge design approval such that it occurs at the lowest appropriate organizational level in order to expedite design completion.	✓	TBD	TBD	TBD	✓	✓	TBD	✓	TBD	

Key:
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Table 4-2
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.	✓	PI, 2011	✓	✓	✓	✓	✓	✓	2010	SC DU: Badly needs updating.
	3.II.b.	Perform a formal Value Engineering Study for projects larger than $1 million.	✓	✓	NI	✓	✓	NI	✓	✓	NI	LA: For projects > $10M LB: As needed SC: As needed SD: As needed SF: As needed SJ: For projects > $5 million
	3.III.a.	Use a formal Quality Management System.	✓	PI, 2010	✓	✓	✓	NI	✓	✓	2010	SD: Some Divisions only
	3.III.b	Perform and use post-project reviews to identify lessons learned.	✓	2009	✓	✓	✓	✓	✓	✓	✓	SC DU: For selected projects in one-on-one meetings with design and construction staff. Also includes feedback from client. Intended to promote candid discussion.
	3.III.k 2007	Establish a Utility Coordinating Committee with members from public and private entities.	✓	PI	✓	NI	✓	✓	✓	✓	✓	
	3.III.l 2007	Designate a responsible person for and establish a process of notifications and milestones for utility relocations.	✓	NI	TBD	NI	✓	✓	✓	✓	PI, 2010	

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Table 4-2
Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Quality Assurance/ Quality Control	3.III.m 2008	Maintain and regularly update electronic standard contract specifications and related documents as well as technical/special provision.	✓	2011	✓	TBD	✓	✓	✓	✓	2009	
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.	✓	✓	✓	✓	✓	✓	✓	✓	✓	LA: Draft Special Order prepared.
	4.II.a.	Include a formal Dispute Resolution Procedure in all contract agreements.	✓	NI	✓	✓	✓	✓	✓	✓	✓	SJ: For projects > $10 M
	4.III.a.	Use a team building process for projects greater than $5 million.	✓	✓	✓	✓	✓	NI	✓	✓	✓	LB: As-needed SD: As-needed SF: As-needed SJ: For projects > $10 M
	4.IV.a.	Involve the Construction Management Team prior to completion of design.	✓	✓	✓	✓	✓	✓	✓	✓	✓	SD: Some Divisions only
	4.V.a. 2003	Delegate authority below Council to make contract awards under $1 million.	✓	✓	NI	NI	NI	NI	✓	✓	✓	

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Table 4-2
Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Construction Management	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.	2010	✓	TBD	PI, 2008	✓	PI. 2008	✓	2009	✓	LA: Requested this through our ITA Dept for integration with our bid outreach application, but implementation will depend on their resource availability. SF: Documents on CD in interim
Project Management	5.I.f.	Assign a client representative to every project.	✓	✓	✓	✓	✓	✓	✓	✓	✓	SD: Only for large projects SF: Documents on CD in interim
	5.I.j 2003	Create in-house project management team for small projects.	NI	NI	✓	✓	NI	NI	NI	✓	✓	SC DU: Not enough PMs to justify this. Don't want to restrict staff to small, less-rewarding projects.
	5.I.k 2004	Institutionalize Project Manager performance and accountability.	✓	✓	✓	✓	2009	PI, 2009	✓	✓	PI, 2010	SC DU: There is interest but no definite plan.
	5.II.a	Provide formal training for Project Managers on a regular basis.	✓	TBD	✓	✓	✓	NI	✓	✓	PI, 2010	LB: Program implementation put on hold due to budget cuts
	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 analysis, etc).	✓	TBD	✓	✓	✓	NI	✓	2010	2010	

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Table 4-2
Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Project Management	5.III.a.	Adopt and use a Project Control System on all projects.	✓	✓	✓	✓	✓	NI	✓	✓	✓	
	5.III.e 2006	Implement a financial system that tracks expenditures by category to monitor project hard and soft costs during project delivery.	✓	✓	✓	✓	✓	✓	✓	✓	✓	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.
	5.III.f 2006	Implement a Work Breakdown Structure (WBS) to measure progress on project deliverables.	2010	✓	✓	PI, 2009	PI, 2010	NI	✓	✓	PI, 2010	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.	2010	NI	✓	PI, 2008	PI, 2010	NI	PI, 2010	✓	NI	
	5.III.h 2007	Include a fixed ROW acquisition milestone schedule and obtain commitments from participating City departments.	PI	TBD	TBD	NI	✓	PI, 2008	NI	NI	✓	SF: No additional ROW required outside military base closure.
	5.III.i 2008	Implement an electronic progress payment system to improve efficiency.	TBD	NI	TBD	TBD	NI	TBD	TBD	✓	TBD	

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Table 4-2
Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Project Management	5.IV.a 2006	Bundle small projects whenever possible.	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	5.IV.b 2007	Have a coordinator with expertise in the environmental process within the department delivering the engineering/ capital project.	✓	NI	NI	NI	NI	NI	✓	✓	PI, TBD	
Consultant Selection and Use	6.c.	Include a standard consultant contract in the RFQ/RFP with an indemnification clause.	✓	✓	✓	✓	✓	✓	✓	✓	✓	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	✓	✓	2009	SC DU: Threshold is $100,000.

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Table 4-2
Implementation of BMPs (cont'd)

Category	Ref:*	BMP	LA	LB	OK	SC			SD	SF	SJ	Notes
						DGS	DT	DU				
Consultant Selection and Use	6.g.	Implement and use a consultant rating system that identifies quality of consultant performance.	✓	PI	✓	✓	NI	NI	✓	✓	PI	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.	✓	✓	✓	✓	✓	PI	✓	✓	✓	
Sustainable Development	7.a. 2009	Identify the environmental benefits of the project at the time of award	2010	✓	TBD	TBD	TBD	TBD	TBD	PI, TBD	2010	

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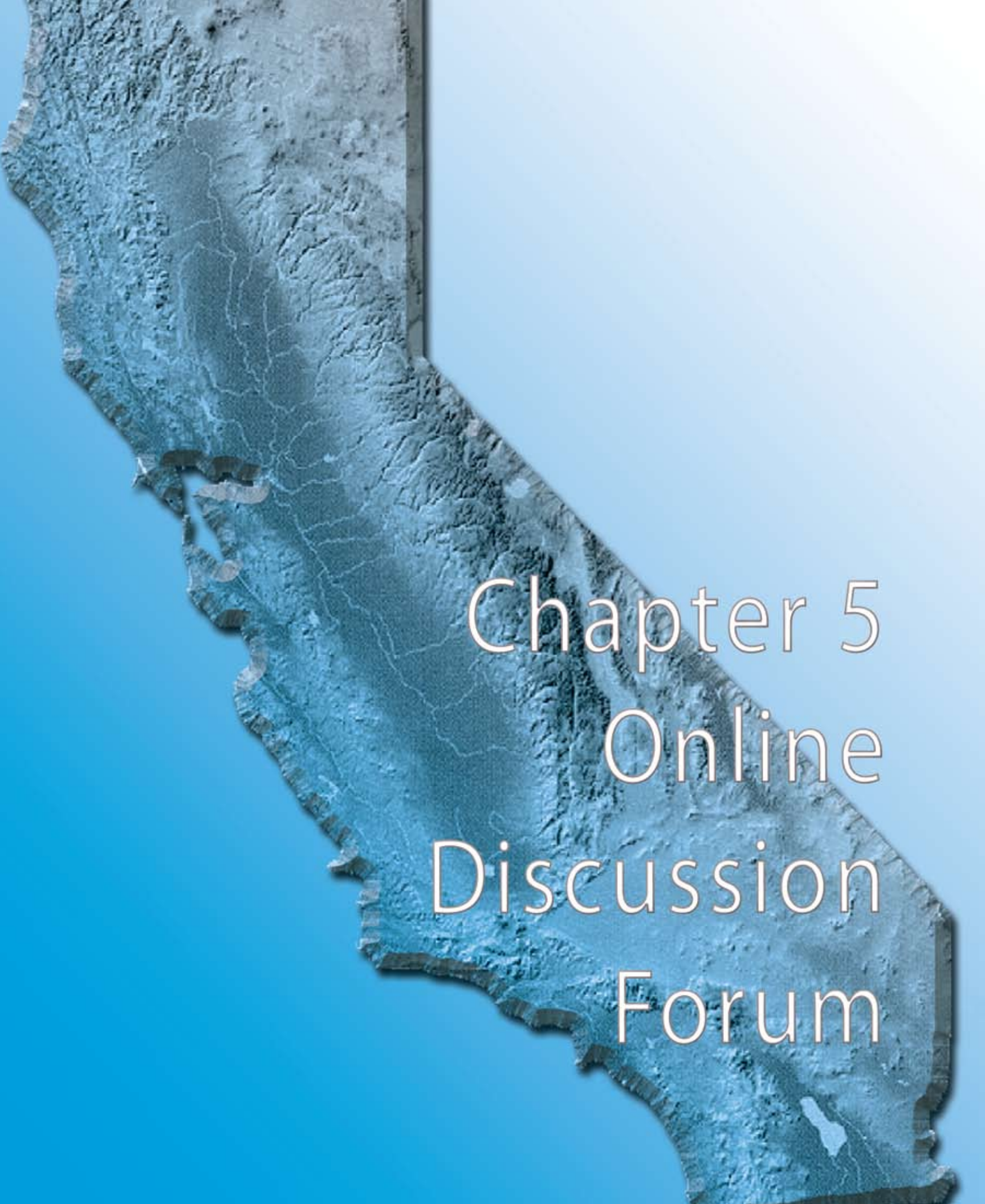


Chapter 5
Online Discussion Forum

CHAPTER 5 Online Discussion Forum

One of the benefits most appreciated by the Project Team is the ability to share issues or concerns in a web based forum and receive input from their fellow team members. During the year, a total of 14 topics were discussed. From this set of discussions, the following 9 topics are presented as an example of the types of informational exchanges that took place within the *Update 2009* online discussion forum.

- Infrastructure and Fixed Asset Capitalization Policies
- Permeable and Pervious Pavements
- Separate Section for Estimating and Scheduling
- Resource Level Scheduling
- Qualification Based Consultant Selection (QBCS) Policy/Procedure
- Materials Testing Laboratory Services
- Project Labor Agreement
- Covered Pedestrian Walkways
- Job Order Contracting

A. INFRASTRUCTURE AND FIXED ASSET CAPITALIZATION POLICIES

The City of San Diego was seeking any formal policies pertaining to asset capitalization for infrastructure projects. So they asked the group for any relevant information on infrastructure and fixed asset capitalization policies, formal, informal or administrative. In addition, they wanted to know whether infrastructure assets were categorized into classes and if useful life was assigned to the various categories.

The City of Long Beach responded that they follow the provisions of the Governmental Financial Standards Board Statement (GASB) #34. Long Beach also provided the various classifications along with the useful life of newly installed items.

The City of San Jose completed a report in 2008 on their deferred maintenance and infrastructure backlog. For that report, they categorized their infrastructure assets into 13 categories. While each program is different and responsible for their own condition evaluation and asset management, they all try and use similar asset management programs wherever possible. GASB #34 requires the Finance Department to include the valuation of the City's infrastructure in the Comprehensive Annual Financial Report (CAFR) which includes date of construction, costs, and useful life cycles to come up with a depreciated value.

The City of Los Angeles provided a copy of their Capitalization policy. Their programs either use the depreciated method or the modified approach. The Wastewater system uses four different category codes to help classify the assets. They are as follows:

1. Location
2. Cost Center
3. Asset Category
4. Asset Description

The Capitalization Policy provides useful life of newly constructed infrastructure along with a listing of various categories.

B. PERMEABLE AND PERVIOUS PAVEMENTS

The City of San Francisco is using pervious pavement in the parking strip of one street of which the contract was just awarded and is in the process of reviewing draft guidelines for pervious pavement for developers and staff.

The City of San Francisco, Department of Public Works, Bureau of Engineering inquired about other cities experience with the use of Permeable/pervious Pavements similar to their inquiry in 2004. Specifically, they asked the following three questions:

1. Has your jurisdiction implemented any design standards for the use of permeable/pervious pavement?
2. If you are allowing the use of permeable/pervious pavement, do you have any technical specifications that you can share?
3. Has your jurisdiction constructed roadway, sidewalk, parking strips, parking lots, etc…using permeable/pervious pavement? How is it holding up to use and how is it working with regards to reducing storm water runoff?

The City of San Diego has permitted two private projects about 3 years ago that tried porous paving, both of which ended in failure. These projects were not well thought out and didn't use any previous design criteria. Currently the City allows site-specific designs on a case-by-case basis that are reviewed and approved through the review process. The City raised many good questions that should be considered when reviewing and approving projects of this nature. A Draft Technical Guidelines was provided for Geotechnical reports for infiltration devices to provide a guideline for the geotechnical consultant to evaluate feasibility of such systems on the permit side.

The City of San Jose has used pervious materials in limited locations, such as porous concrete in a library courtyard and pavers in landscaped areas. This year, the City plans to evaluate the use of pervious concrete and asphalt for trail paving as well as permeable pavers in park strips between sidewalks and curbs. They noted that the Greenbook (copy provided with City's response) recently added a pervious concrete spec that could be helpful in developing a City specification.

The City of Long Beach responded that while no projects of this nature had been completed to date, they were considering the use of permeable/pervious pavements on several projects next year. In addition, they were currently developing technical specifications.

The City of Los Angeles provided a copy of a City Council motion and a Bureau of Street Services report on this topic. Efforts thus far have been limited and mainly for evaluating performance. The City added that their focus has been geared more toward green street elements to direct runoff into planter areas for infiltration. In all cases, no permeable pavement has been installed in a roadway.

C. SEPARATE SECTION FOR ESTIMATING AND SCHEDULING

With estimating and scheduling services being provided by consultants and having separate divisions for each service, the City of San Francisco, Bureau of Construction Management was evaluating creating just one division to provide both services.. The City initiated this topic by asking the following series of questions:

Does your agency have a separate section for…

1. Estimating
2. Scheduling
3. Estimating and Scheduling
4. None of the Above

If you do have section(s) for estimating and/or scheduling, are the following done?

1. Engineer's estimate
2. Project schedule
3. Change order estimating
4. Change order negotiations
5. Contractor schedule review and approval

Nearly every City responded that they do not have a separate section for estimating and scheduling. Each City described their process. The City of Los Angeles stated that project scheduling and cost estimating is the responsibility of the Project Manager, while the City of Oakland stated it was the responsibility of the Project Engineer for in-house projects. The City of Sacramento DGS's response was similar to the response of Los Angeles, however, they also use design consultants in addition to the Project Managers for preliminary estimating of scheduling activities. They added that change orders are estimated by the contractor and checked and negotiated by the Construction Manager. The City of Long Beach stated that in-house resources are used on projects designed in-house while consultants are responsible for estimating and scheduling efforts on projects that they design: however, they are managed by in-house Project Managers.

The City of San Diego stated it was the responsibility of the designer/project manager to prepare and maintain the cost estimate and schedule during phases of design. Their project implementation/ technical services division helps the engineers with their estimates with historical bid data. The City utilizes Primavera supporting group for scheduling and generating the needed reports for the entire CIP program.

Generally estimates/schedules, for the City of San Jose, are performed by Project Managers using the Capital Project Management System (CPMS). Microsoft Project and Primavera may be utilized in addition to CPMS on larger City-managed projects. When consultants are engaged for the design of a project, these services may be provided in whole or in part by those consultants. On very large projects, such as their recent airport project, where construction management consultants are engaged , those entities/ consultants are using cost and schedule engineers to specifically track such matters and provide such information to the City Project Manager.

The City of San Francisco will not be creating a separate section at this time, but has a cost database and is training its project engineers in estimating using the database. Project Engineers are responsible for generating project estimates and schedules. Resident Engineers are responsible for change order estimating and contractor schedule review.

D. RESOURCE LEVEL SCHEDULING

The City of San Diego was looking for a methodology to better plan and forecast their labor resources, given the peaks and valleys in the demand for said resources. With a potential to implement the resource level scheduling methodology, they asked the question below. They noted that they were using $100/hr as a weighted average cost.

1. Which labor resources methodology is your organization implementing? Are you using "Resource Level Scheduling" or "Composite Person Scheduling" (weighted average cost of the classifications that worked on a CIP project) or some other methodology

2. If "Resource Level Scheduling" is utilized by your organization; how is it working for you? Do you have a full time staff assigned to maintain it? Have you performed a cost benefit analysis of the methodology before implementation?

The City of Sacramento, DGS uses composite person They provided a spreadsheet that listed the blended hourly rates of divisions of General Services. They stated that this blended rate methodology works better with merged groups because it allows the in-house trades to remain competitive with outside construction and maintenance costs.

The City of San Jose replied that they use a "Cost Estimating/Resource Module" (CERM) which is built into their Capital Project Management System (CPMS), an in-house web-based database application. For each Capital project, the CERM is used to develop an estimate for the soft and hard costs. A Project Manager enters anticipated resources that will be used over the life of a project. Each resource (classification) has a fully loaded costs associated with it. Some resources are a composite rate such as Materials Testing resources. The CERM is used during the annual Capital Budget development cycle to develop a staffing plan, since all projects entered are rolled up to a composite report that will demonstrate the staffing needs for the upcoming fiscal years. They noted some shortcomings with multiyear projects and a lack of schedule which would better articulate peaks and valleys of resource demands.

The City of Long Beach has always maintained a nominal workforce and use consultants to cover the peak demands in any given year. Projects are first assigned to in-house staff based on availability with all remaining work issued to on-call consultants.

The City of Los Angeles maintains Master Schedules for all their projects which show a three year period and are broken down into Programs. Their Work Program Resource Requirements is tied into the master schedules and is based on their Uniform Project Reporting System (UPRS). When first resourcing a project, they start with templates based on construction cost. As more detailed information is known, actual staff resources replace the template amounts.

The City of Oakland stated they were in the process of developing Resource Level Scheduling. They are currently writing a formula to determine the number of full time employees needed on each project per month. The formula is based on the schedule and staff costs allocated to the PM and CM for each project in their CIP database.

The City of San Francisco, Department of Public Works provided a sample histogram that they use. This monthly histogram is created in Excel and is updated by the Section Managers on a monthly basis. The work hours for each project for the duration of the project are entered into the spreadsheet. The Bureau's histogram is created by combining all the sections' data.

E. QUALIFICATION BASED CONSULTANT SELECTION (QBCS) POLICY/ PROCEDURE

The City of San Jose was in the process of revisiting a council-approved Qualifications Based Consultant Selection (QBCS) Policy/Procedure that applied strictly to architectural/engineering services. This process prompted them to ask the project team whether they had an architectural/ engineering consultant selection policy and/or procedure. There were also interested in obtaining information if a city has a general policy/procedure for professional services consultants if it did not have a policy that applied strictly to architectural/engineering consultants.

The City of Long Beach responded that it followed SB419, also known as the Mini Brooks Act, for consultant selection. The Mini Brooks Act outlines a qualifications based selection procedure. They referenced CELSOC and APWA as having great publications on this topic. They provided a 1991 legislative legal review which states that Charter cities are required to comply with the Mini Brooks Act.

The City of San Francisco, Department of Public Works provided excerpts from their departmental procedures manual which outline the procedures for request for qualification/proposals, consultant selection process and administering consultant contracts.

The City of San Diego provided a document from their Administrative Regulation 25.60 regarding consultant selection. This document lists all categories of services that are subject to Administrative Regulation 25.60.

The City of Los Angeles stated that their procedure for professional services can be found in their Project Delivery Manual. The document is on their webpage and can be found at http://eng.lacity.org/index.cfm. This site also includes a list of Pre-Qualified On-Call consultants.

The City of Sacramento, Department of Transportation provided sections 8.1 through 8.13 of their Project Delivery Manual which includes guidelines relating to professional services selection and management. The manual includes checklists and forms that are used throughout the process.

F. MATERIALS TESTING LABORATORY SERVICES

San Jose operates its own accredited materials testing laboratory which provides critical QA/QC services to both its capital improvement program and private development review program. From a budget planning analysis standpoint, San Jose was interested in determining whether the other participating agencies had an in-house materials testing laboratory to serve their capital improvement program and what scope of services were provided. Furthermore, San Jose was seeking to understand whether such agency labs provided testing for public improvements constructed by private developers in the public right-of-way, or if private developers were given the option of using an acceptable private laboratory. A total of five (5) questions were asked and responses were received from all six agencies. The detailed responses can be found in **Table 5-1** below.

Table 5-1
City of San Jose Survey

Questions	1. Does your agency have an in-house materials testing laboratory? If so, what general services are provided?	2. If not, who performs materials testing laboratory services for your Capital Improvement projects?	3. Does your City allow developers the options of hiring a private lab vs. using your materials testing lab (if you have one) to perform testing on private development projects that construct improvements (i.e. pavement/concrete work) in the public right-of-way?	4. If they have the option, does your City establish an approved list of private material testing labs or leave it up to the developer to hire anyone?	5. May we contact someone in your organization for more information? If so, please provide contact info.
City of Long Beach	No, it was closed 12 years ago.	Use private labs that are under as-needed multiyear contracts.	All testing done in the public right-of-way is handled by City construction inspectors using as-needed contracts. This includes CIP related contracts as well as work being done by developers on utilities.		Gillis Monroe Construction Services Officer (562) 570-6537
City of Los Angeles	Yes. They test soil, asphalt and Portland cement concrete, groundwater, sewage, aggregate, special materials testing, soil and ground water contamination, and soil samples. The materials lab has limited capacity. The materials testing labs would be part of the pre-qualified on-call Geotechnical consultant list managed by the Bureau's Geotechnical Engineering Group giving the ability to augment City staff.		Private developers usually have their own materials testing labs to perform their quality control testing for B-permit work in the City right-of-way. However, the City will use City testing lab to perform verification testing on soil, asphalt, concrete, etc.	Department of Building and Safety, for work outside of the public right-of-way, has a list of approved materials testing labs to do work on private property within the City. City doesn't require an approved list since the City performs verification testing within the public right-of-way.	Contact Michael Brown who'll direct you to the appropriate person.
City of San Diego	Yes, Trench compaction, sub-grade, asphalt concrete, concrete sampling, earthwork, plant inspection for pipe and asphalt, slurry and misc. product sampling	N/A	No, this option is typically only considered on a case-by-case basis as part of a dispute resolution process	N/A	Jose Navarro (858) 627-3276 jnavarro@sandiego.gov
City of Oakland	Yes, compaction, asphalt concrete, gradation on all City engineering projects. However, outside lab hired to perform special inspections and materials testing on City building projects.	N/A	Inspections on private projects are handled through the Building Department.	Does not have a certified list.	Joseph Tanios Materials testing lab Supervisor (510) 615-5537

Table 5-1
City of San Jose Survey (cont'd)

Questions	1. Does your agency have an in-house materials testing laboratory? If so, what general services are provided?	2. If not, who performs materials testing laboratory services for your Capital Improvement projects?	3. Does your City allow developers the options of hiring a private lab vs. using your materials testing lab (if you have one) to perform testing on private development projects that construct improvements (i.e. pavement/concrete work) in the public right-of-way?	4. If they have the option, does your City establish an approved list of private material testing labs or leave it up to the developer to hire anyone?	5. May we contact someone in your organization for more information? If so, please provide contact info.
City of Sacramento-DOT	No	Private consultant materials testing firms providing our materials testing for all work within the right-of-way. Consultant list is established through a RFQ process.	Do not allow developers to hire their own private lab to perform testing. Developers pay a fee which the City uses to engage one of their contracted materials testing firms.	See answer to question #3.	Jon Blank Supervising Engineer (916) 808-7914
City of San Francisco	Yes, which functions under the Bureau of Construction Management, Department of Public Works. Material Testing Lab (MTL) provides quality control to ensure construction projects are built in compliance with contract plans and specifications. Services include design consultation, plan and spec review, quality assurance plans, concrete/soil/aggregates sampling and testing, and masonry/asphalt concrete/ welding/reinforcing steel testing, core-drilling of concrete and soil samples during the design phase for exploration purposes.	For testing services not provided, have as-needed contracts with private labs.	MTL mainly services public agencies on City projects. MTL usually does not perform testing on private projects within public right-of-way.	Maintains an approved list of private material testing labs for different tests.	Ophelia Lau (415) 748-4105 (415) 554-8351

G. PROJECT LABOR AGREEMENT

In receiving a request from representatives of the Building Trades to establish a Project Labor Agreement (PLA) for the federal Stimulus projects and City CIP projects, the City of Oakland requested responses for other Agencies on four (4) questions. These questions and Agency's responses are listed in **Table 5-2** below.

Table 5-2
City of Oakland Survey

Questions	1. Does your City currently have a Project Labor Agreement (PLA) for capital improvement projects?	2. Is your City contemplating a PLA for projects in the near future?	3. Is your City contemplating a PLA specifically for stimulus projects?	4. Do you see benefits or have concerns about a PLA< especially relative to stimulus projects?
City of Long Beach	No	Have been in discussion for over two years but have not been able to work out all the details.	Advised the other Cities that prior President prohibited PLAs on federally funded projects which would apply to ARRA projects unless it's changed.	Unable to provide details since negotiations are ongoing.
City of Los Angeles	Yes, visit http://bca.lacity.org/index.cfm?nxt_body=local_hiring.cfm for a list of projects and the actual agreements.	Yes, currently there is no official policy on when to use PLAs. The Board of Public Works, through our Bureau of Contract Administration, is working to develop a Department of Public Works wide PLA.	No	Expressed concern using a PLA due to the many specific requirements on ARRA projects. With non-ARRA projects, potential benefits include orderly settlement of labor disputes and grievances without strikes, work stoppages or lockouts. Potential downside is it may reduce bidder pool.
City of San Diego	No			Expressed concern about limiting the contractor bidder pool.
City of Sacramento-DOT	No	No	No	No concern as City policy is to pay prevailing wage.

Table 5-2
City of Oakland Survey (cont'd)

Questions	1. Does your City currently have a Project Labor Agreement (PLA) for capital improvement projects?	2. Is your City contemplating a PLA for projects in the near future?	3. Is your City contemplating a PLA specifically for stimulus projects?	4. Do you see benefits or have concerns about a PLA< especially relative to stimulus projects?
City of Sacramento- DU	No	None that they are aware of.	None that they are aware of.	Experience with limiting the bidding pool but felt it was a minor issue.
City of San Francisco	Yes, the SFO Master Plan had an Airport Master Plan – Project Stabilization Agreement (PSA)	Tried to establish another PSA but was unsuccessful due to Union internal issues.	No	Only used on projects over $250 million.
City of San Jose	Yes, for their Airport Master Plan projects. Also had a PLA on the 3-year old City Hall. Due to relationship of Councilmember, a kind of moratorium exists on PLA's.	Not at this time.	No	Benefit in terms of avoidance of labor actions affecting construction projects. Some contractors will not bid PLA projects which limits the competitive pool.

H. COVERED PEDESTRIAN WALKWAYS

The City of San Diego initiated a six (6) question survey on the subject of permitting and inspection of covered pedestrian walkways in the public right-of-way. Responses were received by 5 out of the 6 agencies. Please see **Table 5-3** below for all six questions and the Agency responses.

Table 5-3
City of San Diego Survey

Questions	1. How does your agency permit covered pedestrian walkways placed in the public right-of-way by private parties during construction? Is it via a right-of-way permit, a traffic control permit, or some other type of permit?	2. What level of review does your agency provide to a plan showing covered pedestrian walkways?	3. Does your agency require inspection of covered pedestrian walkways when they are first installed?	4. Does your agency require insurance or posting of a bond related to covered pedestrian walkways?	5. In general, does your agency inspect private traffic control setups in the public right-of-way on major arterials when they are first installed?	6. How does your agency handle its own work in the public right-of-way in terms of design, review and inspection of traffic control setups for construction? Is it handled differently for construction activities than maintenance activities?
City of Long Beach	Building permits for structure and Street Occupancy Permit (SOP) for placing structure in public right-of-way. SOP is obtained through Public Works Department. Building Department Inspectors review completed structure for compliance. Public Works Inspectors review walkway to insure compliance with SOP.	Structural reviews of plans are made at the time of permit application by Building Department.	Yes	Insurance only	Yes	All traffic control plans are prepared in-house by the traffic engineering staff. Traffic control work done by City forces is under the prevue of a trained street maintenance supervisor who works directly with the traffic engineering staff.
City of Los Angeles	Through a Building Materials permit which is equivalent to a right-of-way permit.	No plan review is performed. Contractor is provided with a standard plan for covered walkways.	Yes	No	The DOT reviews and approves traffic control setups.	The same requirements and standards apply to city work in the right-of-way as to private contractors except for permit fees.

Table 5-3
City of San Diego Survey (cont'd)

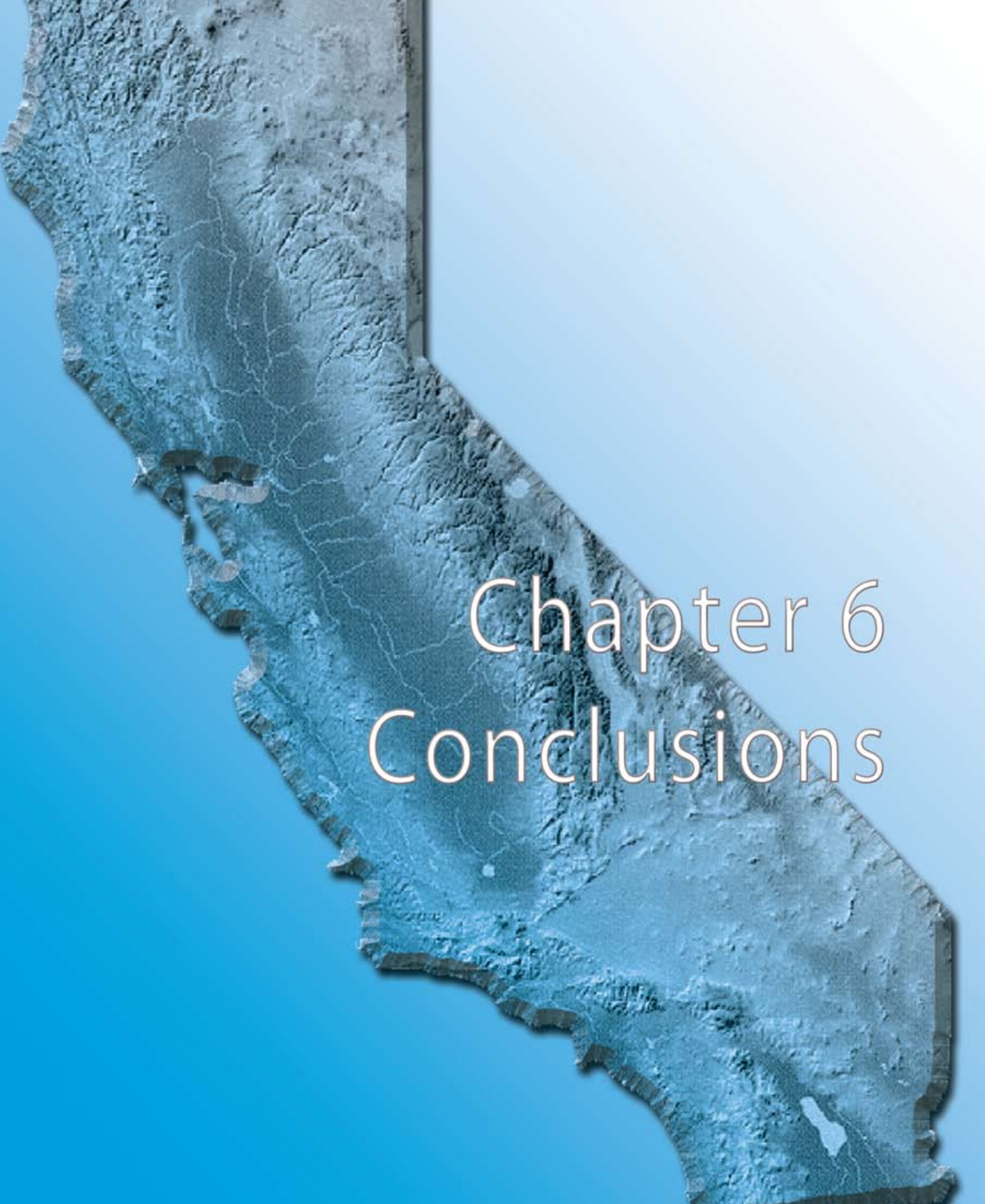
Questions	1. How does your agency permit covered pedestrian walkways placed in the public right-of-way by private parties during construction? Is it via a right-of-way permit, a traffic control permit, or some other type of permit?	2. What level of review does your agency provide to a plan showing covered pedestrian walkways?	3. Does your agency require inspection of covered pedestrian walkways when they are first installed?	4. Does your agency require insurance or posting of a bond related to covered pedestrian walkways?	5. In general, does your agency inspect private traffic control setups in the public right-of-way on major arterials when they are first installed?	6. How does your agency handle its own work in the public right-of-way in terms of design, review and inspection of traffic control setups for construction? Is it handled differently for construction activities than maintenance activities?
City of Oakland	Through obstruction permit accompanied with traffic control plans	Issued over the counter with minimal review. Proposed plan must meet ADA provisions.	Yes	No	Yes	Approved traffic control plans are required for City projects. Contractors follow project specifications and provide traffic control plans for review and approval. Maintenance projects must comply with MUTCD handbook.
City of Sacramento-DOT	Issue building permit to install pedestrian walkways that are attached to buildings over right-of-way. If not attached but in the right-of-way, they issue a revocable permit.	Full detailed plans must be submitted for either permit.	Yes, inspection of the improvement is required for either permit.	Yes	Yes, the City does inspect all traffic control setups in the public right-of-way. Before installing, the contractor must submit a traffic and pedestrian traffic control plan for review and approval.	
City of San Jose	Through a revocable encroachment permit process that may include a traffic control plan if the proposed covered walkway location impacts the traffic lanes.	Encroachment permits are reviewed by entry-level Civil Engineers or Engineering Technicians and approved by Associate Engineers. If a traffic control plan is required, the plan is coordinated with the Project Inspector (PI).	Yes	Yes, insurance and surety are required with all encroachment permits.	Yes	For capital projects, traffic control plans are required from the contractor prior to construction. Plans are submitted to the Project Engineer for review and approval and coordinated with the PI. Process same for maintenance projects except chip seal which are done in-house by DOT.

I. JOB ORDER CONTRACTING

Due in part to the oncoming stimulus package, the City and County of San Francisco is in the process of streamlining the contracting provisions of its administrative code, In addition, they had been planning to modify their Job Order Contracting (JOC) program for several years, so Bureau of Architecture sought input from the other agencies in this study. Detailed responses from participating agencies are summarized in **Table 5-4**.

Table 5-4
City of San Francisco Survey

Questions	1. Does your contracting authority require the JOC contractor to list subcontractors at time of bid or at time of task orders (job orders)?	2. If subcontractor listing is at time of task orders, what are the procedures for the contractor's solicitation of subcontractor bids to avoid/discourage "bid shopping"?
City of Long Beach	They must list them all at the time of task (job) orders.	There are no special JOC rules that apply to subcontractors other than those specified in the general conditions by the City of Long Beach for all contractors.
City of Los Angeles	Have a few different types of contracts that are similar. Some contracts are part of a pre-qualified list of prime contractors using an RFQ process awarded based on an evaluated value of markups or a low bid of assumed quantities. All cases require a good faith effort outreach. Prime contractor is allowed to list as many subcontractors as they wish for each area of subcontracting work.	There is no room for "bid shopping" since the prime and subcontractors all list their dollar amounts when submitting a bid for a task order.
City of Sacramento - DOT	Yes, they are required to submit a list of subcontractors at the time of bid.	There are no procedures to avoid/ discourage "bid shopping."
City of San Diego	Requires listing of subs prior to issuance of each task order. Public contract code applies to each task order as if they were a regular contract.	Provided a portion of their contract documents related to this topic.
City of San Jose	Require JOC contactor to list subcontractors at the time they submit their initial cost proposal which is shortly before the time of the issuance of a task (job) order.	There are no procedures to avoid/ discourage "bid shopping."



Chapter 6
Conclusions

CHAPTER 6 Conclusions

A. PERFORMANCE BENCHMARKING

This year's *Study* focused on refining the modeling methodology used to develop relationships between the different components that constitute project delivery costs and the TCC. Statistical studies to determine the best-fit curve for the projects in the database revealed that the linear trendline was the best-fit curve amongst the five types of curves (logarithmic, exponential, polynomial, power, and linear) selected for evaluation. In addition, the modeling methodology incorporated techniques to analyze project delivery costs over a range of TCCs. Improvements to the model also resulted in good R^2 and p-values indicating good relationships between the project delivery components and the TCC.

In order to incorporate the agencies' observations that on a percentage basis, projects with lower TCCs are more expensive to deliver than projects with higher TCCs, the *Study* Team conducted investigations with an objective to identify a subset of project size (in terms of TCC) that represented what was generally considered as the smaller projects. Regressions and statistical tests for the smaller projects revealed that the delivery costs for the smaller projects were higher than for the full range of projects. Therefore, in Update 2009, project data was analyzed in two ranges of TCC. The results of this analysis conformed to the agencies' practical experiences.

Although the results of the performance analyses are based on historical data provided by the participating agencies, there are several factors that affect project delivery and are not captured in the performance model. These external factors include personnel turnover in the agencies, competitive bids etc which impact project delivery. Since such factors are not captured in the performance model, the reader is cautioned that the improved results of the regression analyses only be used as a reference and not for prediction of future performance.

Due to the current economic conditions, agencies are receiving bids that are significantly lower than the engineer's estimates. Therefore, it should be noted that project data collected over the next few *Study* cycles may exhibit higher project delivery costs as a percentage of the TCC as a result of the low construction bids due to the current economic crisis. It is recommended that the reader use best judgment in the context of the current economic crisis while using the *Study* results for planning and budgeting.

Increasing the size of the project database is a major challenge posed to the *Study* participants. This is primarily because of the 5-year rolling window criterion for project completion dates; even as new projects are added, old projects are excluded from analyses by the window of time. In addition, the agencies are also challenged to identify as many completed 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.

Project delivery percentages (arithmetic averages) for the Update 2009 *Study*

varied between the following values for the full range and the smaller project subset of TCC respectively:

Municipal Projects: 36% - 39%

Parks Projects: 39% - 41%

Pipes Projects: 36% - 39%

Streets Projects: 46% - 49%

B. BEST MANAGEMENT PRACTICES

The agencies have continued to fully implement selected BMPs. Given the current state of the economy and due to staff reductions, furloughs, and the management's increased involvement in resolving budgetary issues, progress on fully implementing BMPs has been impacted. The agencies have focused their efforts on tracking BMPs that have been implemented and which continue to provide efficiencies in project delivery processes for participating departments. As of *Update 2009*, the agencies have fully implemented about 72 percent of all BMPs. Many more have been partially implemented with the goal of complete implementation over the next two to three years.

In Update 2009, the Project Team added one new BMP under a new category called Sustainable Development to the BMP Implementation tracking list. This BMP was developed to address the growing need to incorporate environmental sustainability in engineering design and construction practices. The agencies felt that this new category should be added to Best Management Practices. BMPs in other areas will be discussed and developed during future *Study* phases.

As the BMPs are implemented the participating agencies should begin to realize project delivery efficiencies including but not limited to reduction in delivery times, reduced change orders, and overall project cost reductions.

C. ONLINE DISCUSSION FORUM

In Update 2009, the Agencies transitioned from using emails to an online portal for collaboration on project delivery issues. There are several benefits of this transition one of which is the ability to archive all topics of discussion in a single location which is easily accessible. The use of the online portal also ensures that communication is not lost when a member leaves the Project Team.

The Online Discussion Forum continues to be an increasingly important feature for *Study* participants, with active exchanges occurring frequently and important issues addressed with changes to policy, approach, or BMP implementation. 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. The continued sharing of challenges and solutions through the Online Discussion Forum remains a remarkable advantage to all participants.

D. PLANNING FOR UPDATE 2010

Over the course of *Update 2009*, the Project Team identified a number of activities to consider including next year in *Update 2010*. These activities include:

- Exploring the merits of capturing alternative delivery methodologies in the *Study*.
- Continuing to focus on current topic roundtable discussions.
- Exploring the benefits of BMPs and their impact on project delivery costs.

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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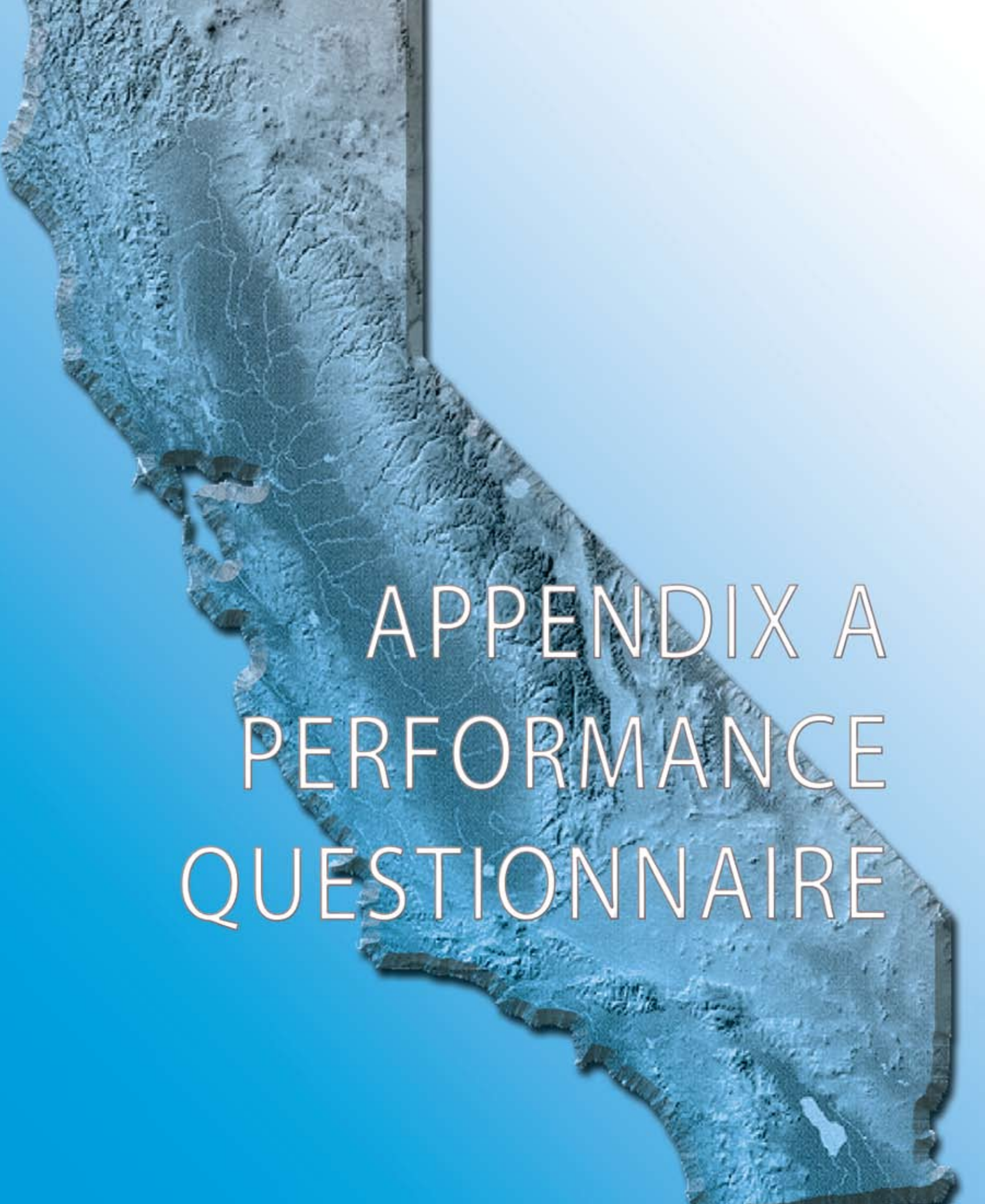
Update 2009 Project Team

APPENDICES



APPENDIX A PERFORMANCE QUESTIONNAIRE

APPENDIX A Performance Questionnaire

California Multi-Agency Benchmarking Study Update 2009 Performance Questionnaire

Agency: | Project Name:

Project type: | ☐ LEED Green Building

New/Rehab Index:

Description:

Comments:

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

AMOUNT OF CONSTRUCTION CONTRACT							
COST OF CHANGE ORDERS	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

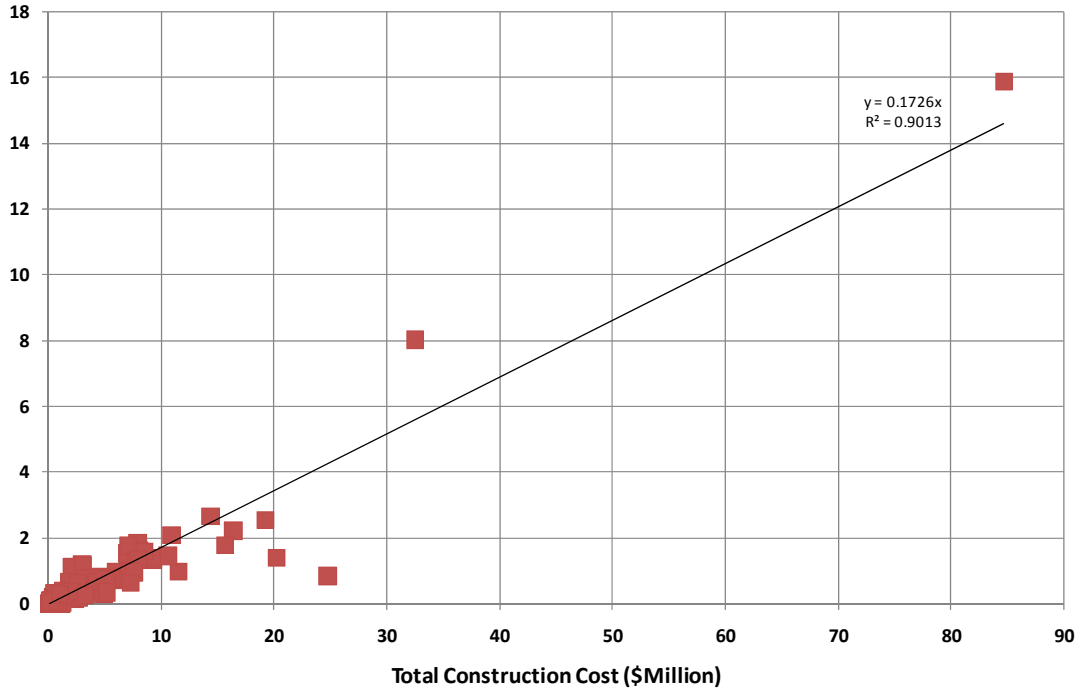
APPENDIX B

Performance Curves

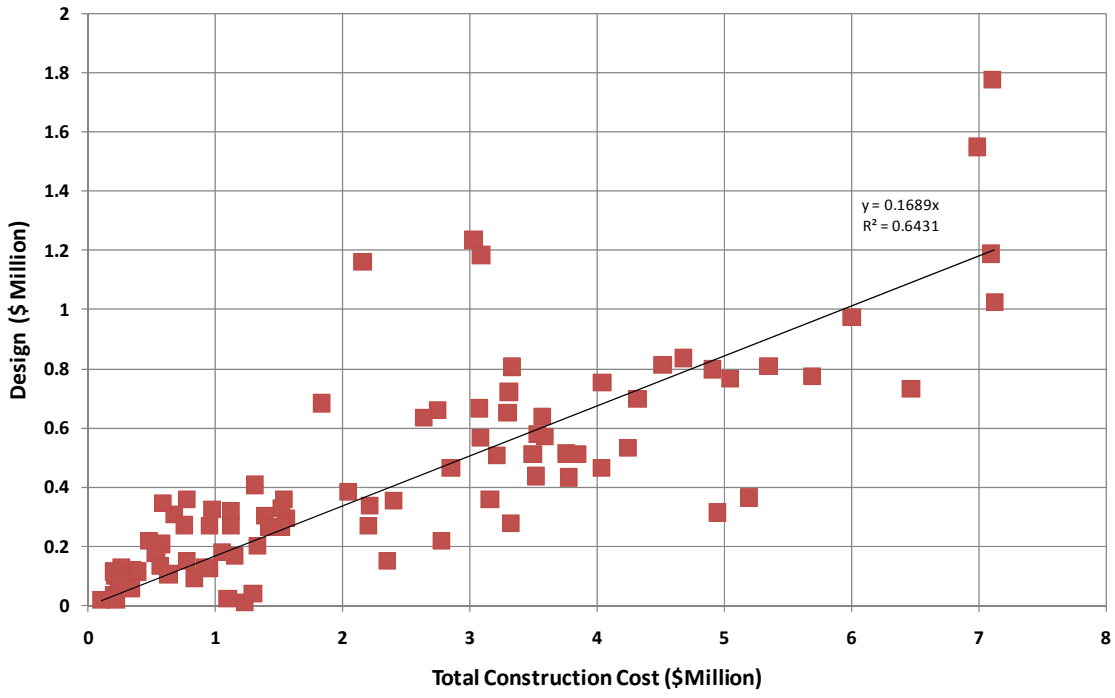
CURVES GROUP 1

Design Cost
vs
Total Construction Cost

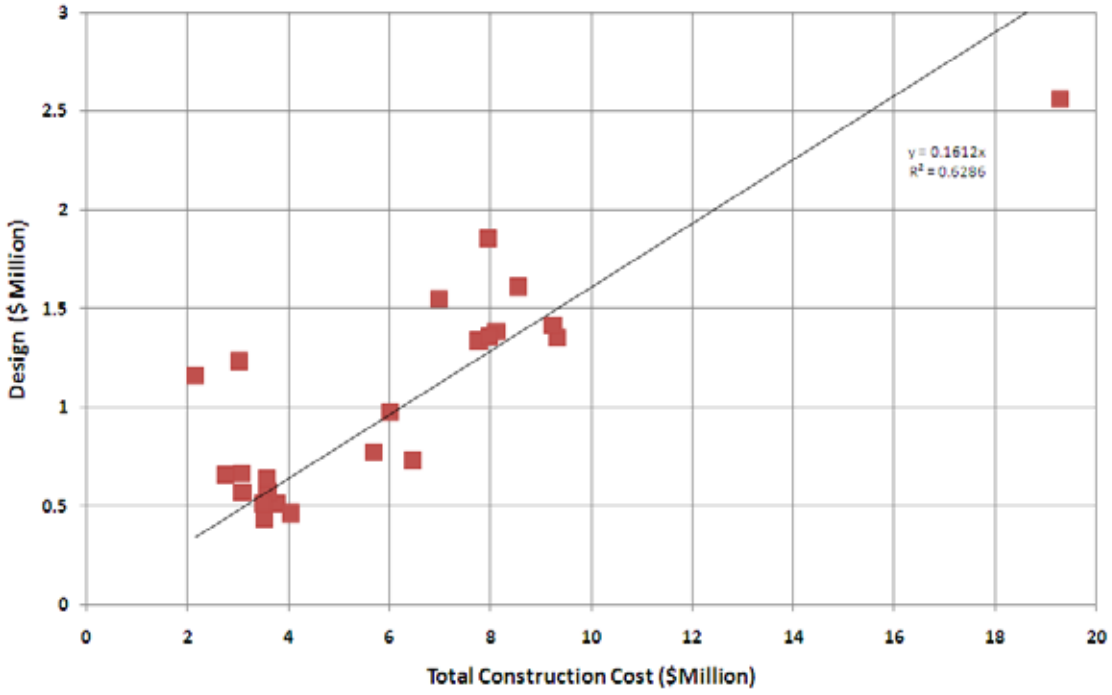
All Projects
Municipal Facilities - All Classifications
Design ($ Million) Versus Total Construction Cost (N=116)



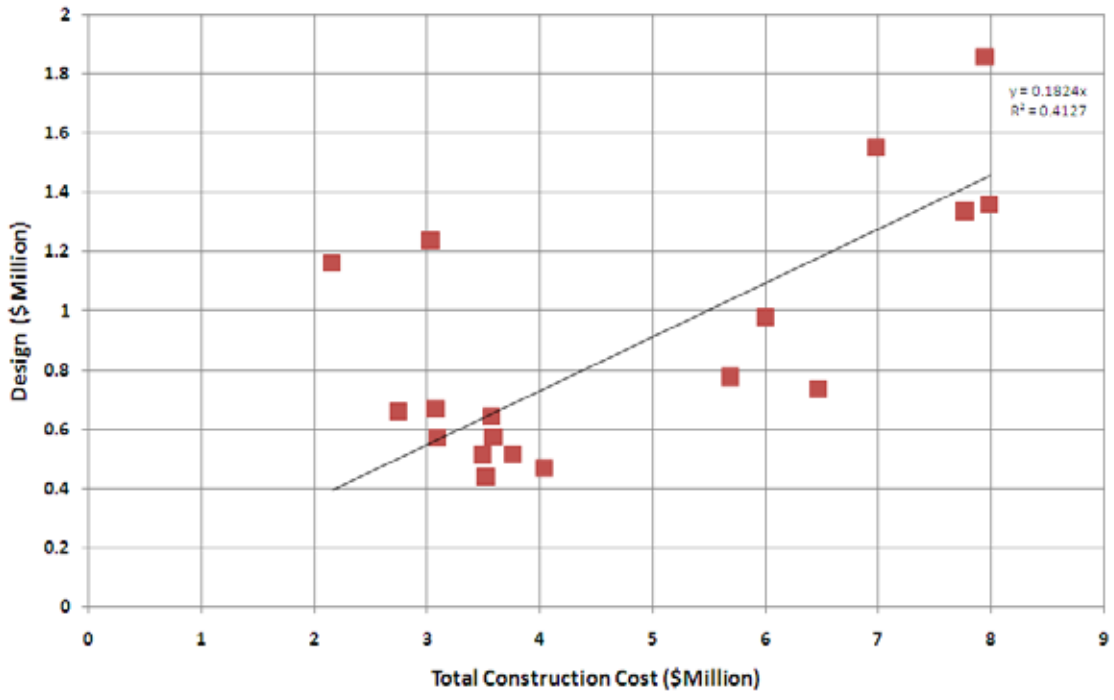
Smaller Projects
Municipal Facilities - All Classifications
Design ($ Million) Versus Total Construction Cost (N=93)



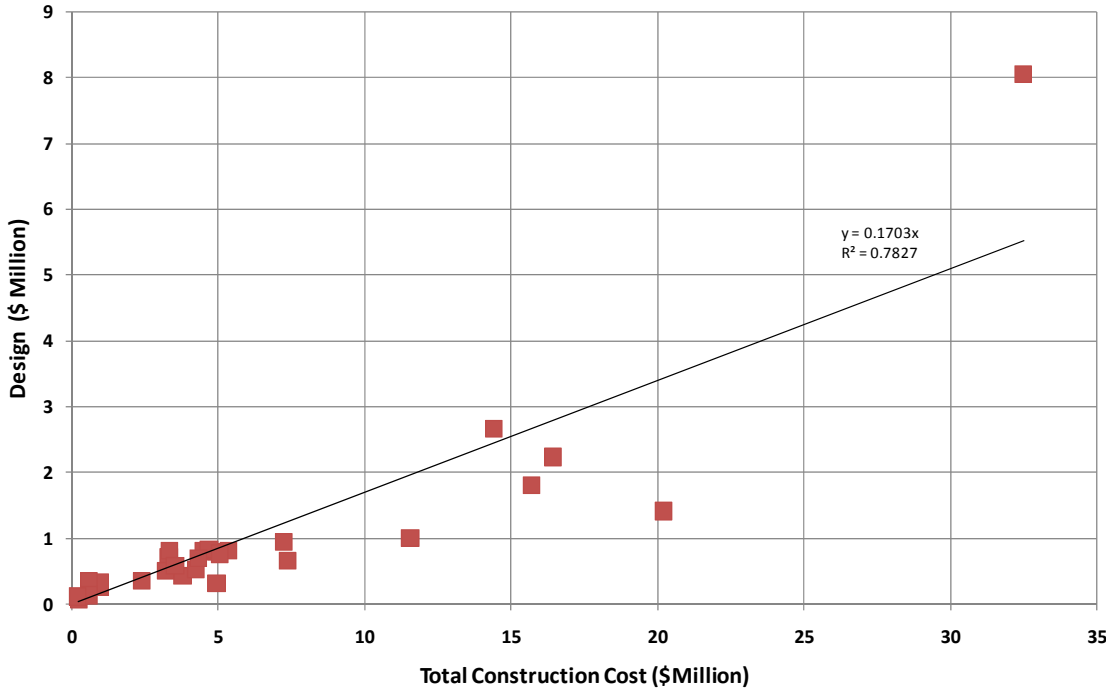
All Projects
Municipal Facilities - Libraries
Design ($ Million) Versus Total Construction Cost (N=23)



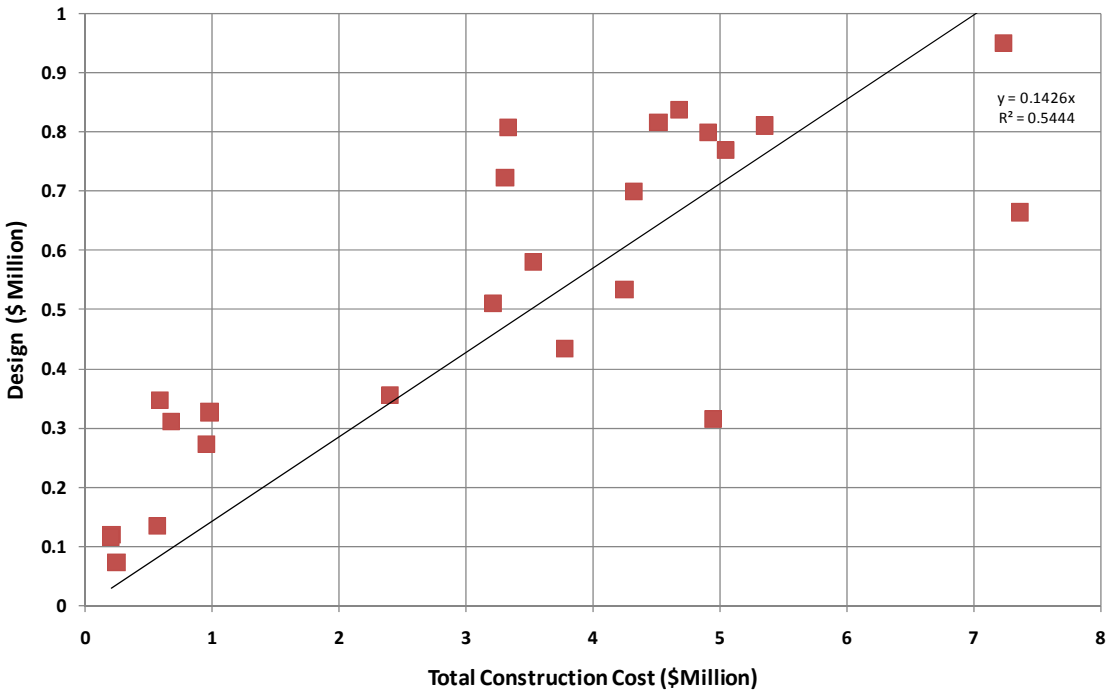
Smaller Projects
Municipal Facilities - Libraries
Design ($ Million) Versus Total Construction Cost (N=18)



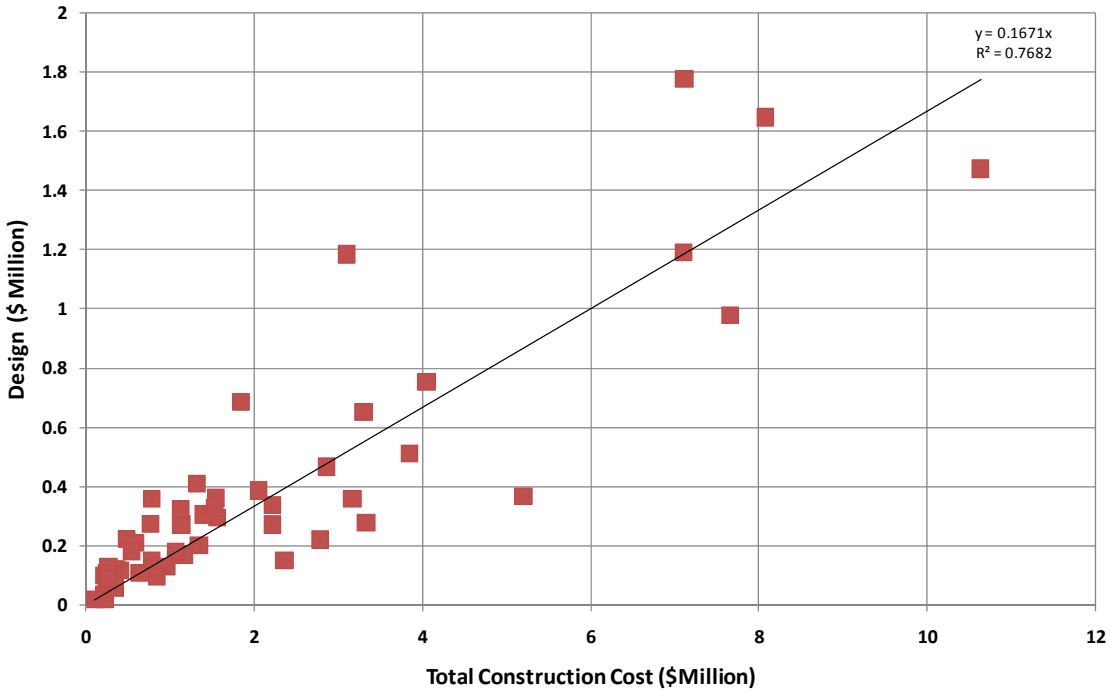
All Projects
Municipal Facilities - Police/Fire Stations
Design ($ Million) Versus Total Construction Cost (N=31)



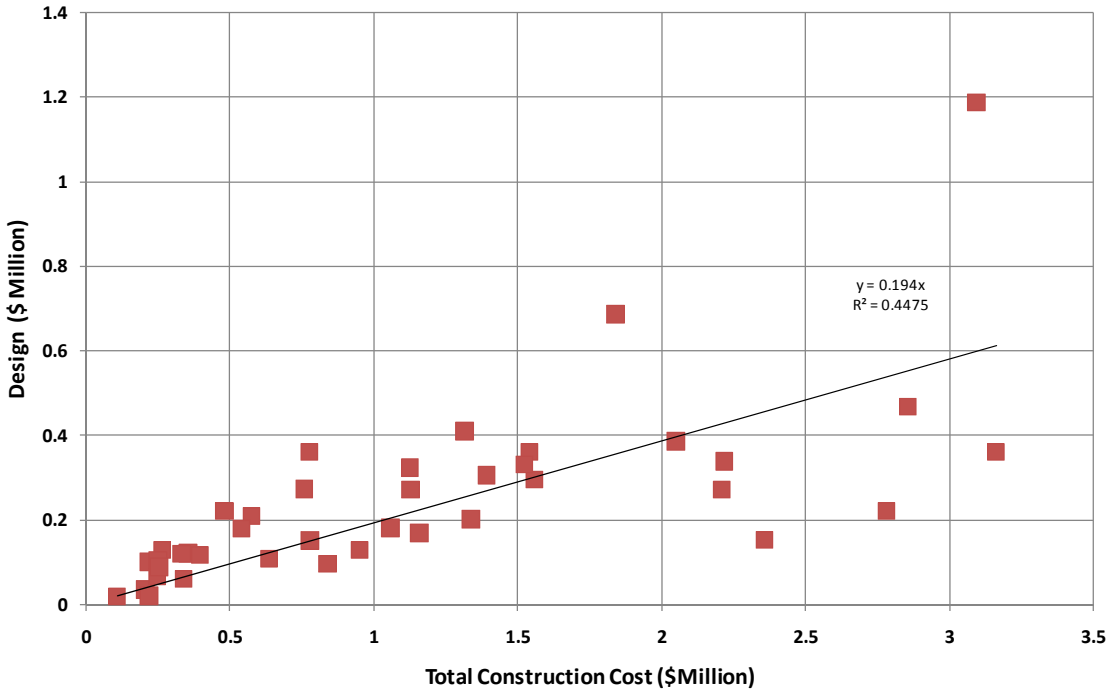
Smaller Projects
Municipal Facilities - Police/Fire Stations
Design ($ Million) Versus Total Construction Cost (N=25)



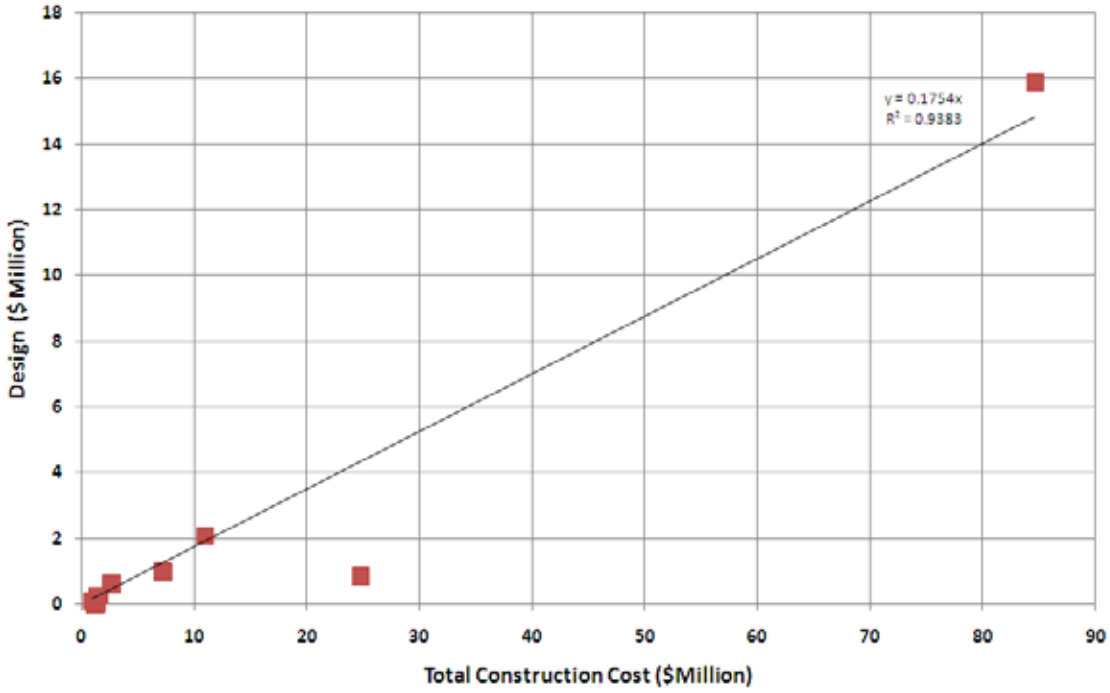
All Projects
Municipal Facilities - Comm./Rec. Center/Child Care/Gyms
Design ($ Million) Versus Total Construction Cost (N=50)



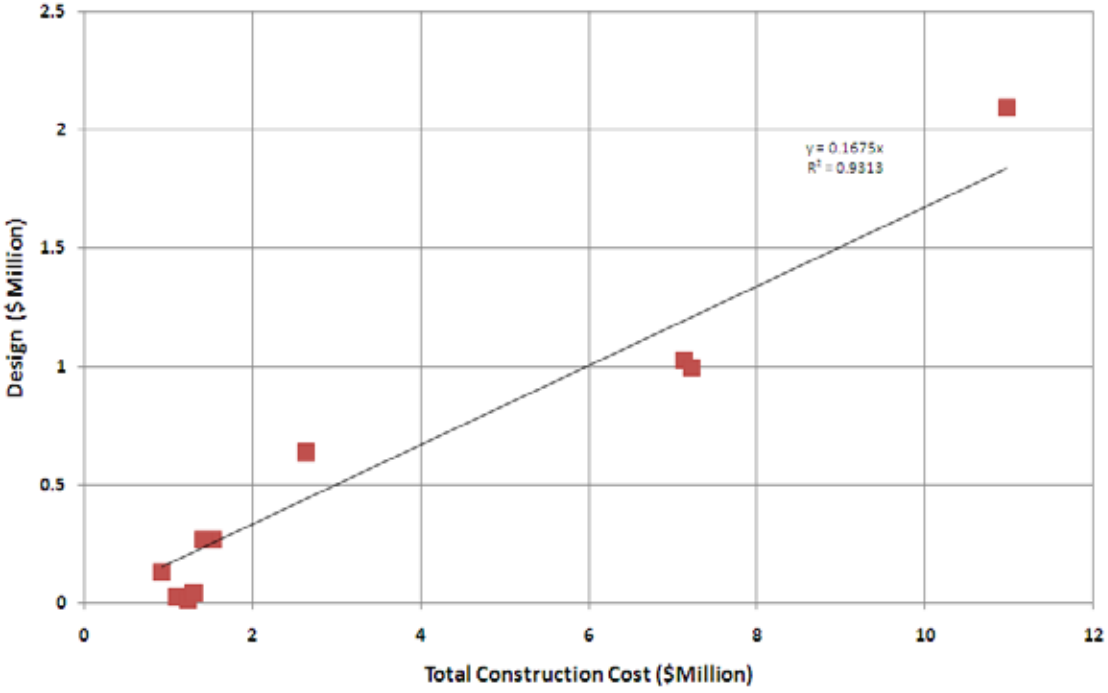
Smaller Projects
Municipal Facilities - Comm./Rec. Center/Child Care/Gyms
Design ($ Million) Versus Total Construction Cost (N=40)



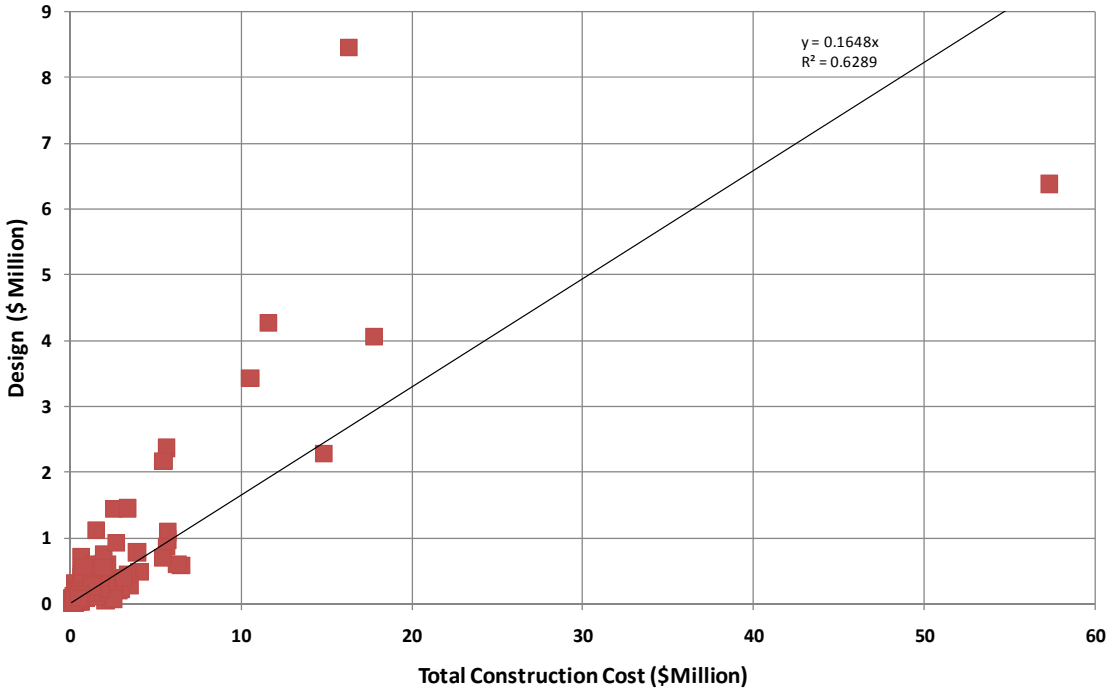
All Projects
Municipal Facilities - Other Municipal Facilities
Design ($ Million) Versus Total Construction Cost (N=12)



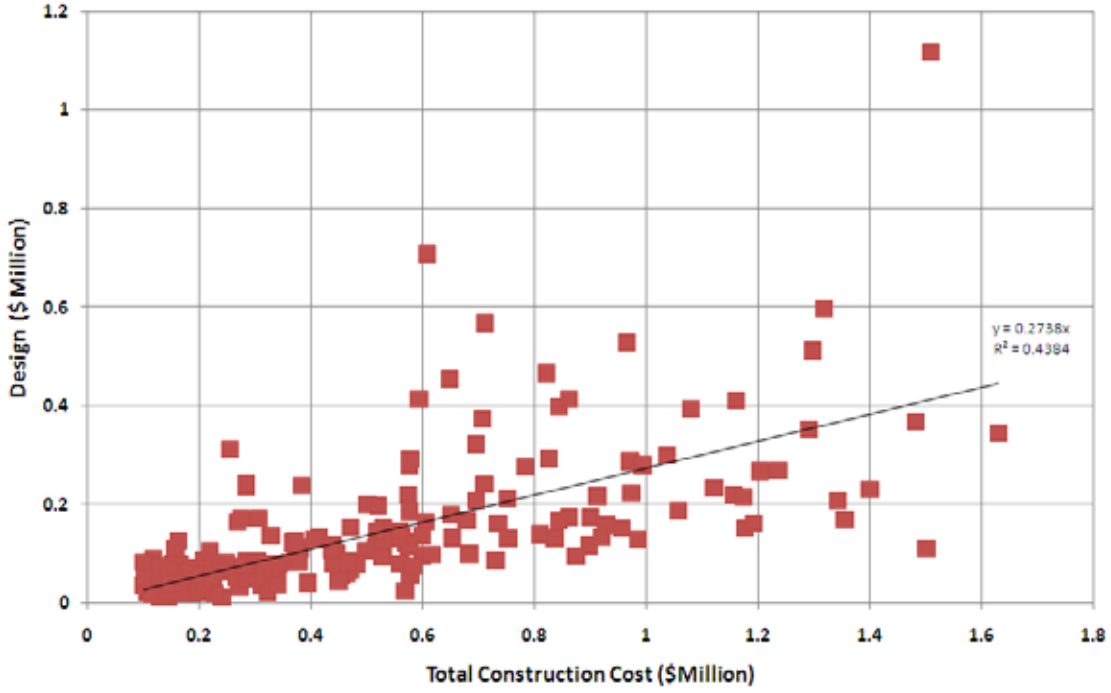
Smaller Projects
Municipal Facilities - Other Municipal Facilities
Design ($ Million) Versus Total Construction Cost (N=10)



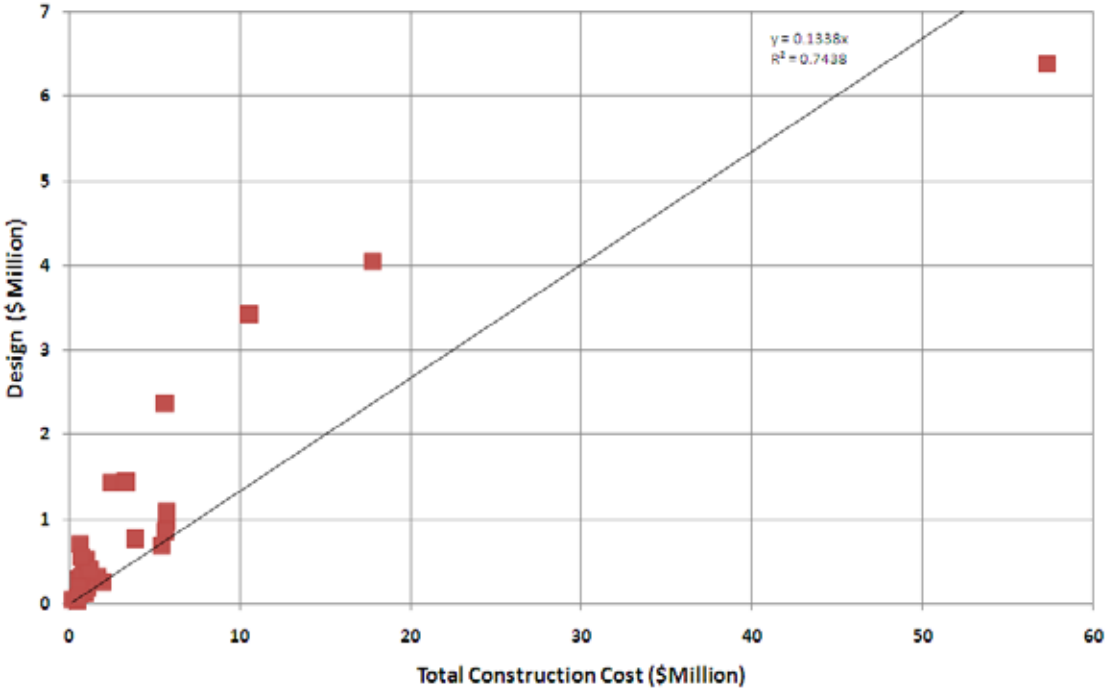
All Projects
Streets - All Classifications
Design ($ Million) Versus Total Construction Cost (N=263)



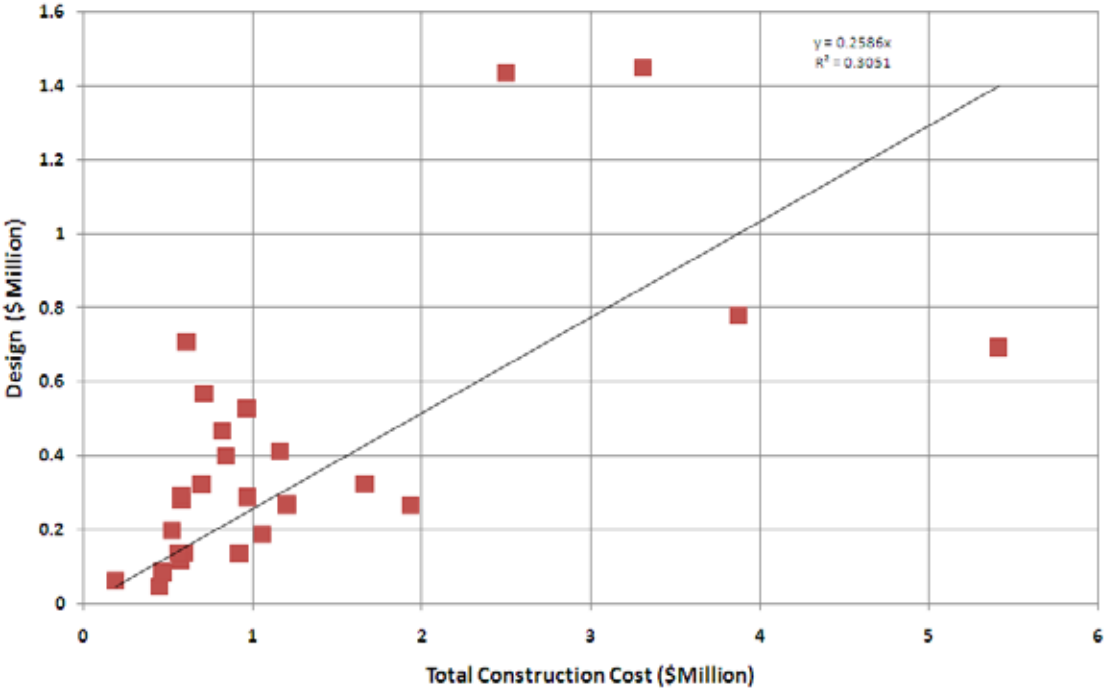
Smaller Projects
Streets - All Classifications
Design ($ Million) Versus Total Construction Cost (N=208)

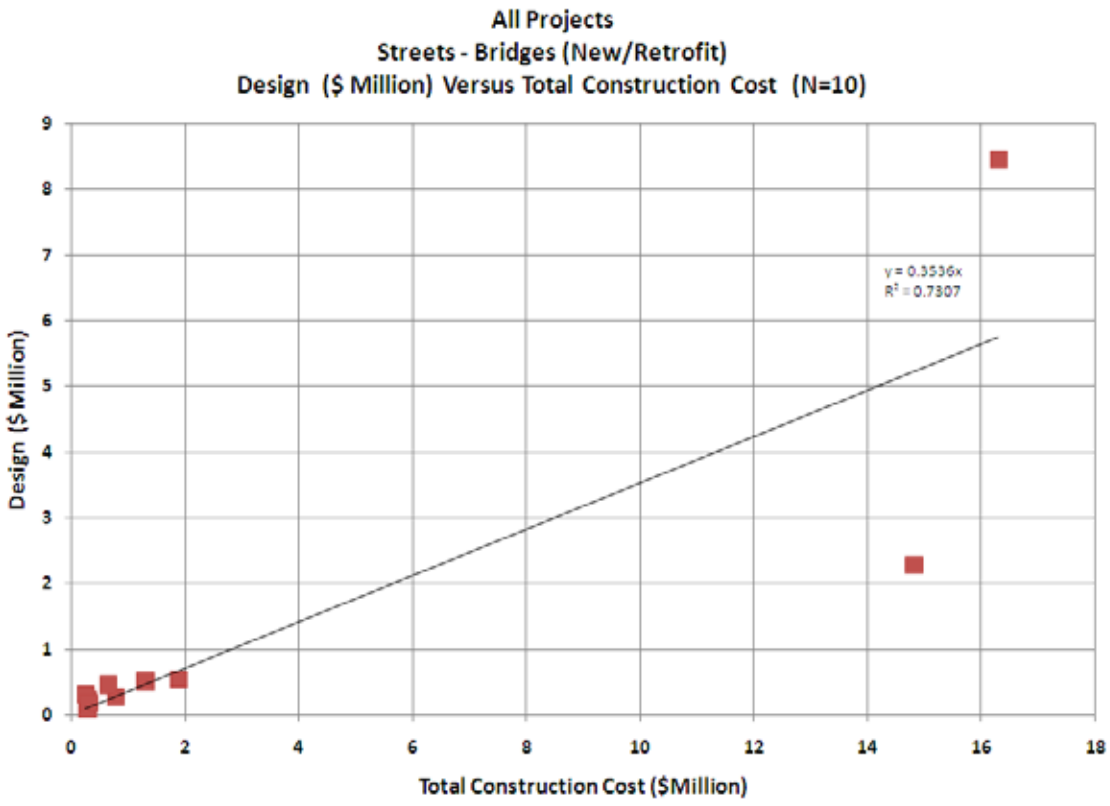


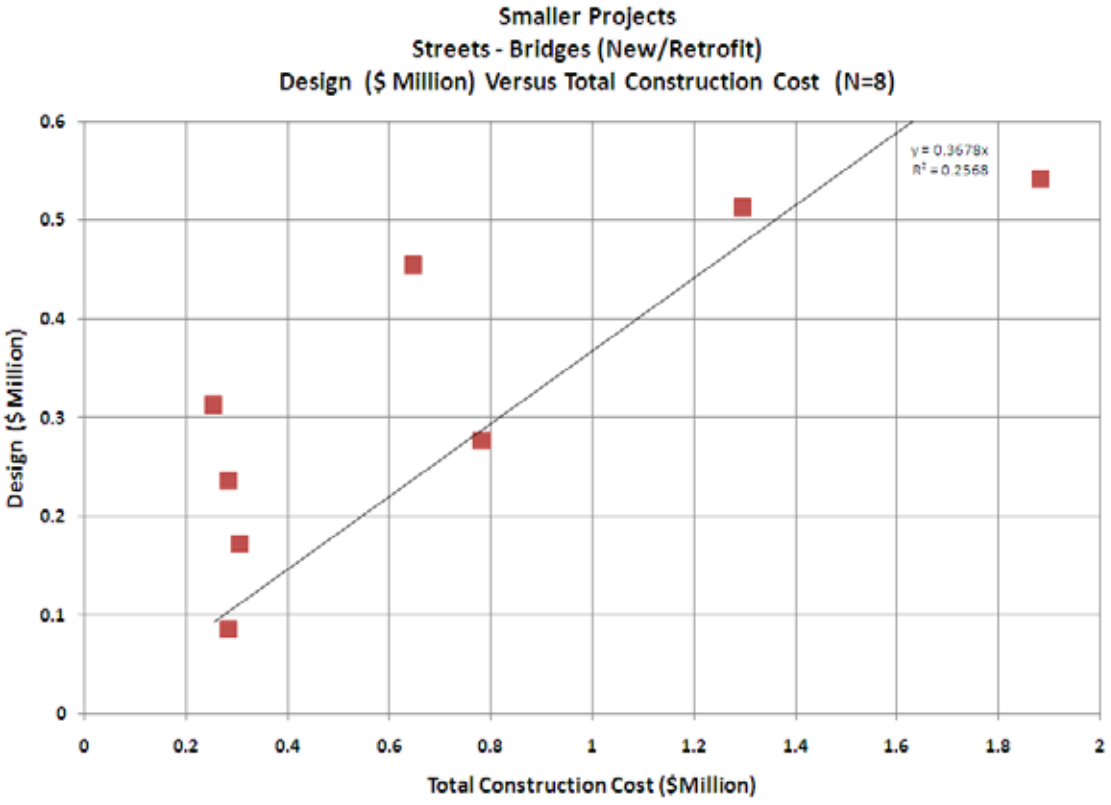
All Projects
Streets - Widening/New/Grade Separations
Design ($ Million) Versus Total Construction Cost (N=33)



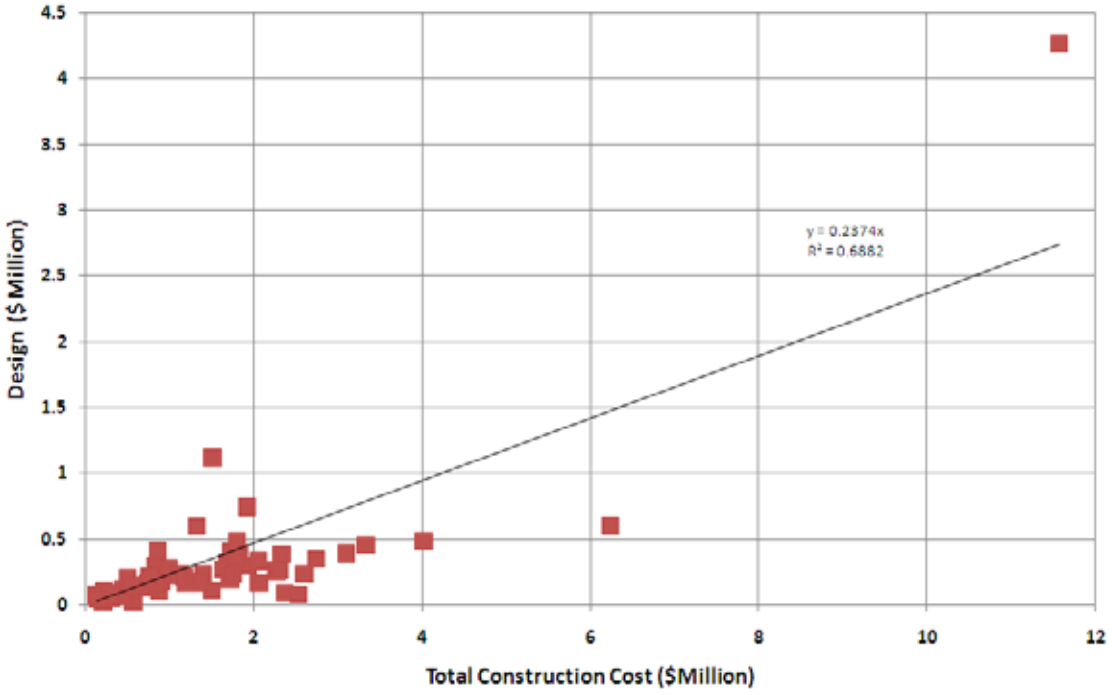
Smaller Projects
Streets - Widening/New/Grade Separations
Design ($ Million) Versus Total Construction Cost (N=26)



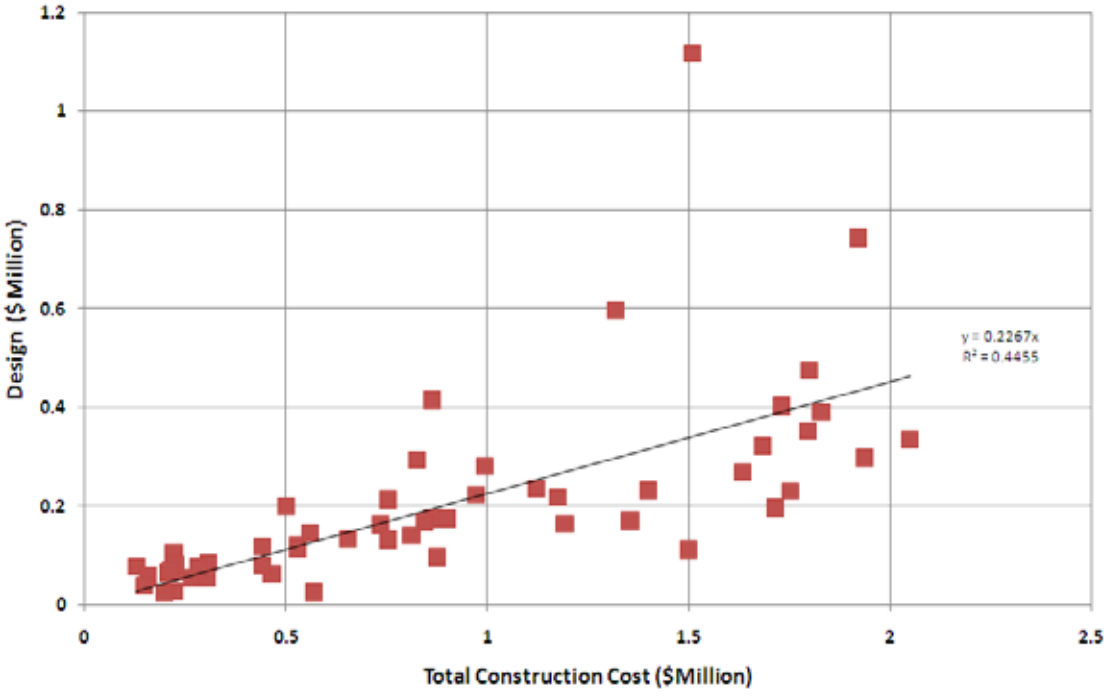

All Projects
Streets - Bridges (New/Retrofit)
Design ($ Million) Versus Total Construction Cost (N=10)
y = 0.3536x
R² = 0.7307
Design ($ Million)
Total Construction Cost ($Million)
0
1
2
3
4
5
6
7
8
9
0
2
4
6
8
10
12
14
16
18


Smaller Projects
Streets - Bridges (New/Retrofit)
Design ($ Million) Versus Total Construction Cost (N=8)
y = 0.3678x
R² = 0.2568
Design ($ Million)
Total Construction Cost ($Million)
0
0.1
0.2
0.3
0.4
0.5
0.6
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2

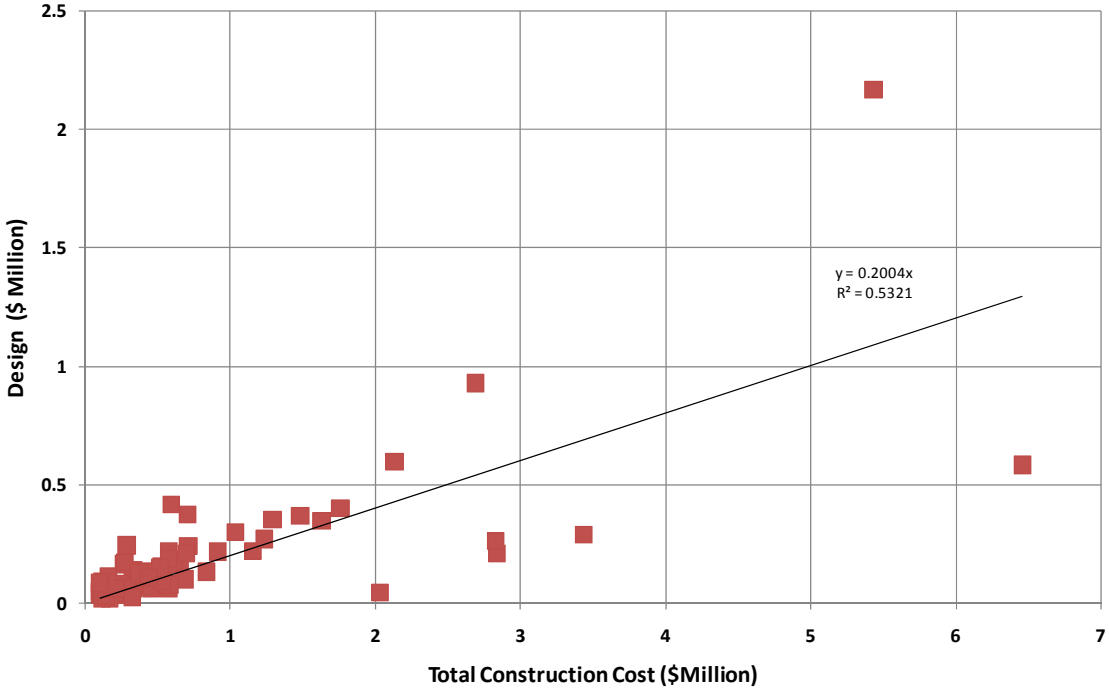
All Projects
Streets - Reconstructions
Design ($ Million) Versus Total Construction Cost (N=69)



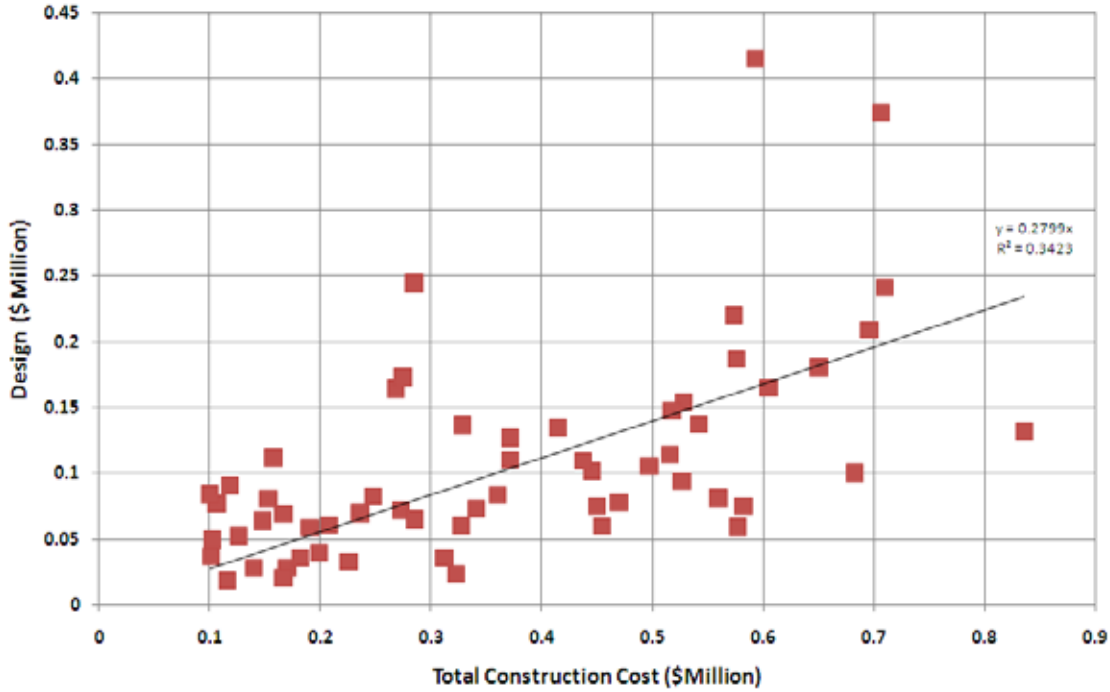
Smaller Projects
Streets - Reconstructions
Design ($ Million) Versus Total Construction Cost (N=55)



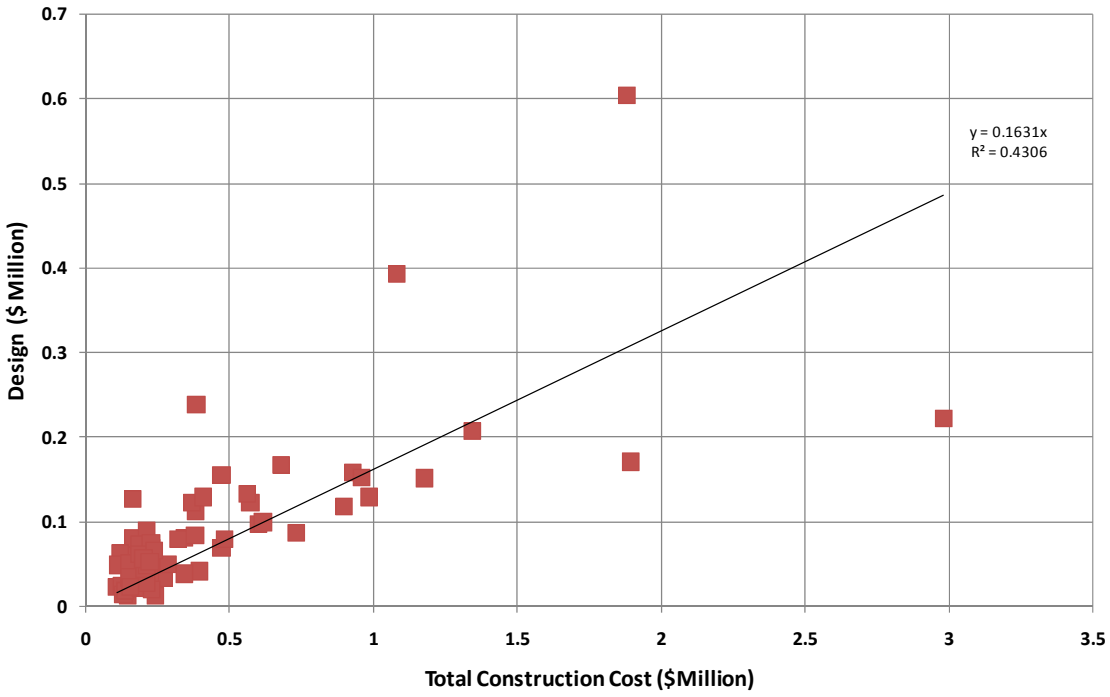
All Projects
Streets - Bike/Pedestrian/Streetscapes
Design ($ Million) Versus Total Construction Cost (N=78)



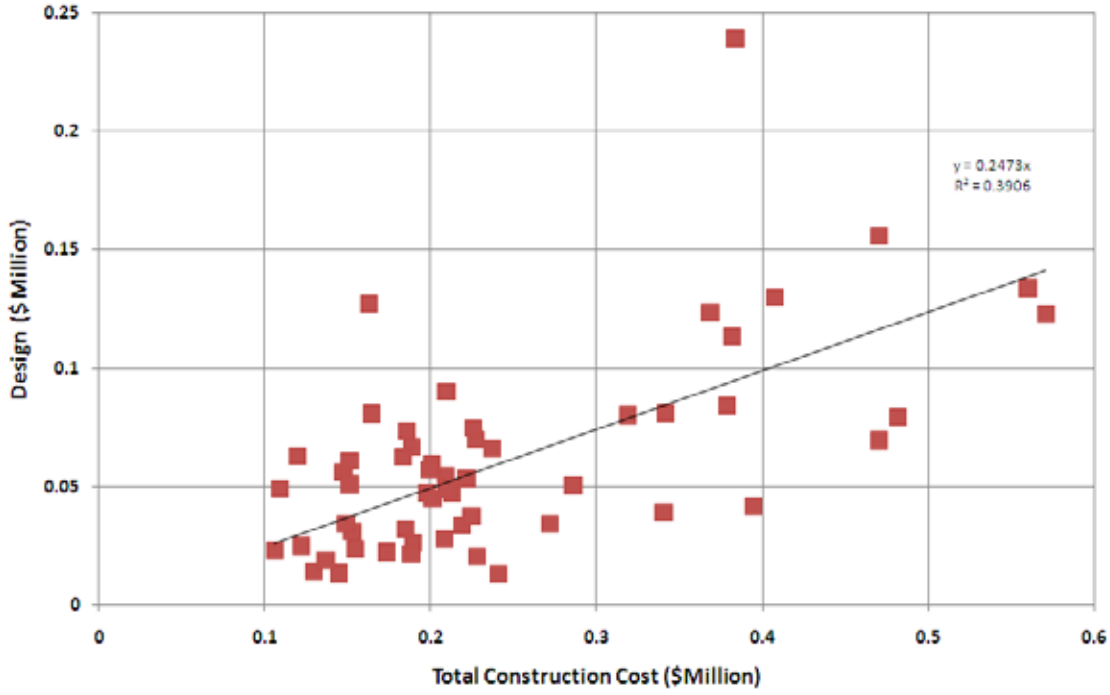
Smaller Projects
Streets - Bike/Pedestrian/Streetscapes
Design ($ Million) Versus Total Construction Cost (N=61)



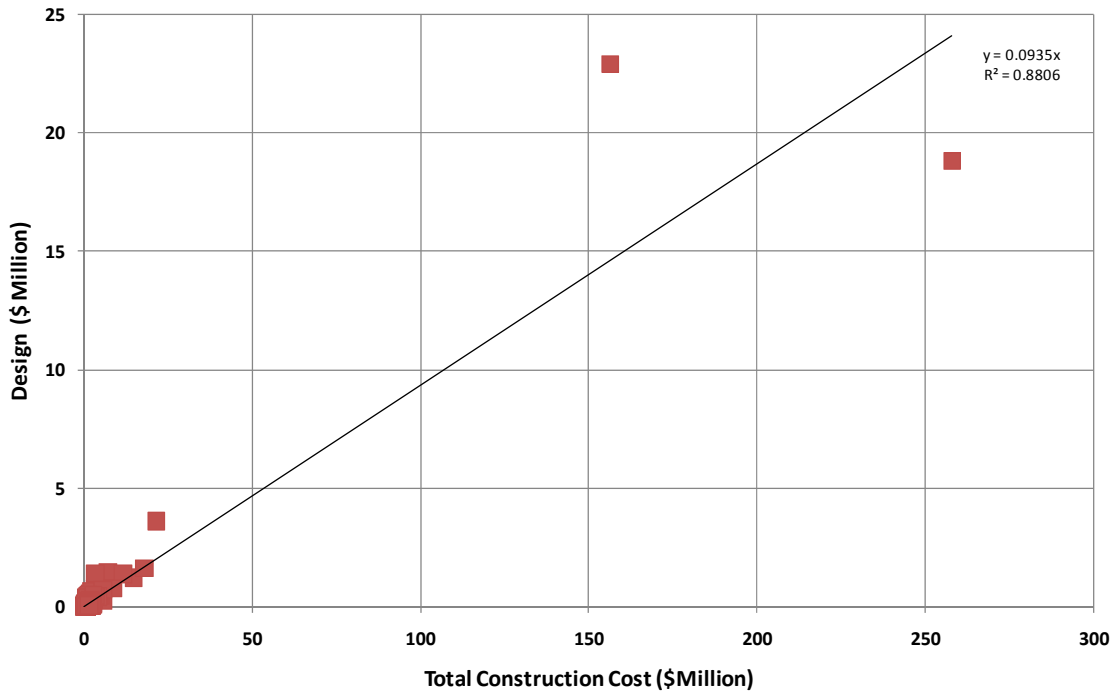
All Projects
Streets - Signals
Design ($ Million) Versus Total Construction Cost (N=73)



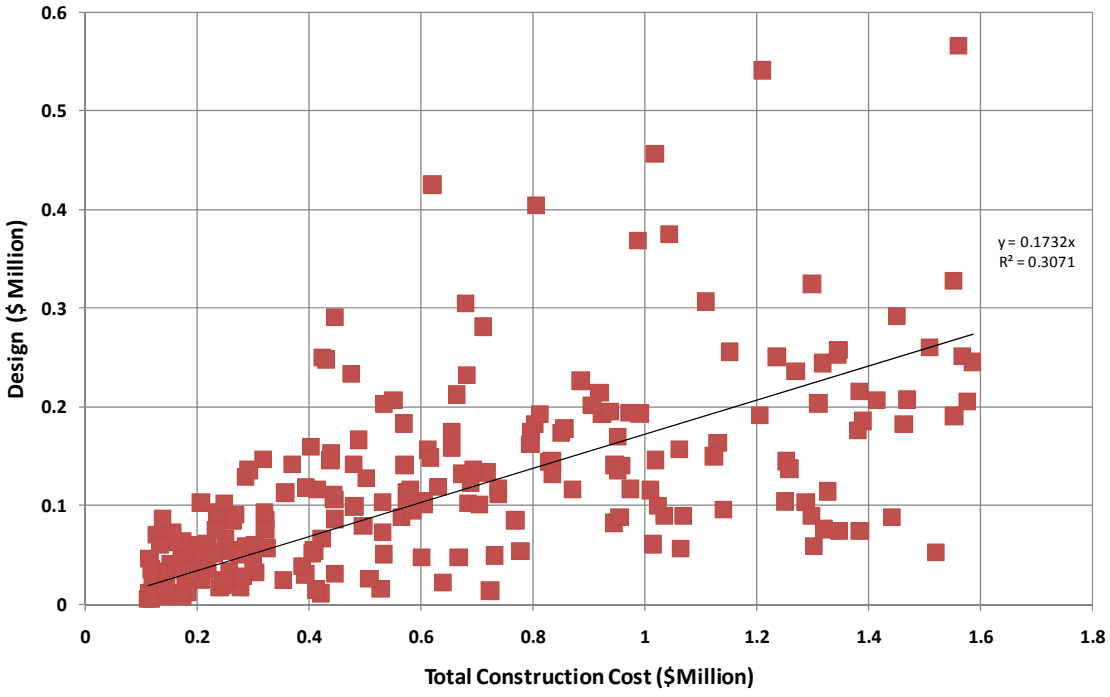
Smaller Projects
Streets - Signals
Design ($ Million) Versus Total Construction Cost (N=58)



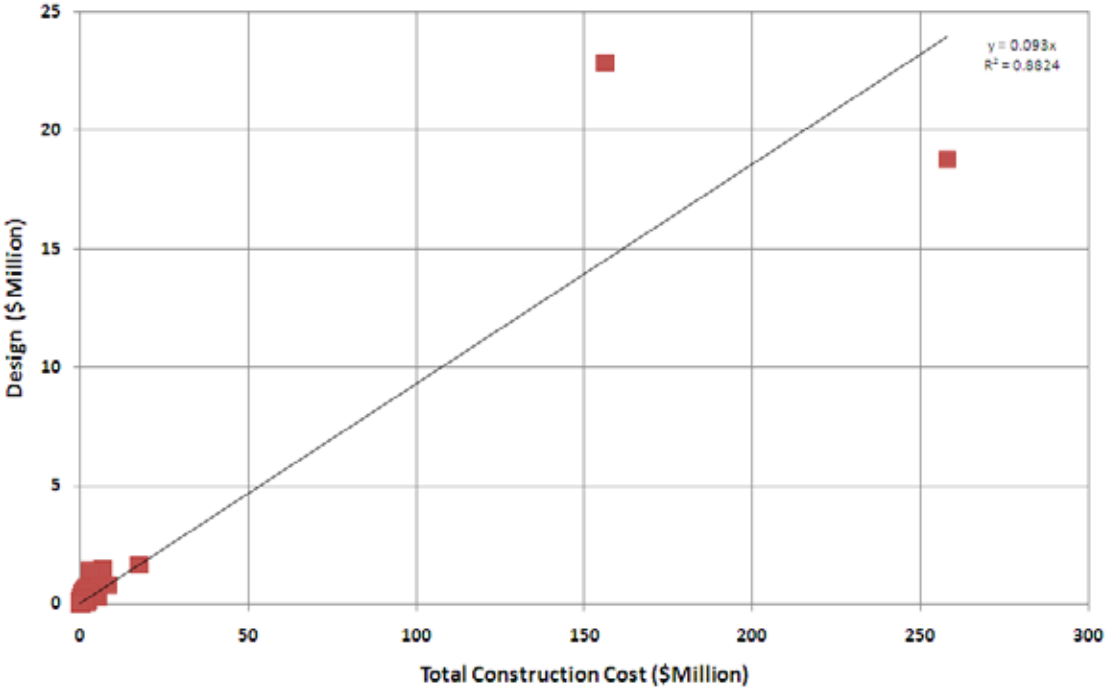
All Projects
Pipe Systems - All Classifications
Design ($ Million) Versus Total Construction Cost (N=267)



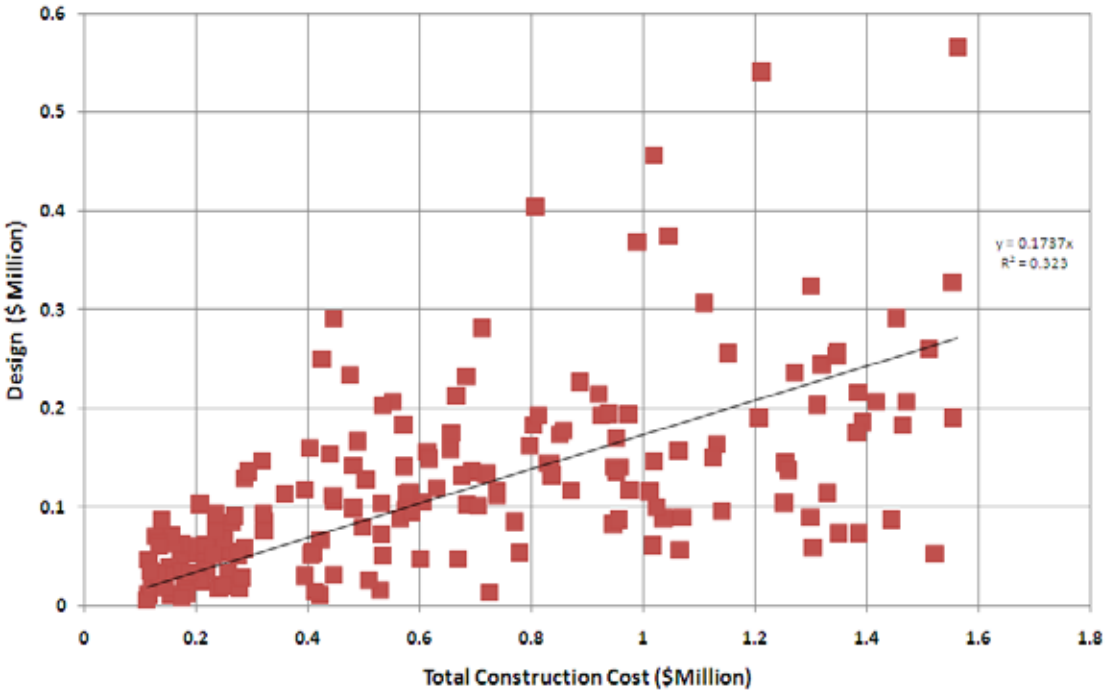
Smaller Projects
Pipe Systems - All Classifications
Design ($ Million) Versus Total Construction Cost (N=214)



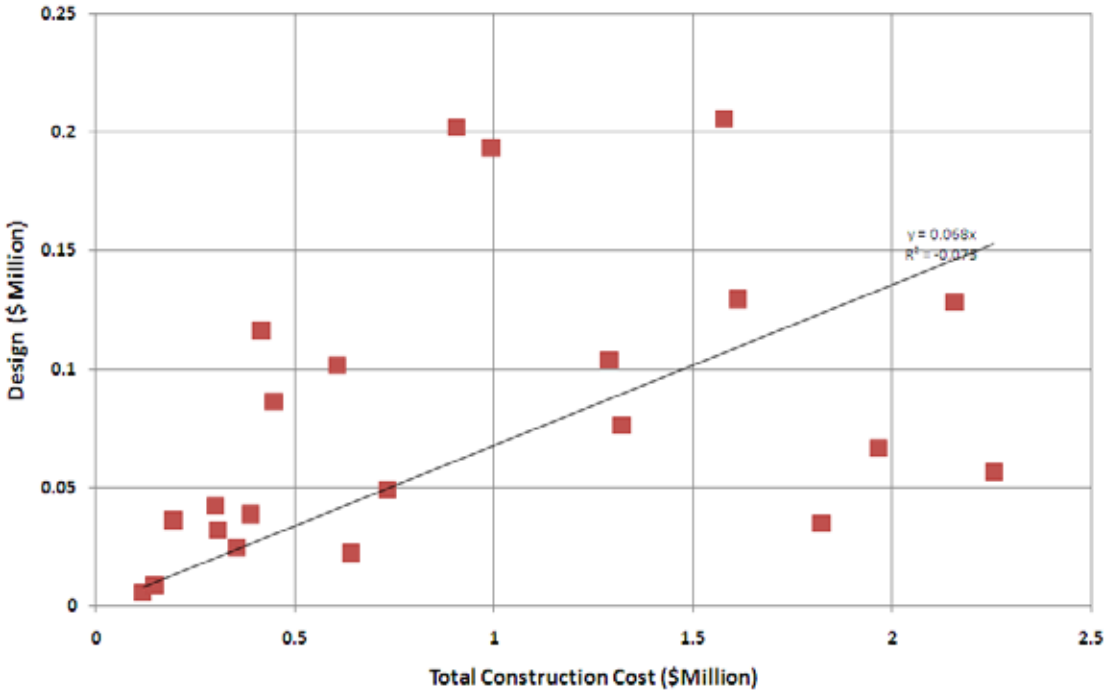
All Projects
Pipe Systems - Gravity Systems (Storm Drains/Sewers)
Design ($ Million) Versus Total Construction Cost (N=226)



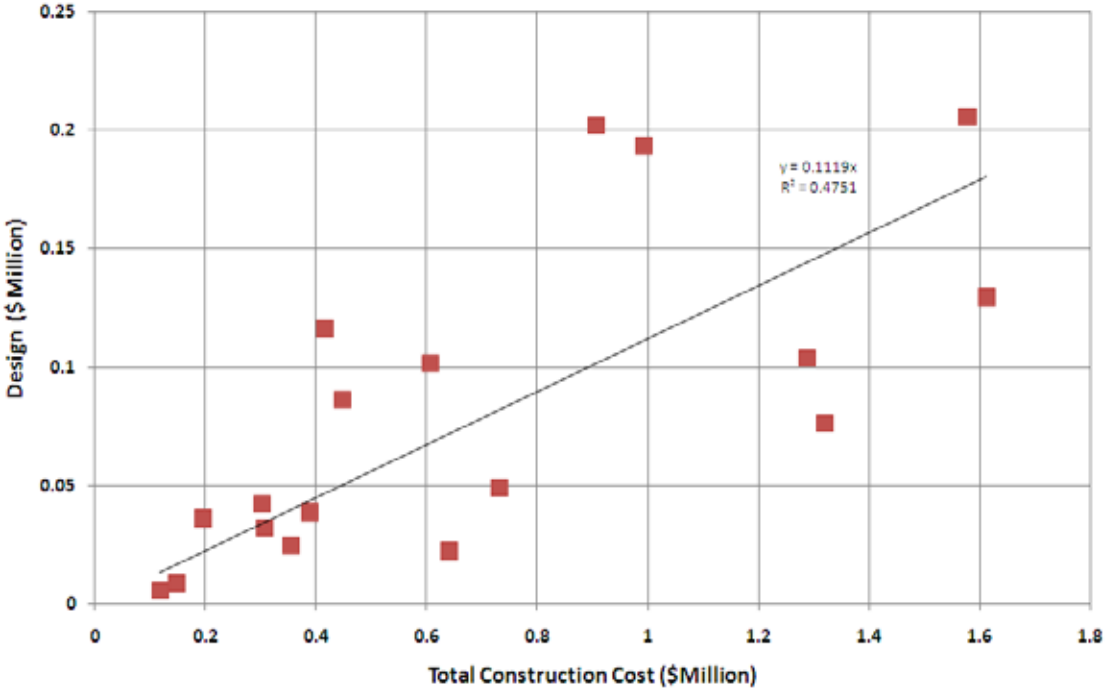
Smaller Projects
Pipe Systems - Gravity Systems (Storm Drains/Sewers)
Design ($ Million) Versus Total Construction Cost (N=181)



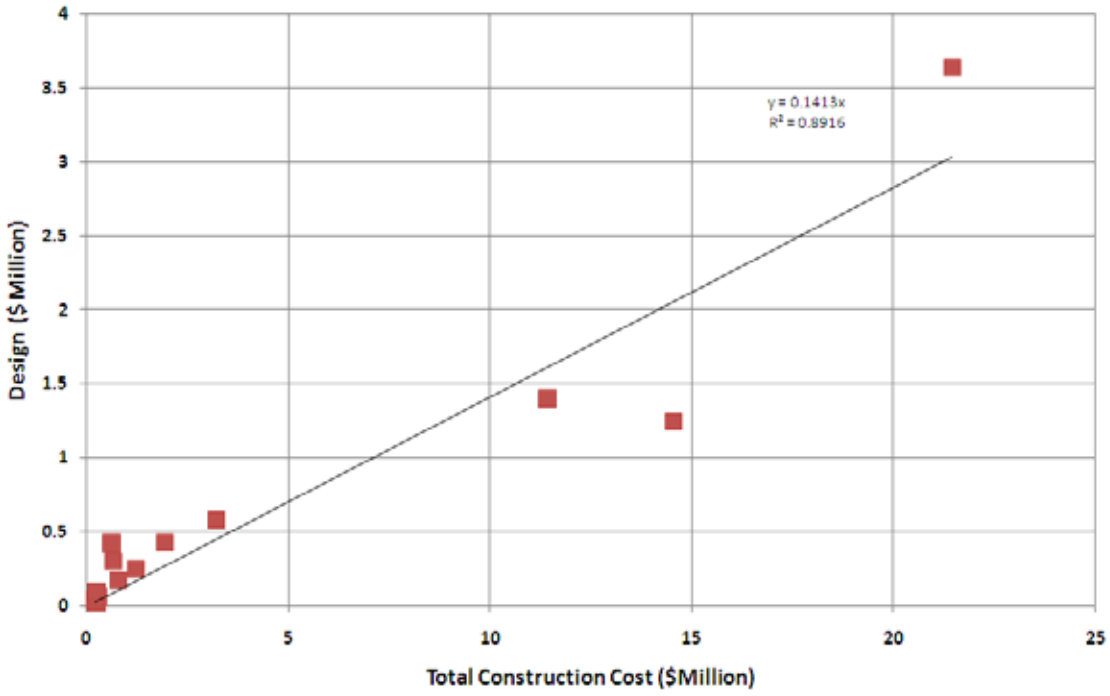
All Projects
Pipe Systems - Pressure Systems
Design ($ Million) Versus Total Construction Cost (N=22)



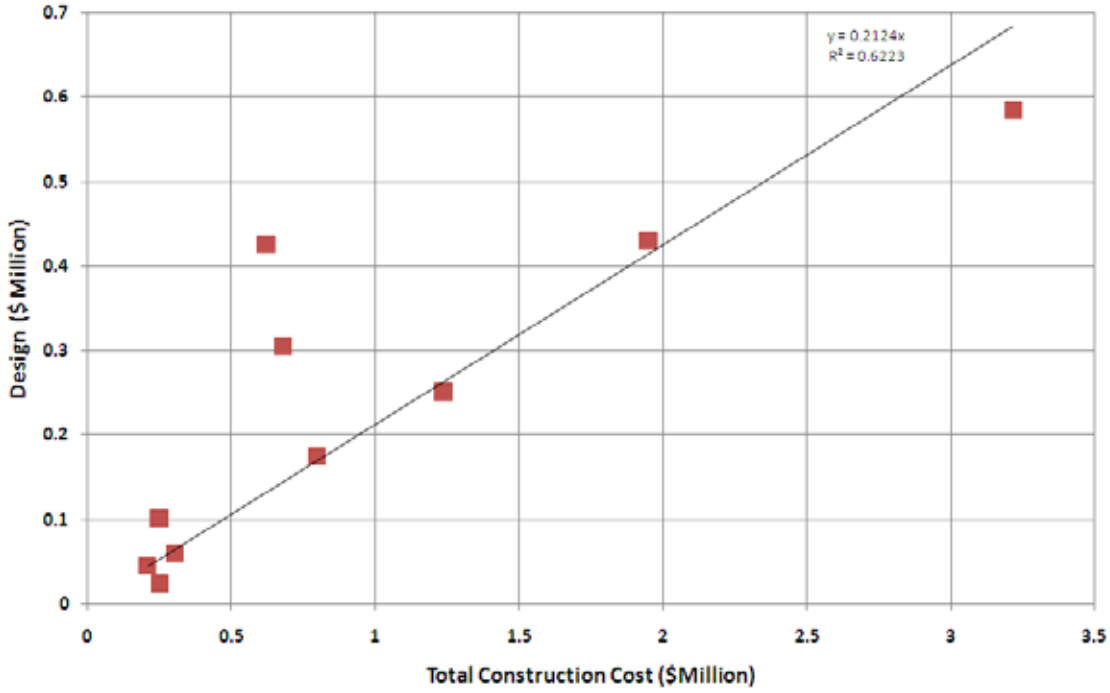
Smaller Projects
Pipe Systems - Pressure Systems
Design ($ Million) Versus Total Construction Cost (N=18)



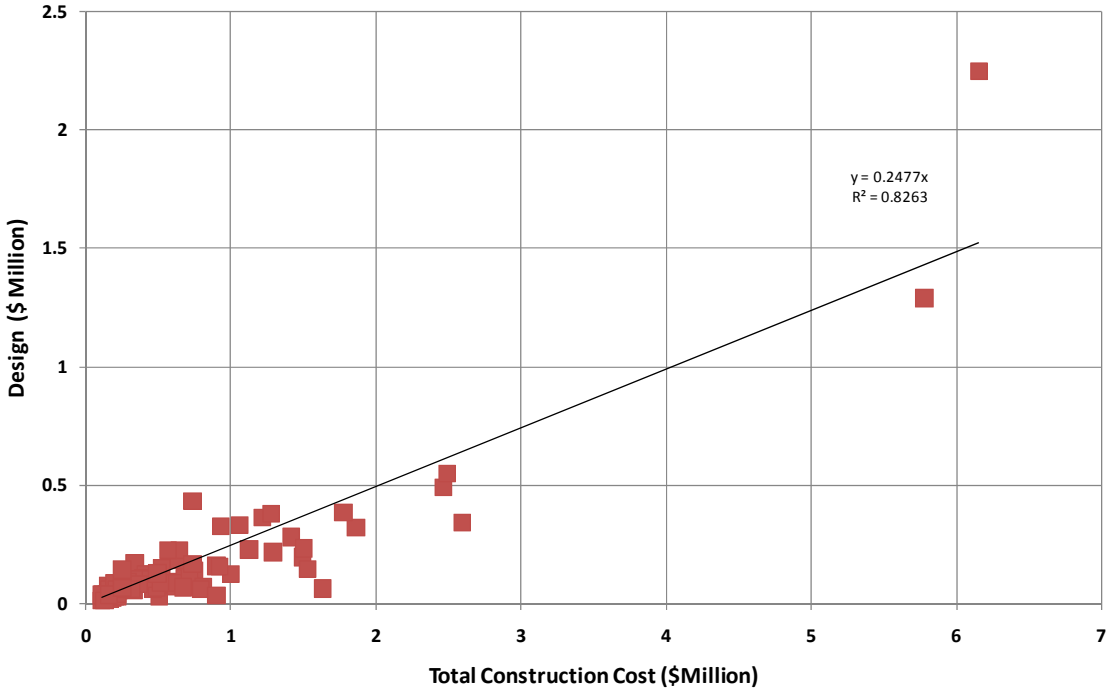
All Projects
Pipe Systems - Pump Stations
Design ($ Million) Versus Total Construction Cost (N=13)



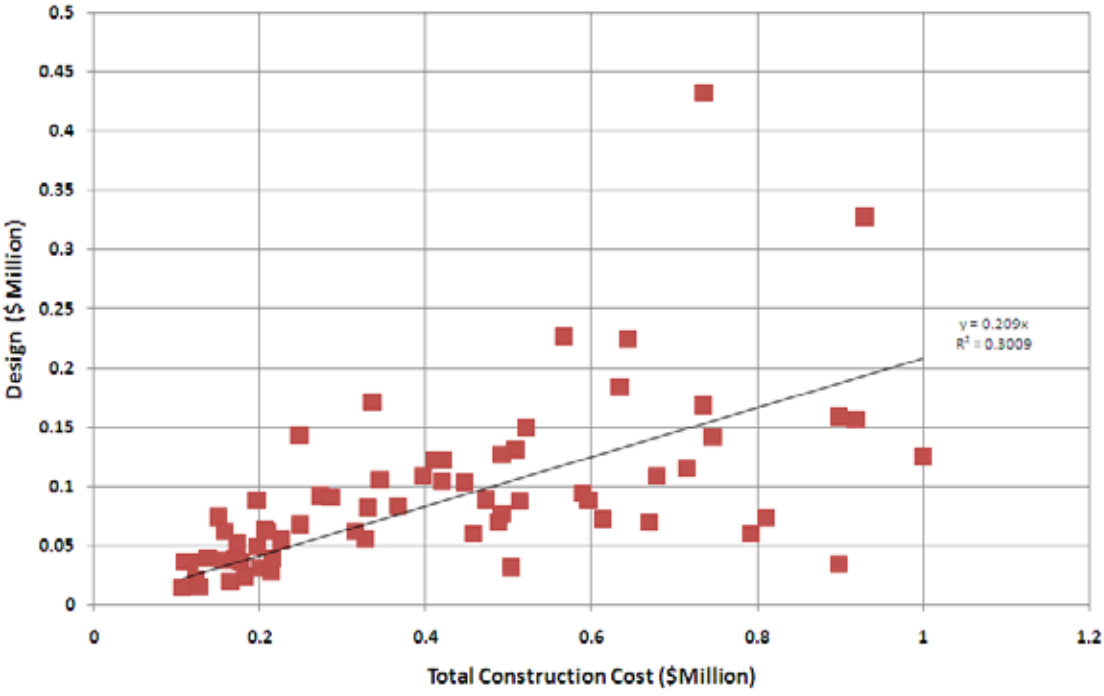
Smaller Projects
Pipe Systems - Pump Stations
Design ($ Million) Versus Total Construction Cost (N=10)



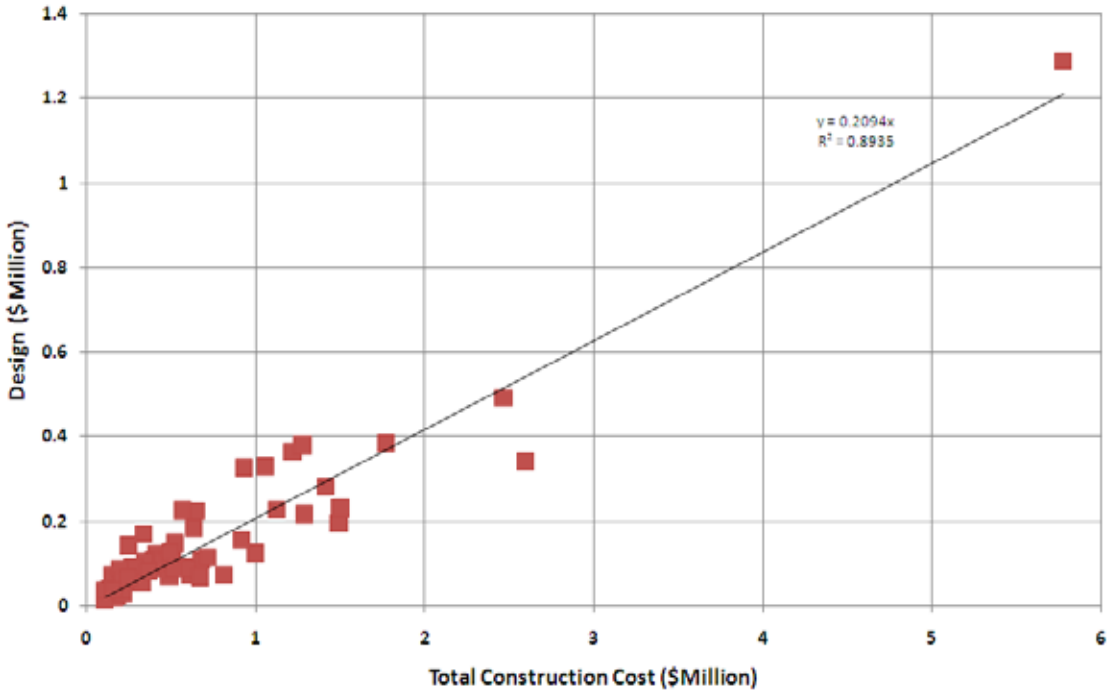
All Projects
Parks - All Classifications
Design ($ Million) Versus Total Construction Cost (N=82)



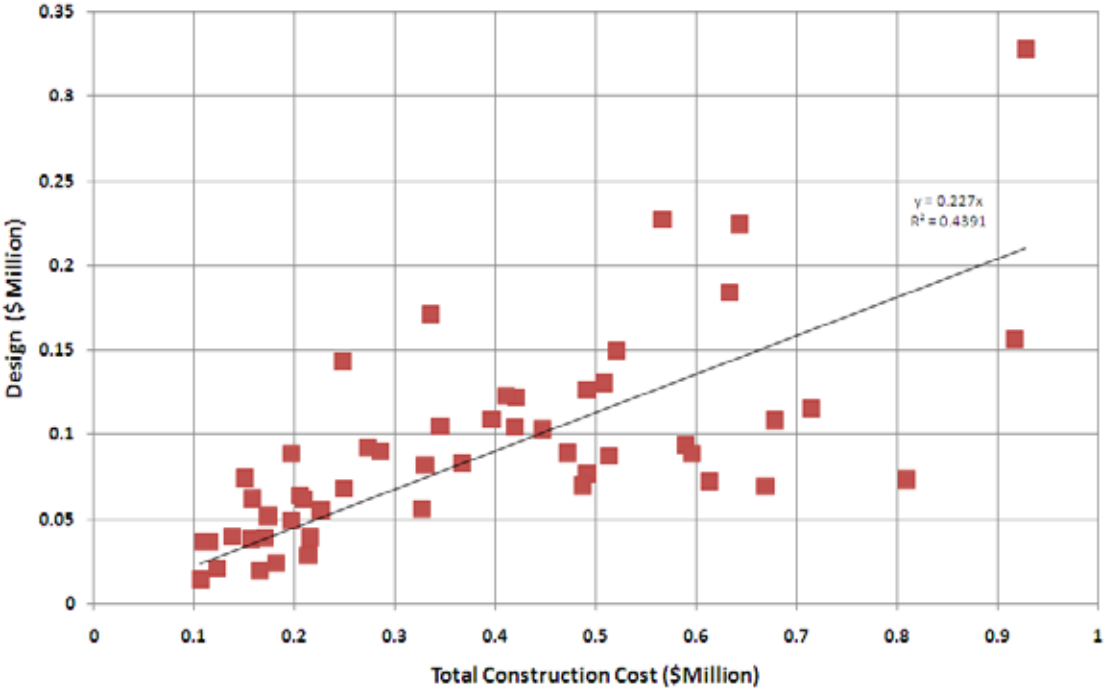
Smaller Projects
Parks - All Classifications
Design ($ Million) Versus Total Construction Cost (N=65)



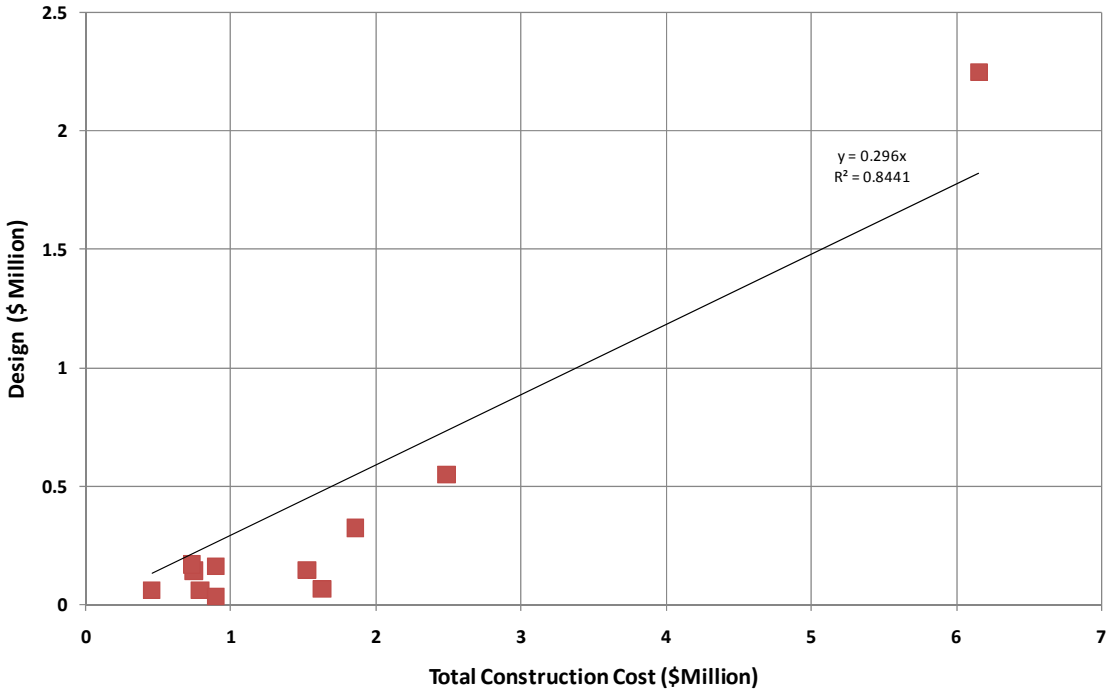
All Projects
Parks - Playgrounds
Design ($ Million) Versus Total Construction Cost (N=65)



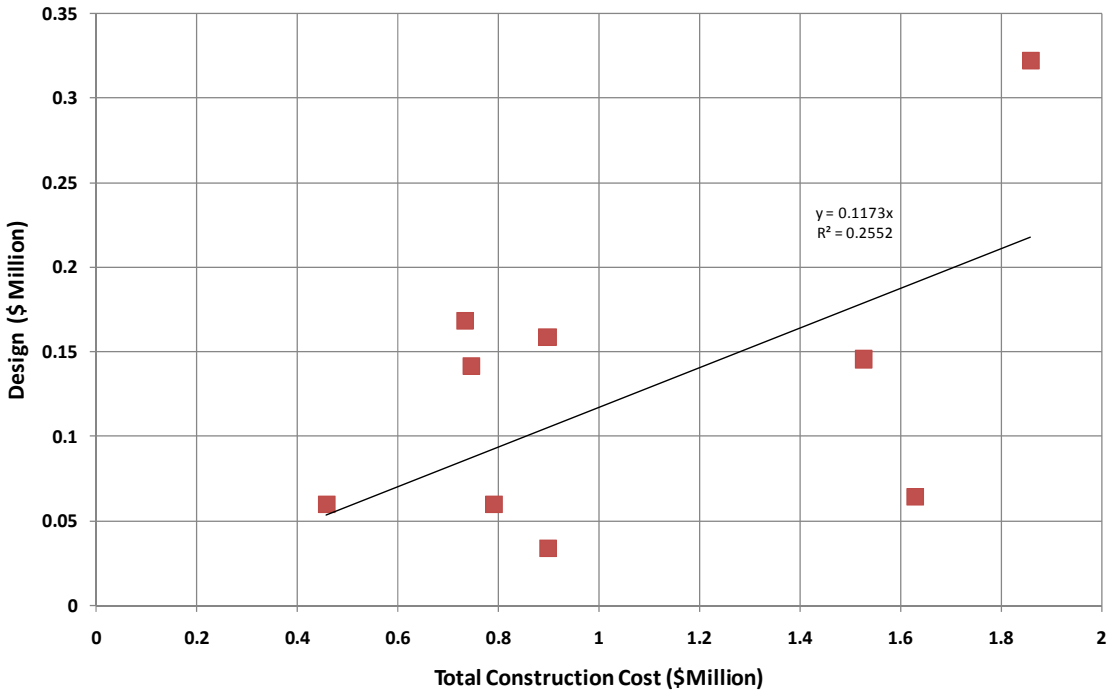
Smaller Projects
Parks - Playgrounds
Design ($ Million) Versus Total Construction Cost (N=52)



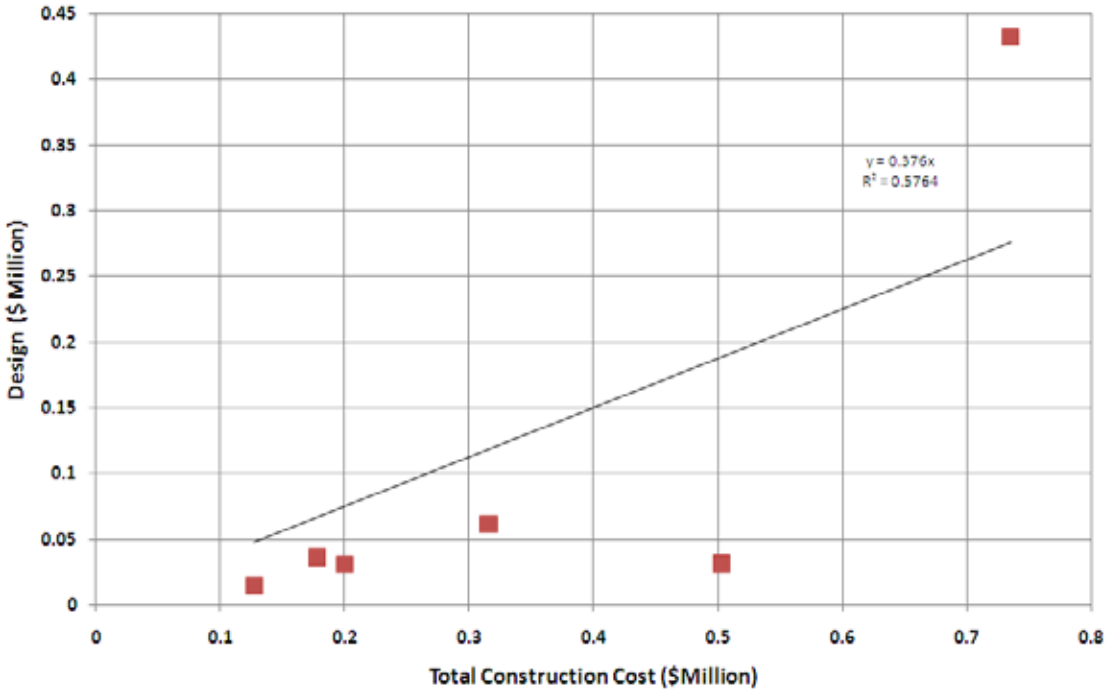
All Projects
Parks - Sportfields
Design ($ Million) Versus Total Construction Cost (N=12)



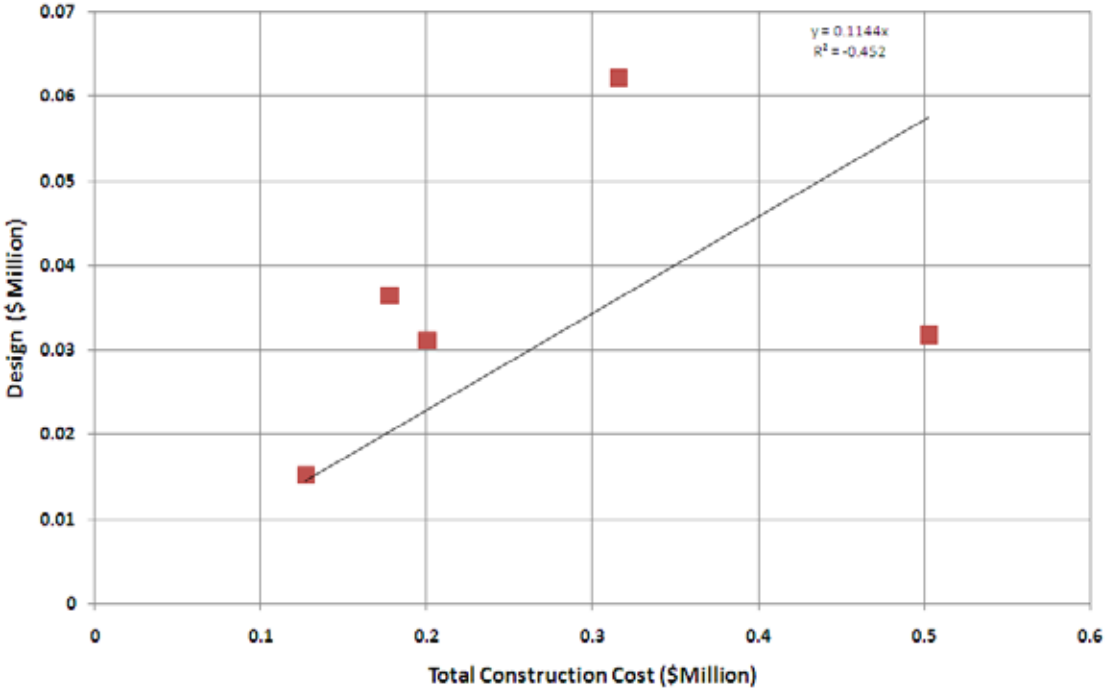
Smaller Projects
Parks - Sportfields
Design ($ Million) Versus Total Construction Cost (N=10)



All Projects
Parks - Restrooms
Design ($ Million) Versus Total Construction Cost (N=6)



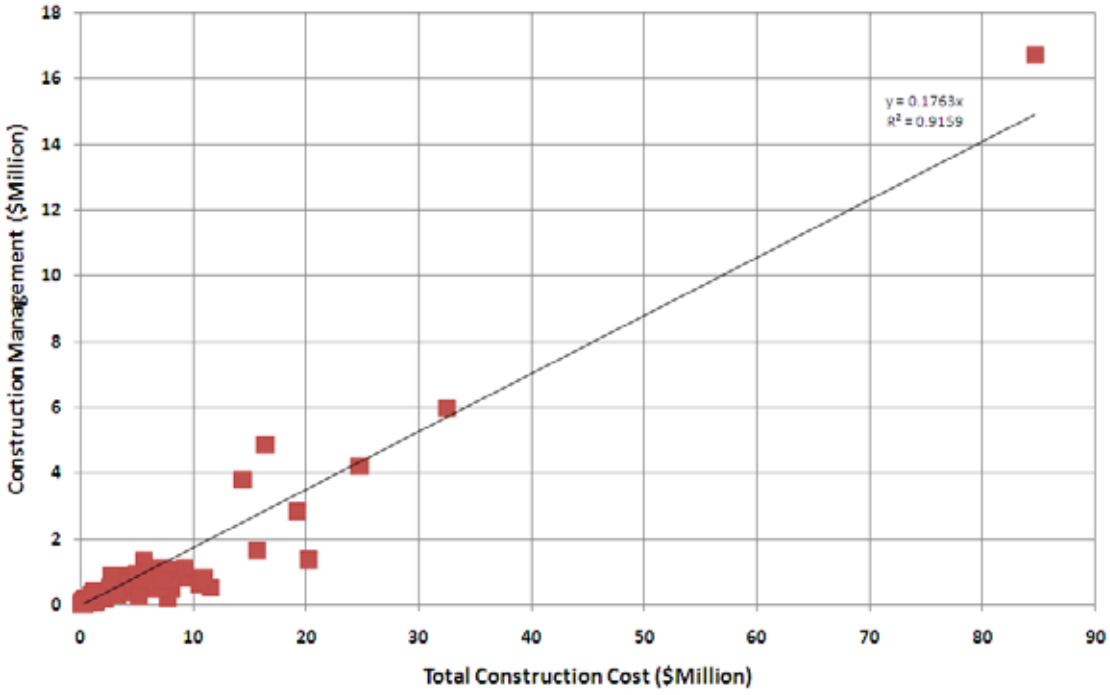
Smaller Projects
Parks - Restrooms
Design ($ Million) Versus Total Construction Cost (N=5)



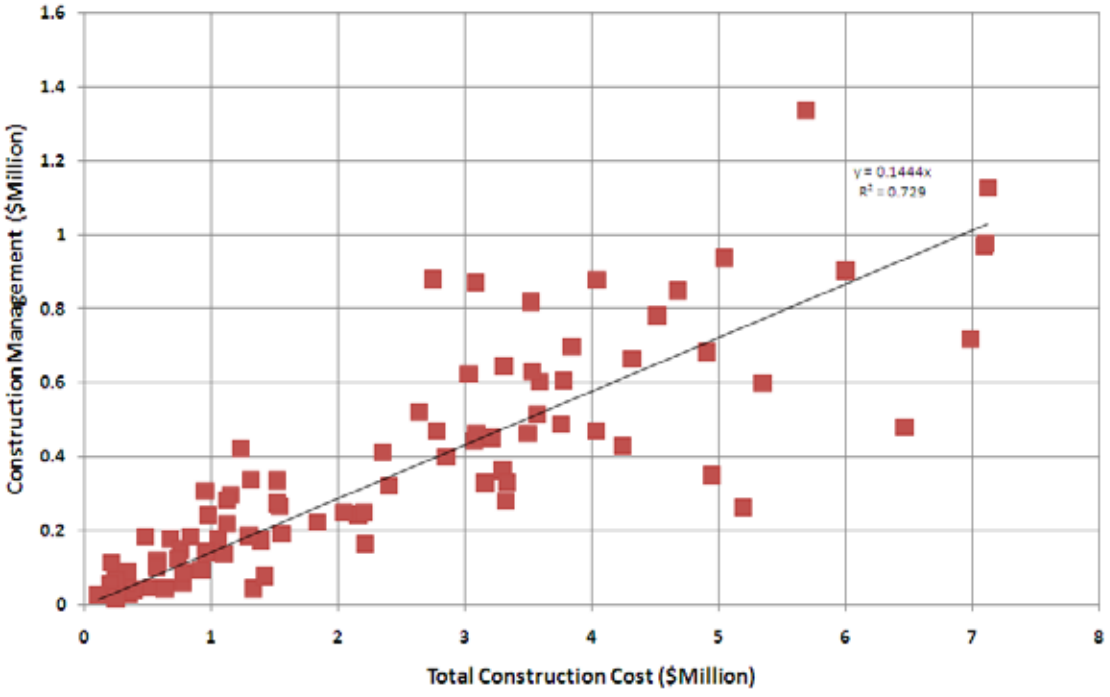
CURVES GROUP 2

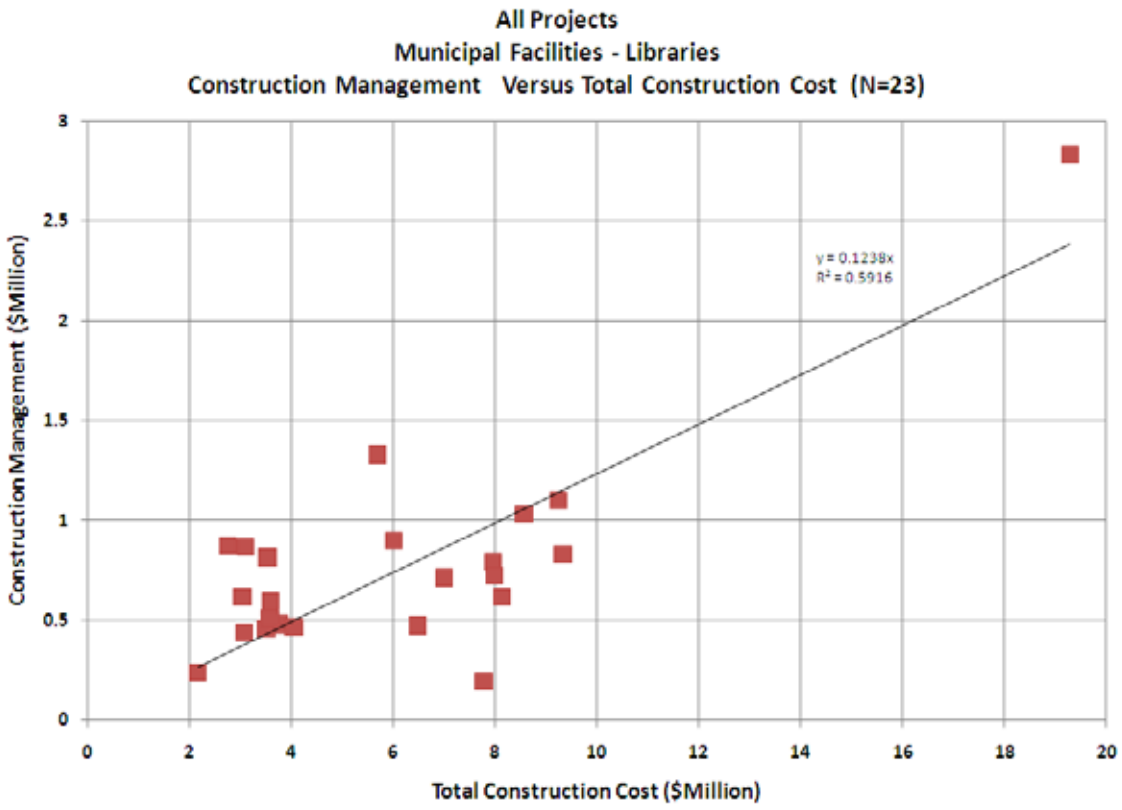
Construction Management Cost
vs
Total Construction Cost

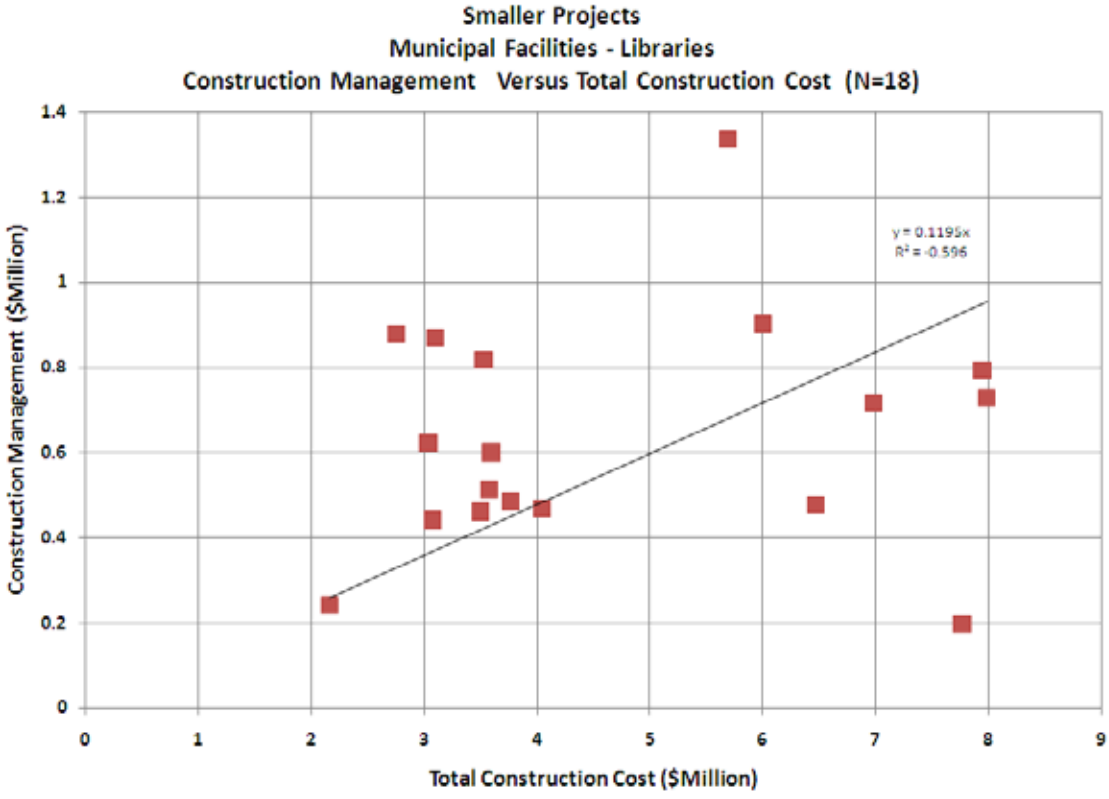
All Projects
Municipal Facilities - All Classifications
Construction Management Versus Total Construction Cost (N=116)



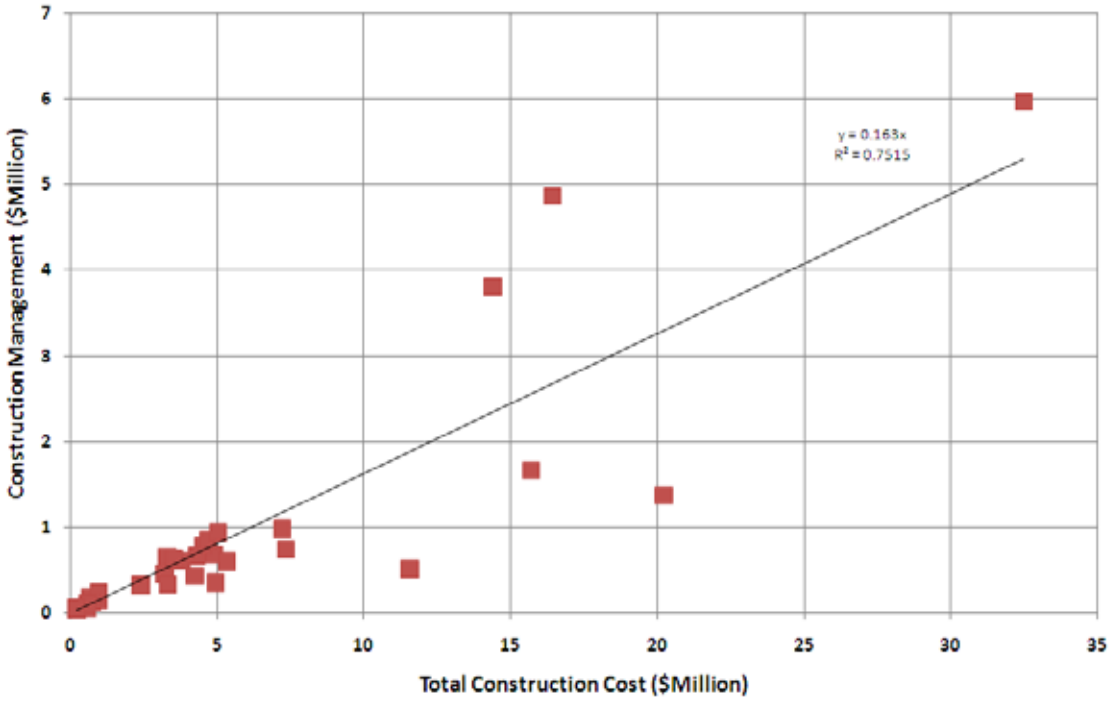
Smaller Projects
Municipal Facilities - All Classifications
Construction Management Versus Total Construction Cost (N=93)



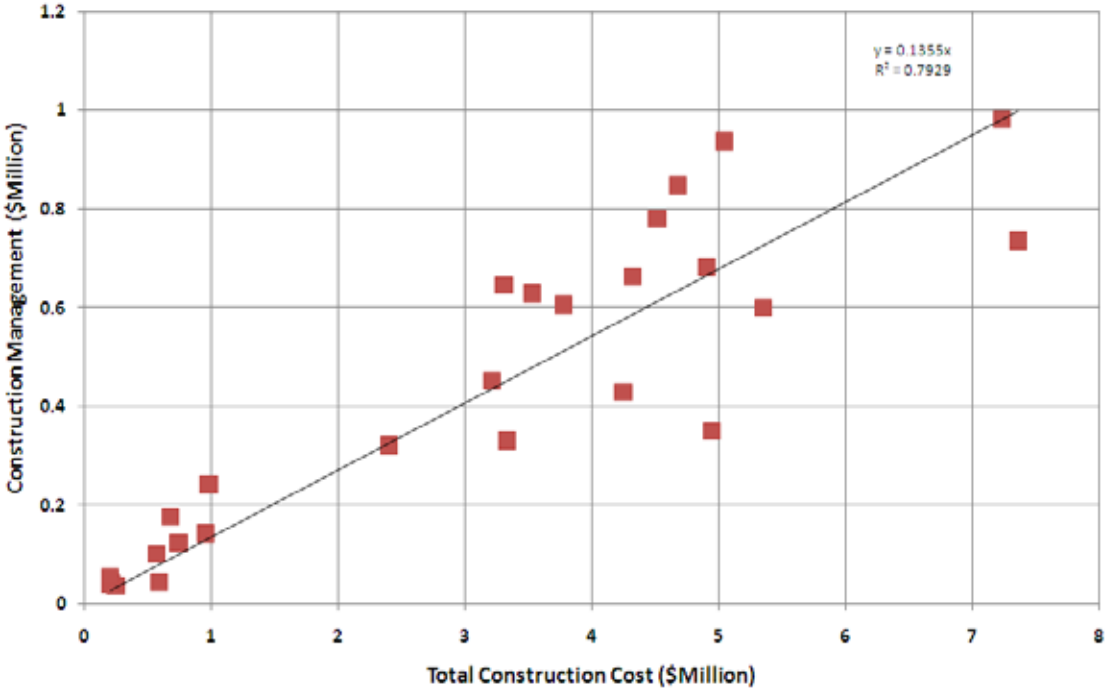

All Projects
Municipal Facilities - Libraries
Construction Management Versus Total Construction Cost (N=23)
y = 0.1238x
R² = 0.5916
Construction Management ($Million)
Total Construction Cost ($Million)
0
0.5
1
1.5
2
2.5
3
0
2
4
6
8
10
12
14
16
18
20


Smaller Projects
Municipal Facilities - Libraries
Construction Management Versus Total Construction Cost (N=18)
y = 0.1195x
R² = 0.596
Construction Management ($Million)
Total Construction Cost ($Million)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
1
2
3
4
5
6
7
8
9

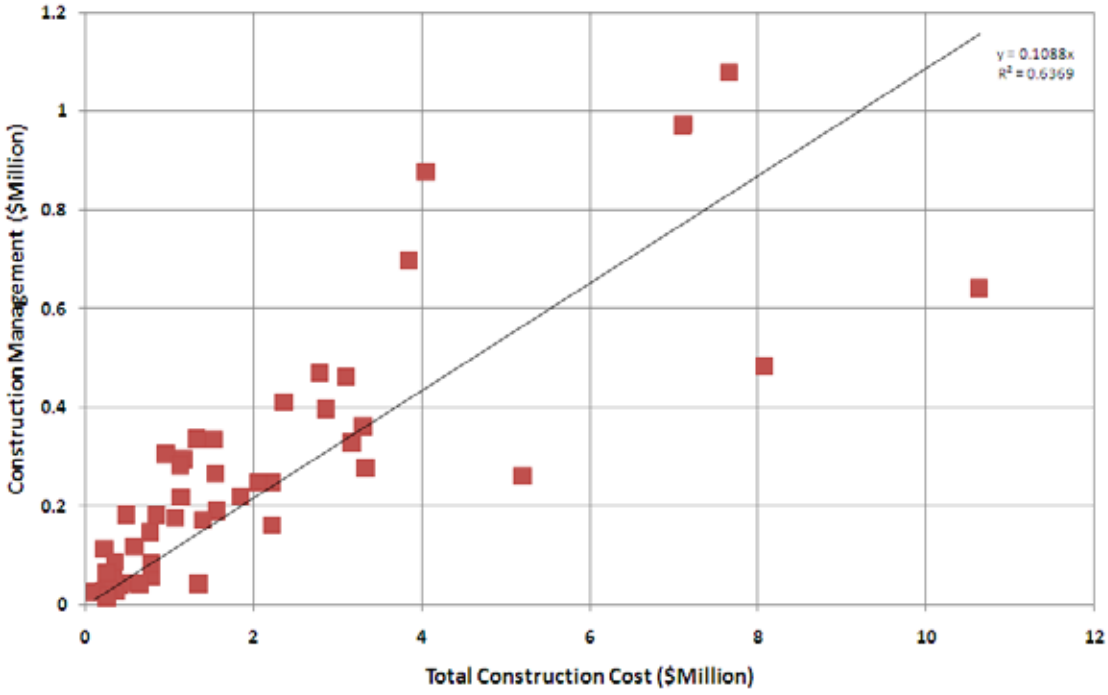
All Projects
Municipal Facilities - Police/Fire Stations
Construction Management Versus Total Construction Cost (N=31)



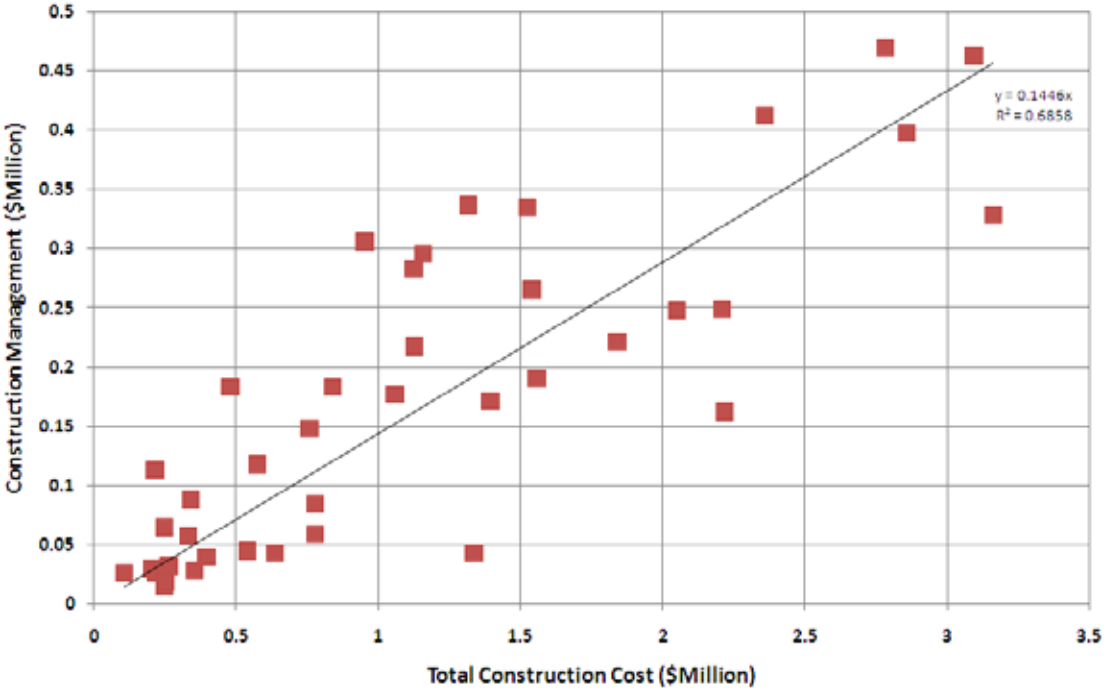
Smaller Projects
Municipal Facilities - Police/Fire Stations
Construction Management Versus Total Construction Cost (N=25)



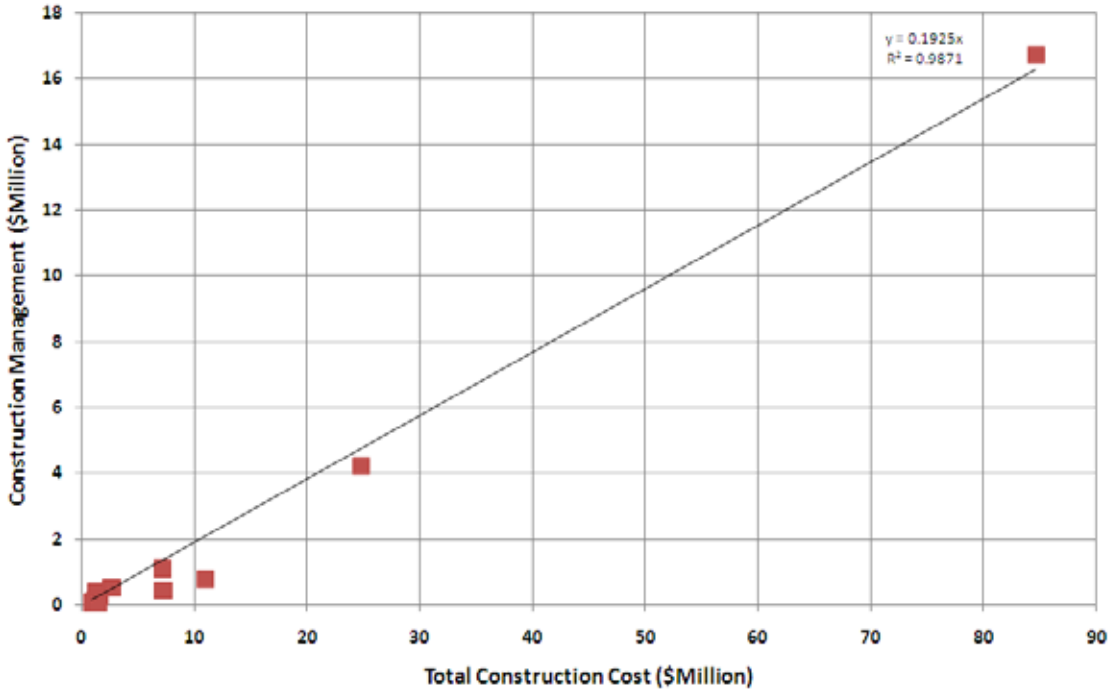
All Projects
Municipal Facilities - Comm./Rec. Center/Child Care/Gyms
Construction Management Versus Total Construction Cost (N=50)



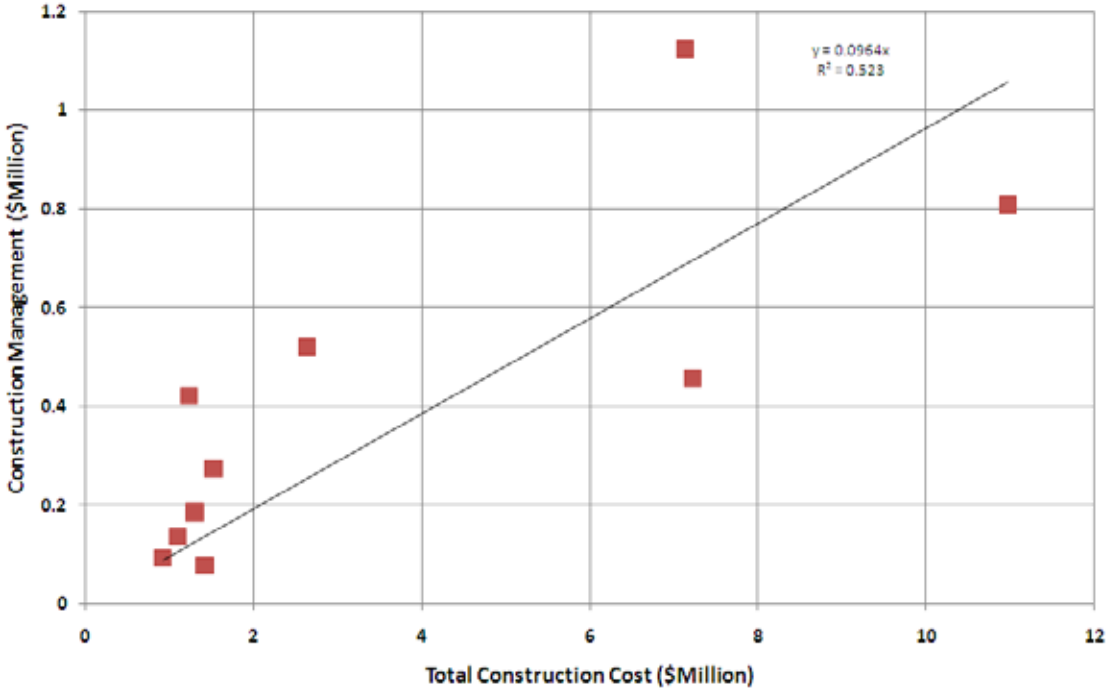
Smaller Projects
Municipal Facilities - Comm./Rec. Center/Child Care/Gyms
Construction Management Versus Total Construction Cost (N=40)



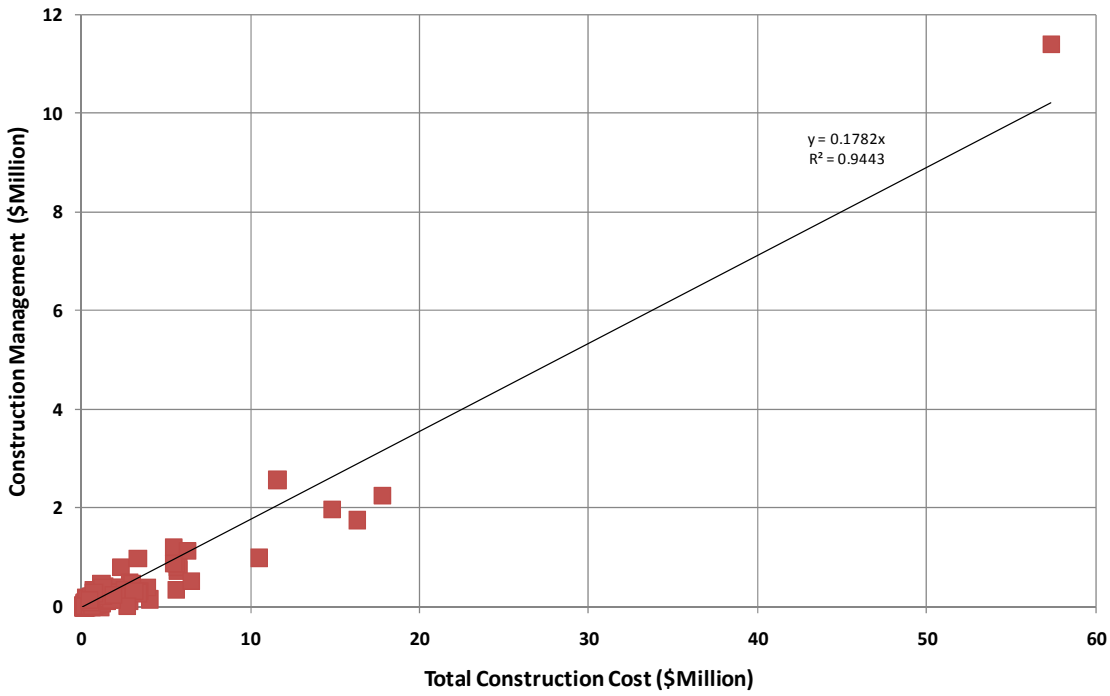
All Projects
Municipal Facilities - Other Municipal Facilities
Construction Management Versus Total Construction Cost (N=12)



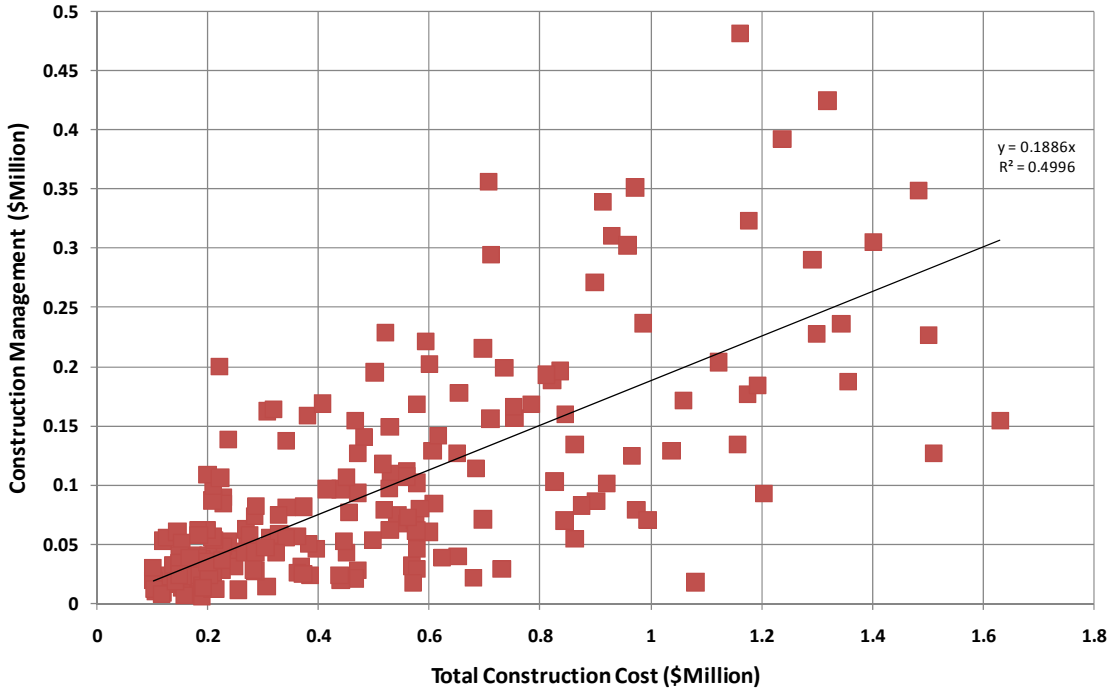
Smaller Projects
Municipal Facilities - Other Municipal Facilities
Construction Management Versus Total Construction Cost (N=10)



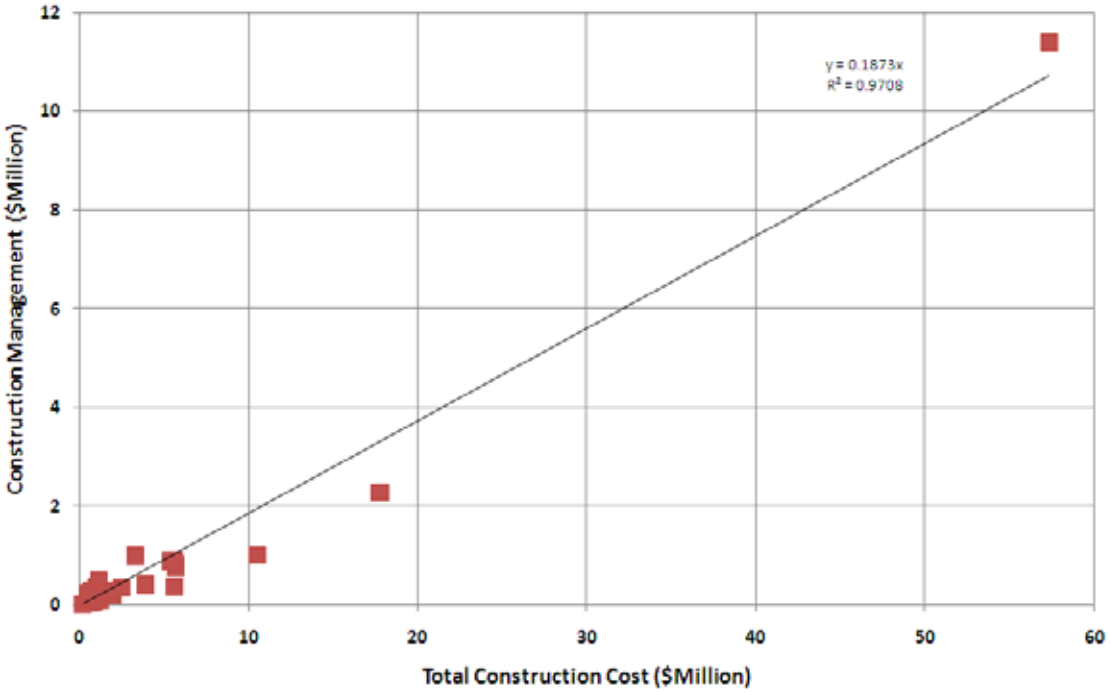
All Projects
Streets - All Classifications
Construction Management Versus Total Construction Cost (N=263)



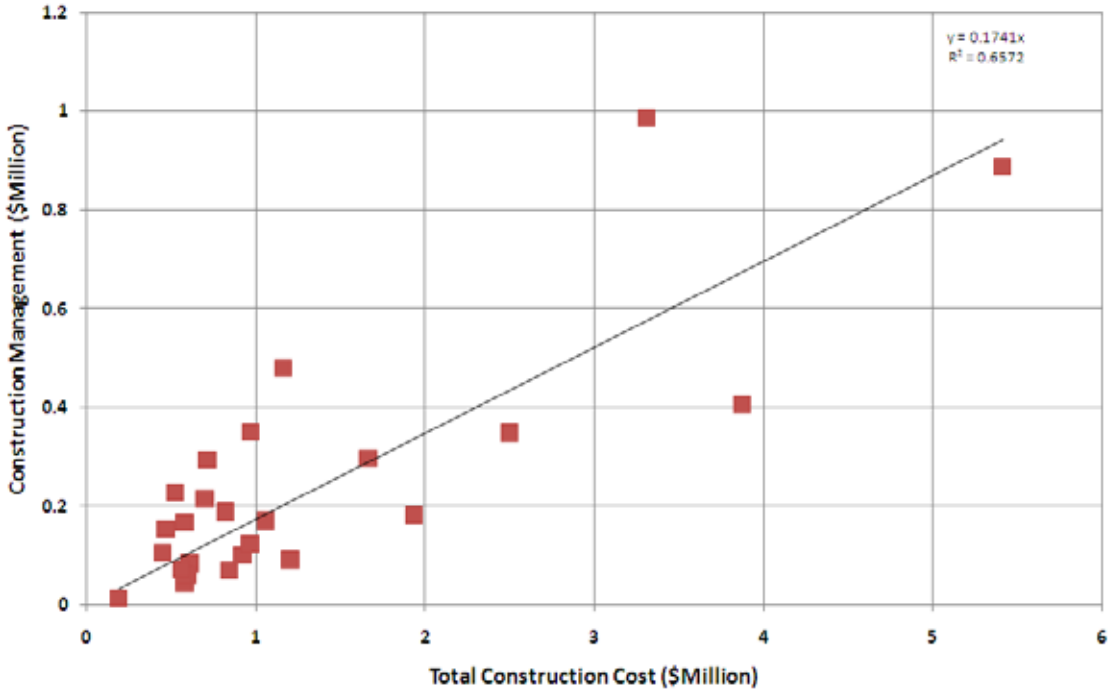
Smaller Projects
Streets - All Classifications
Construction Management Versus Total Construction Cost (N=208)



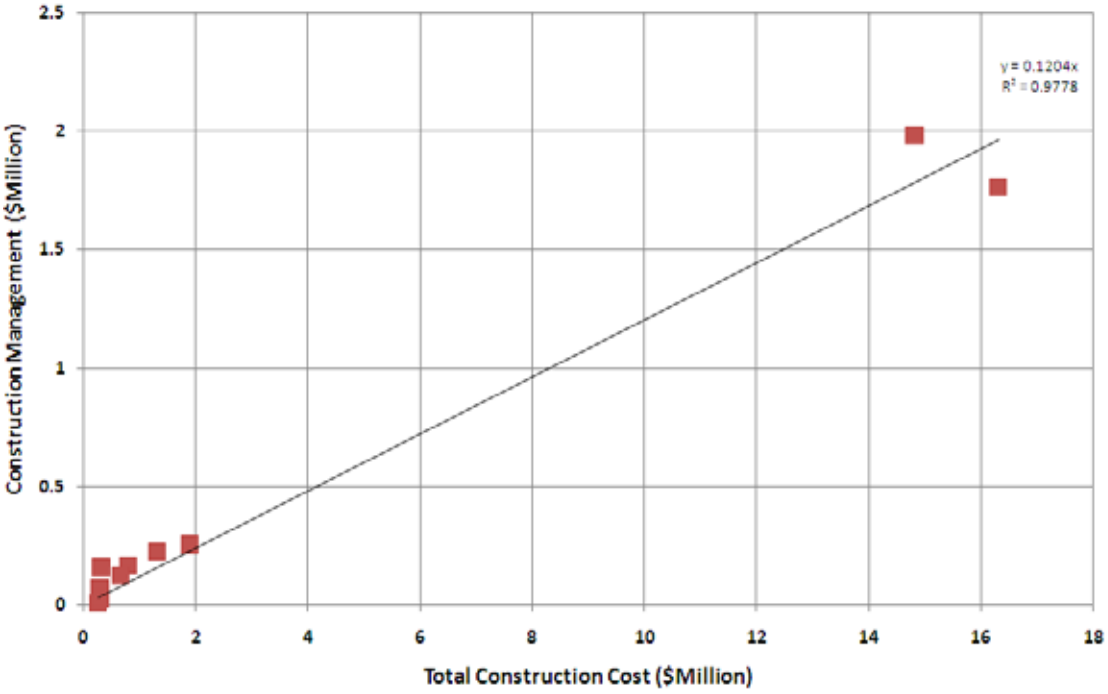
All Projects
Streets - Widening/New/Grade Separations
Construction Management Versus Total Construction Cost (N=33)



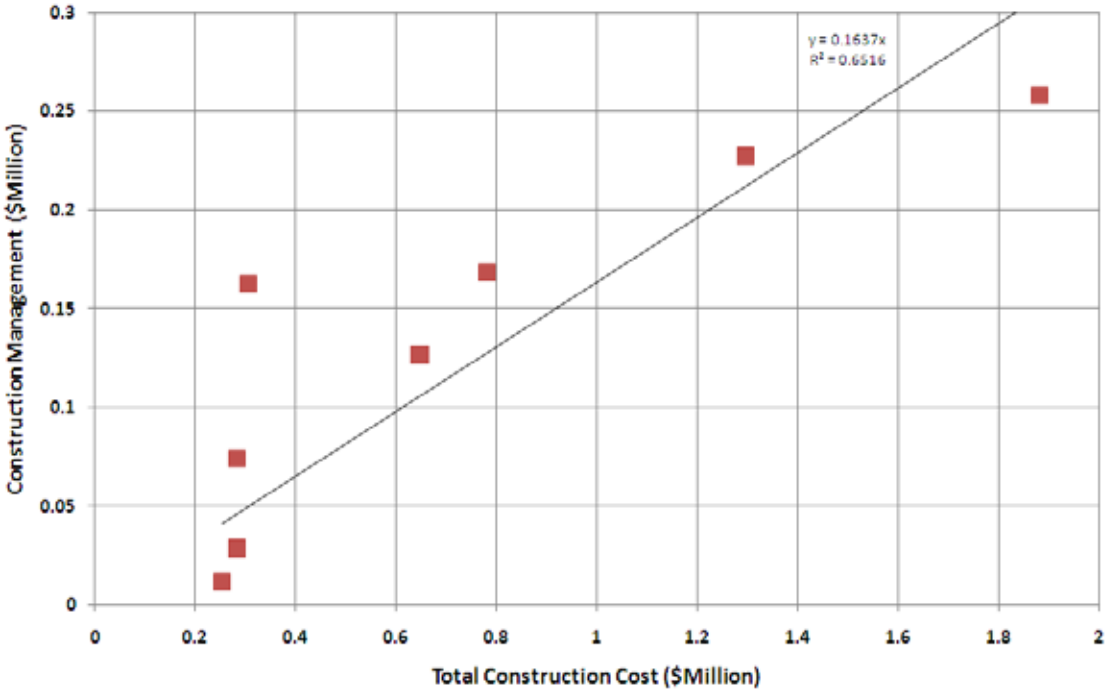
Smaller Projects
Streets - Widening/New/Grade Separations
Construction Management Versus Total Construction Cost (N=26)



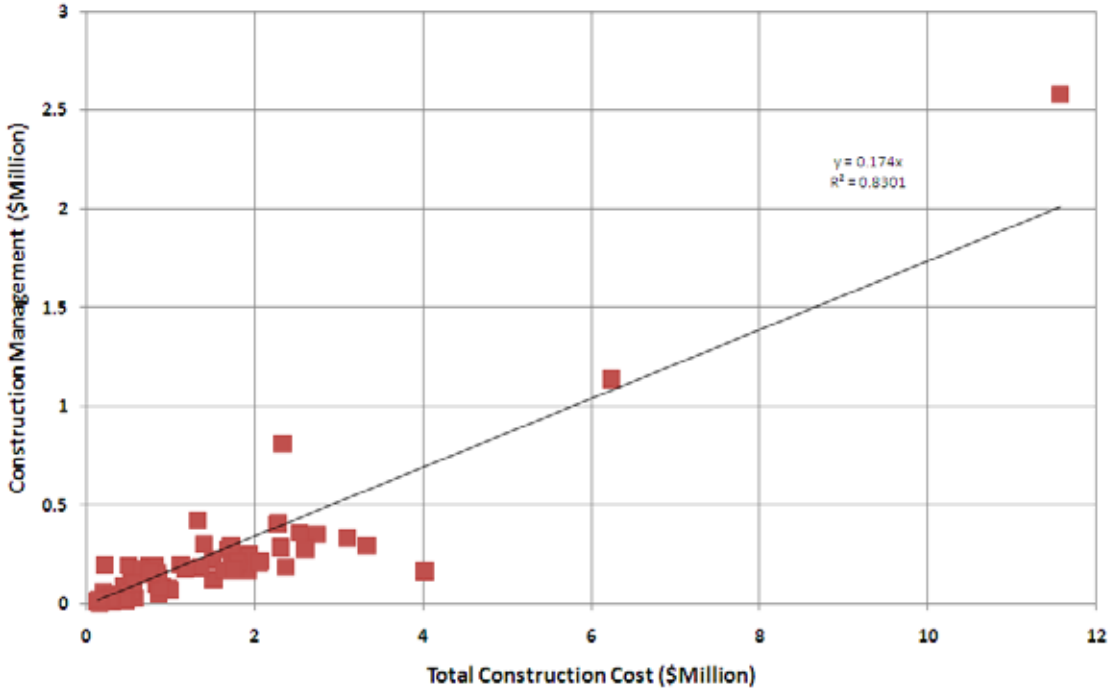
All Projects
Streets - Bridges (New/Retrofit)
Construction Management Versus Total Construction Cost (N=10)



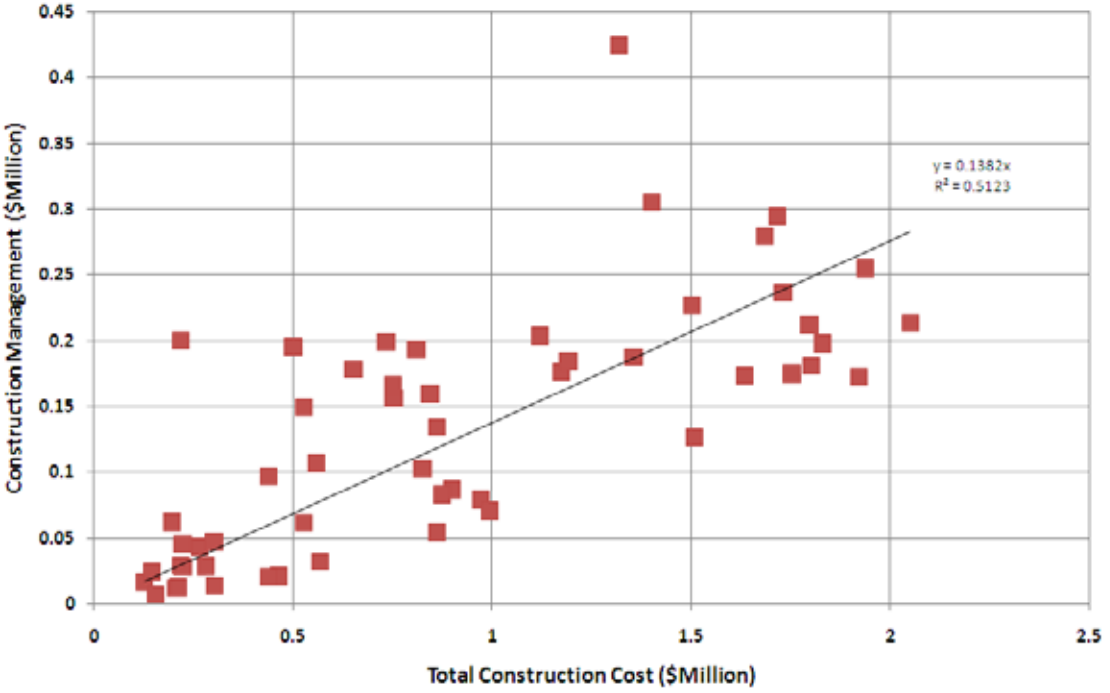
Smaller Projects
Streets - Bridges (New/Retrofit)
Construction Management Versus Total Construction Cost (N=8)



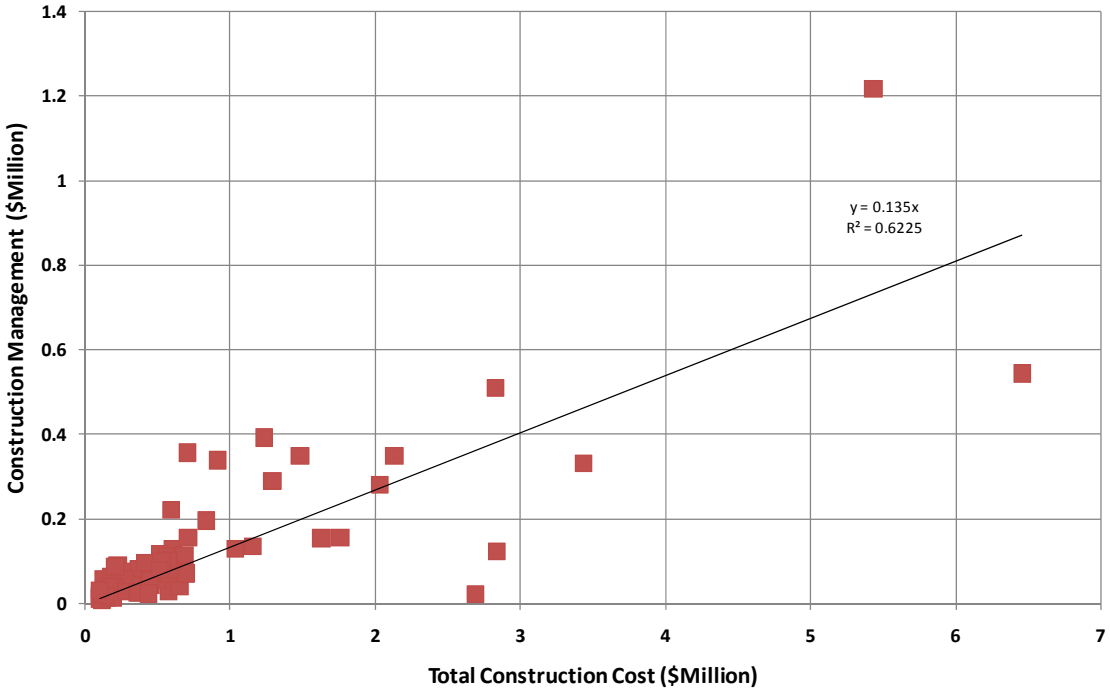
All Projects
Streets - Reconstructions
Construction Management Versus Total Construction Cost (N=69)



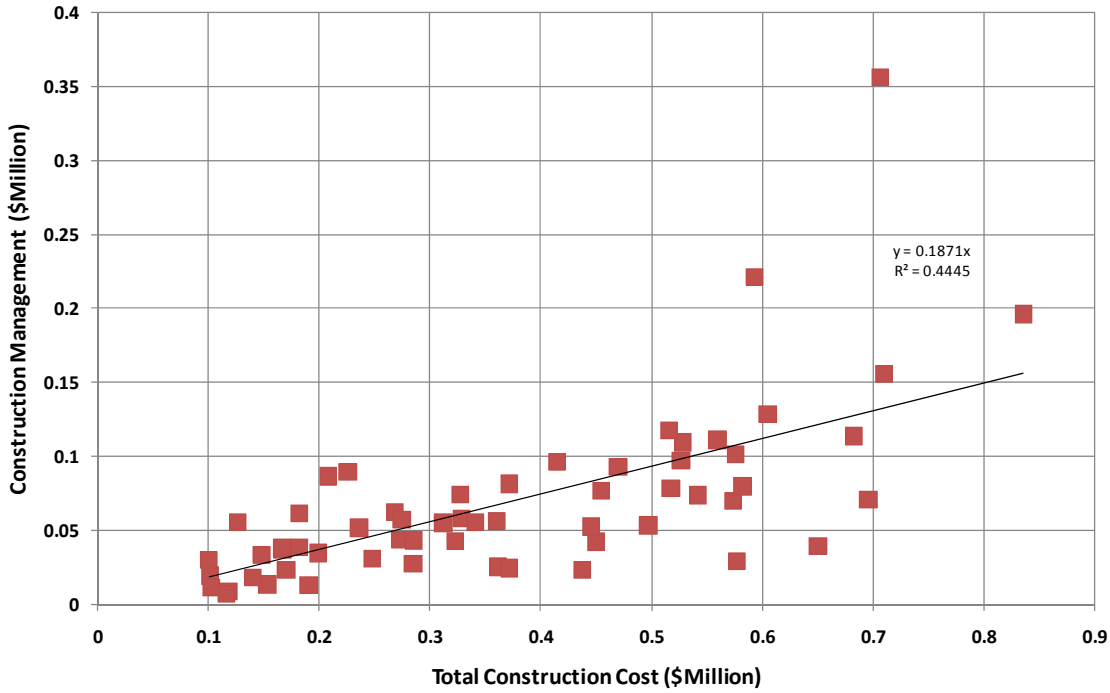
Smaller Projects
Streets - Reconstructions
Construction Management Versus Total Construction Cost (N=55)



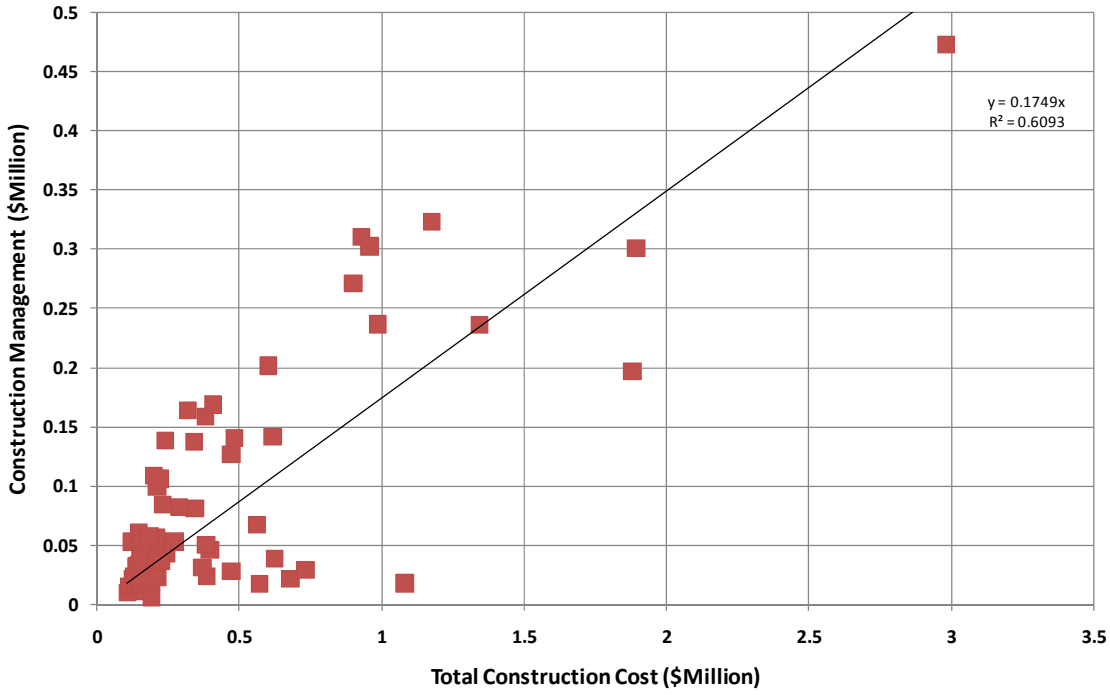
All Projects
Streets - Bike/Pedestrian/Streetscapes
Construction Management Versus Total Construction Cost (N=78)



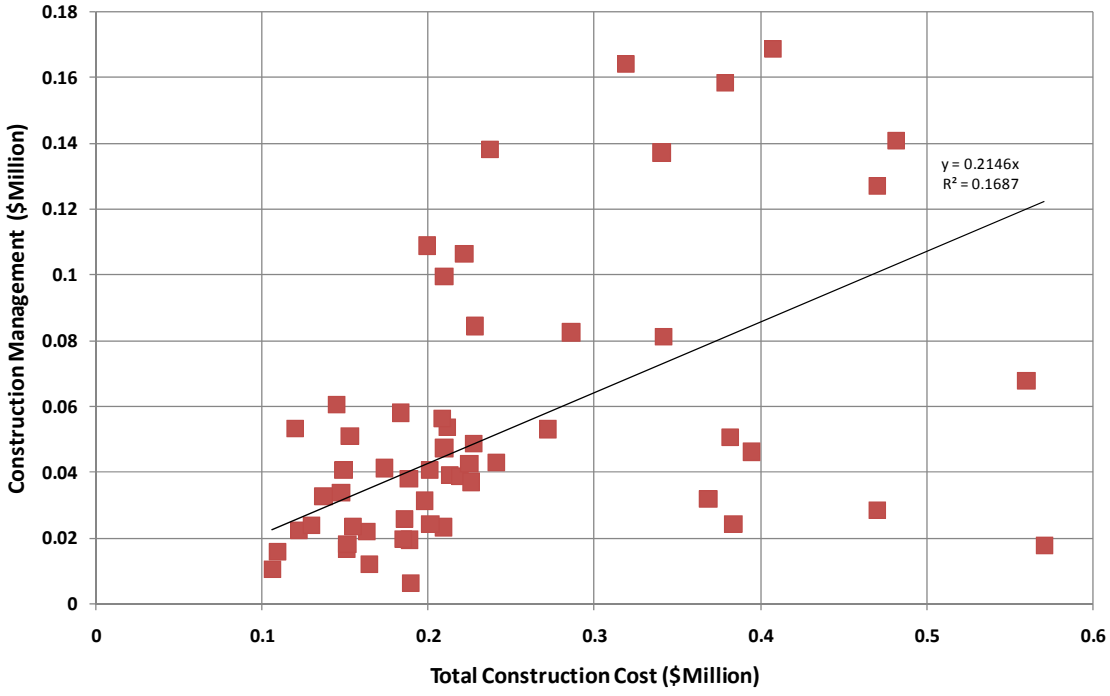
Smaller Projects
Streets - Bike/Pedestrian/Streetscapes
Construction Management Versus Total Construction Cost (N=61)



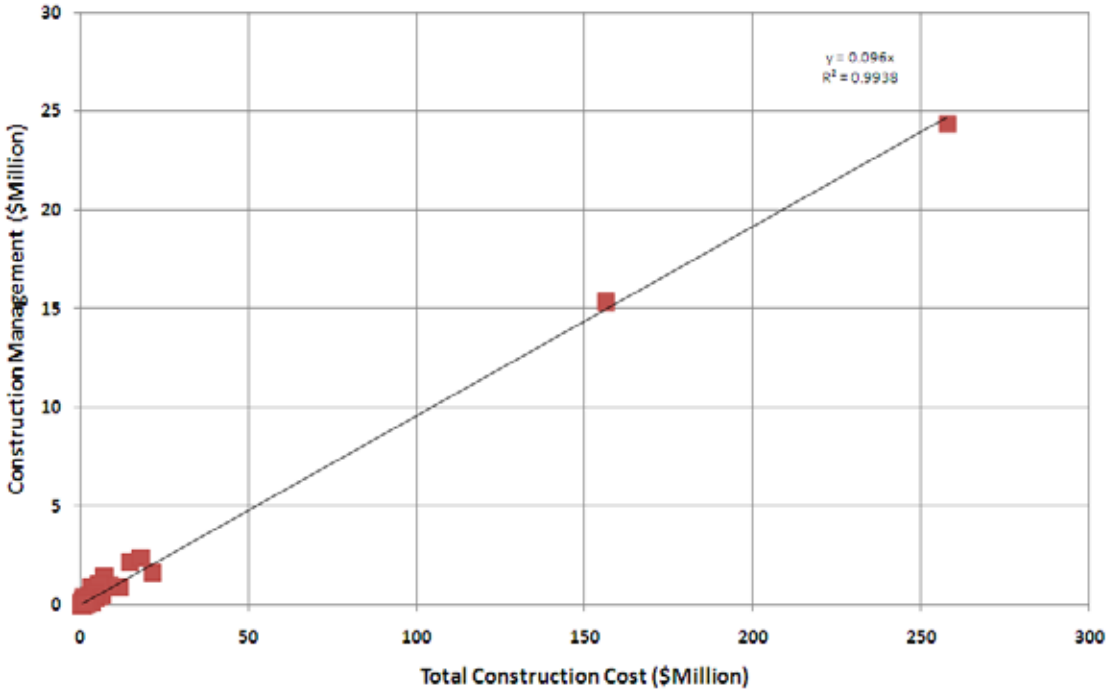
All Projects
Streets - Signals
Construction Management Versus Total Construction Cost (N=73)



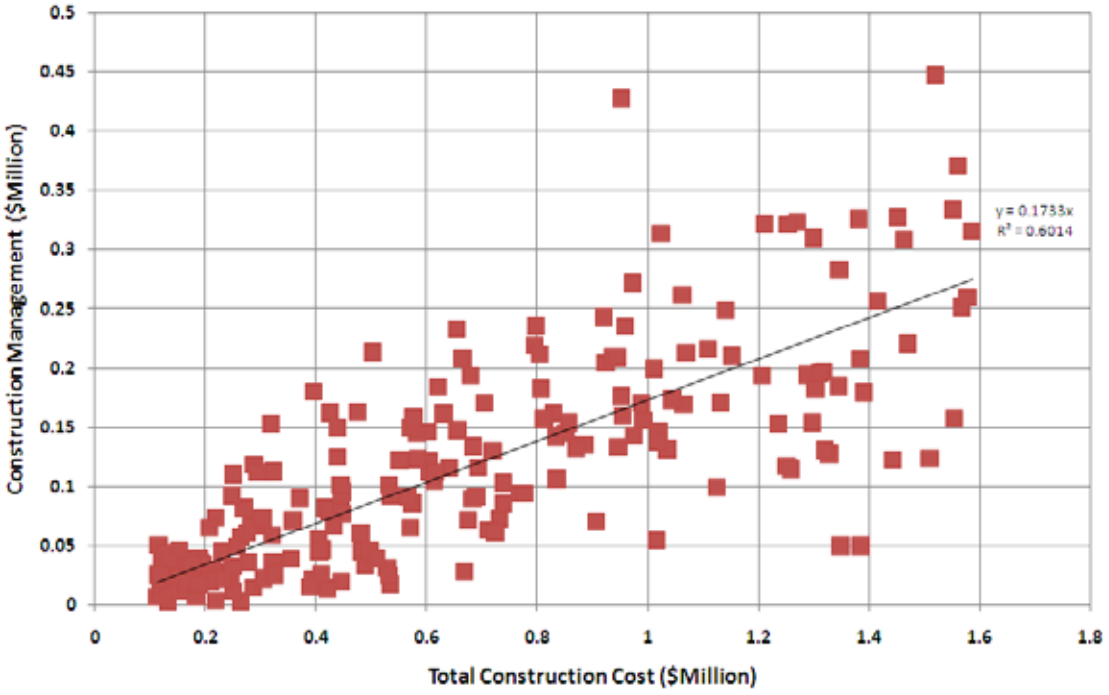
Smaller Projects
Streets - Signals
Construction Management Versus Total Construction Cost (N=58)



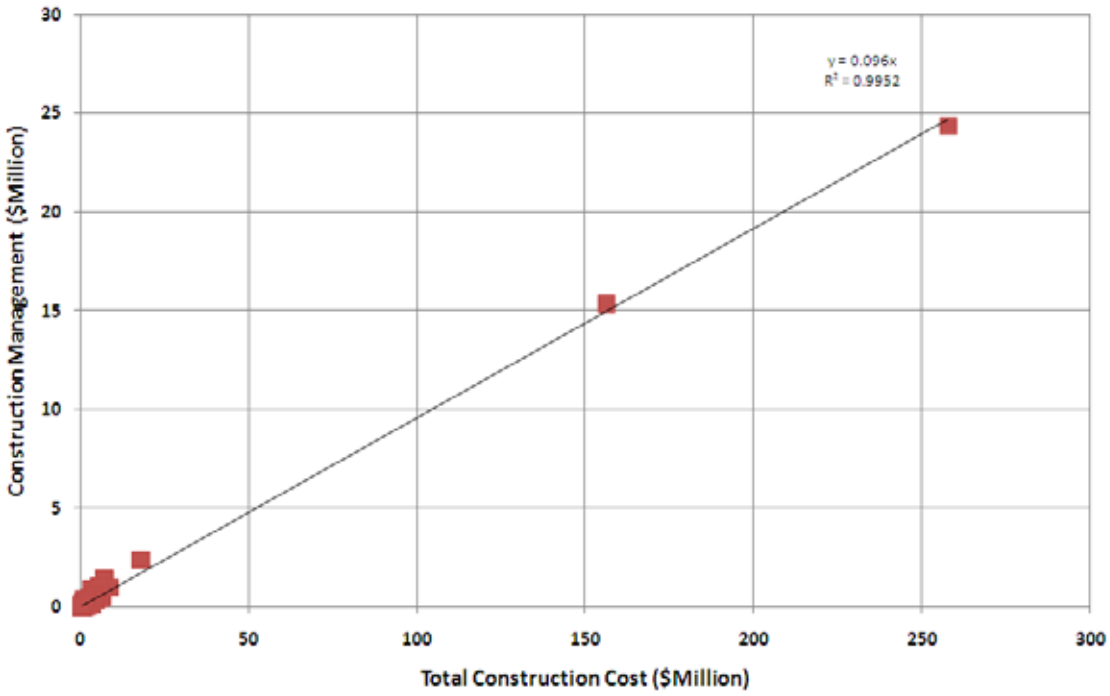
All Projects
Pipe Systems - All Classifications
Construction Management Versus Total Construction Cost (N=267)



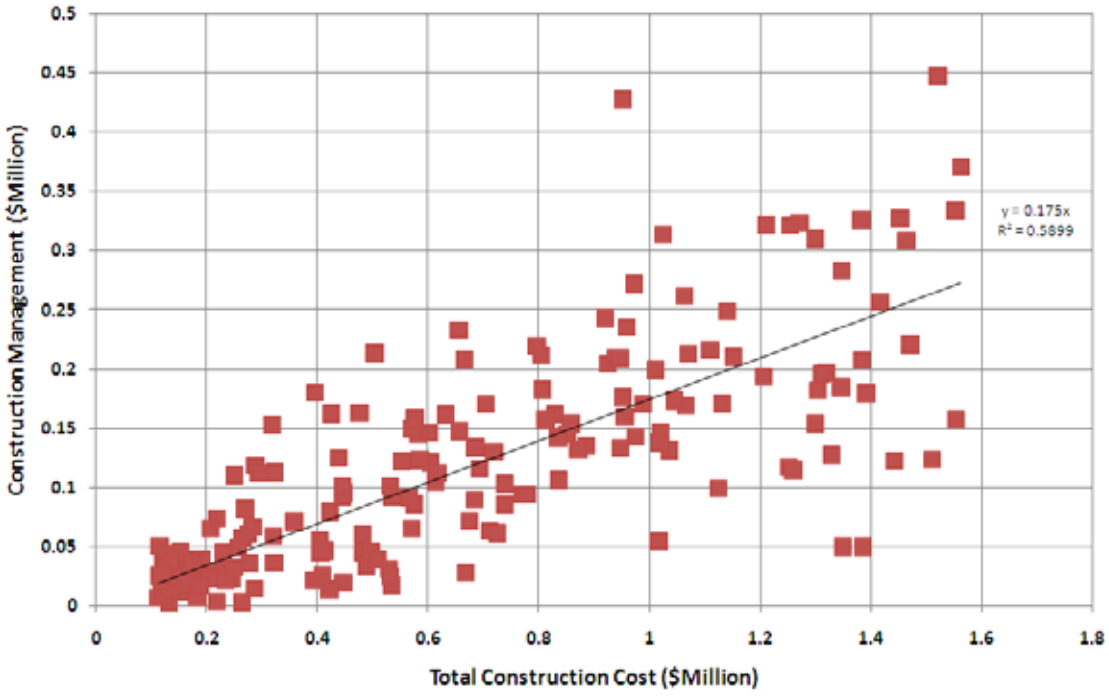
Smaller Projects
Pipe Systems - All Classifications
Construction Management Versus Total Construction Cost (N=214)



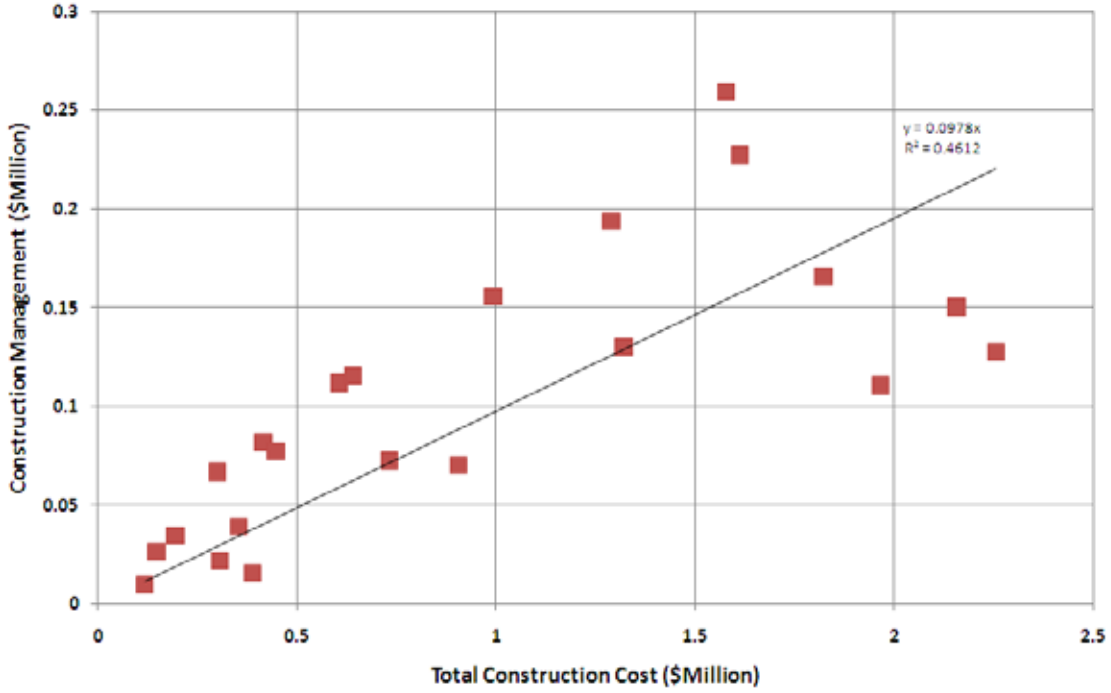
All Projects
Pipe Systems - Gravity Systems (Storm Drains/Sewers)
Construction Management Versus Total Construction Cost (N=227)



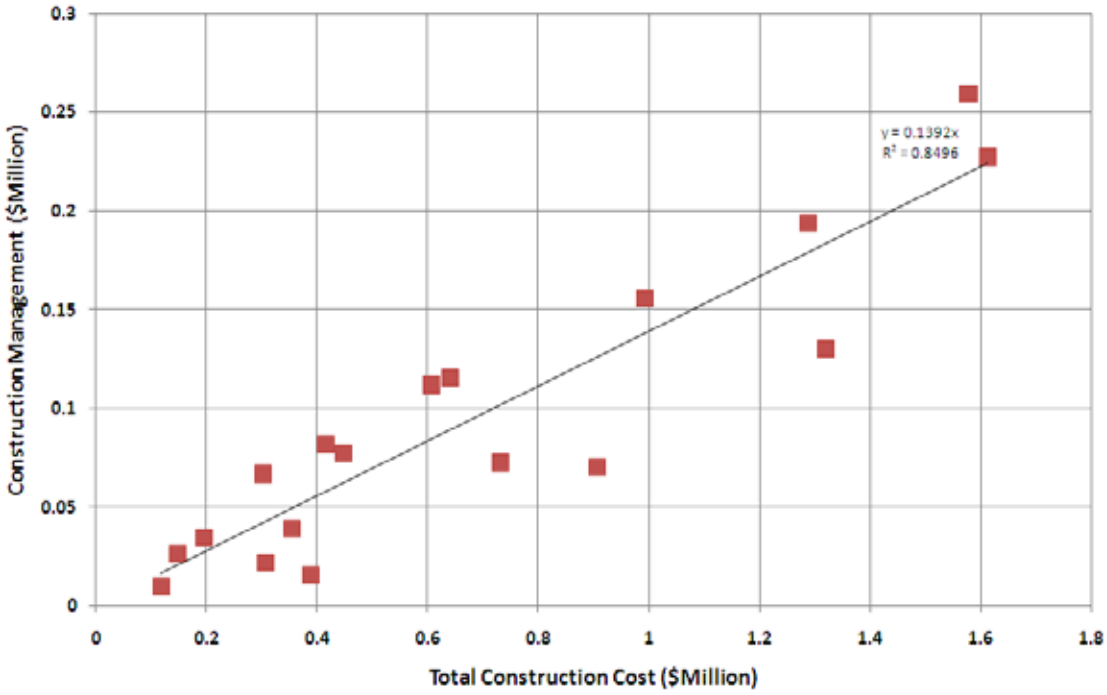
Smaller Projects
Pipe Systems - Gravity Systems (Storm Drains/Sewers)
Construction Management Versus Total Construction Cost (N=182)



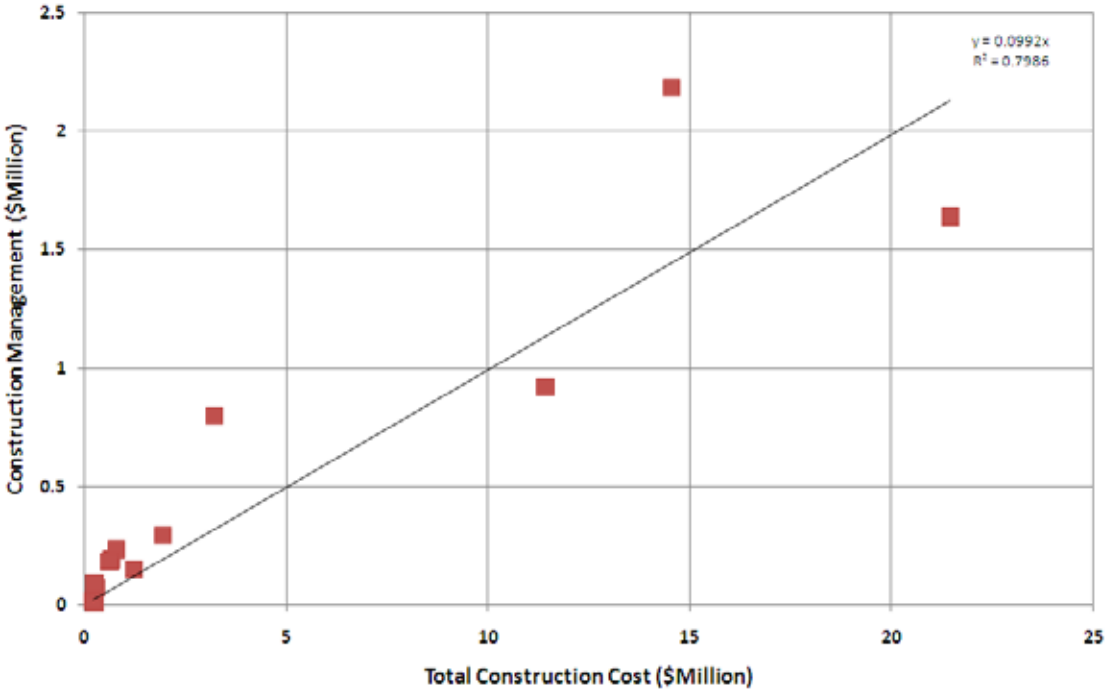
All Projects
Pipe Systems - Pressure Systems
Construction Management Versus Total Construction Cost (N=22)



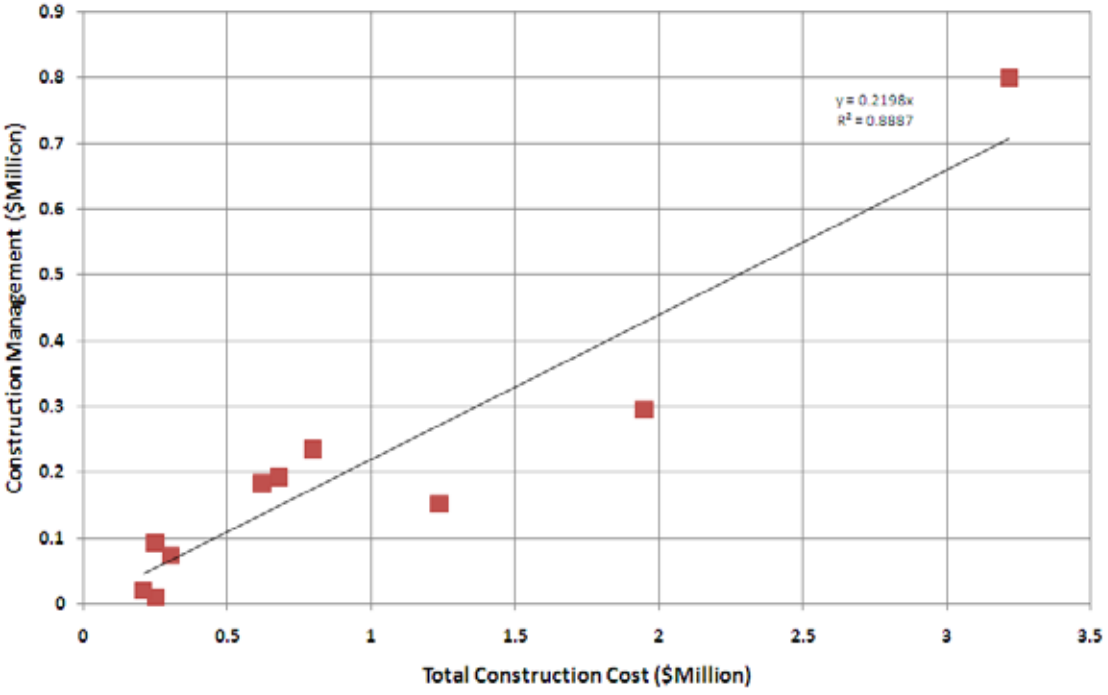
Smaller Projects
Pipe Systems - Pressure Systems
Construction Management Versus Total Construction Cost (N=18)



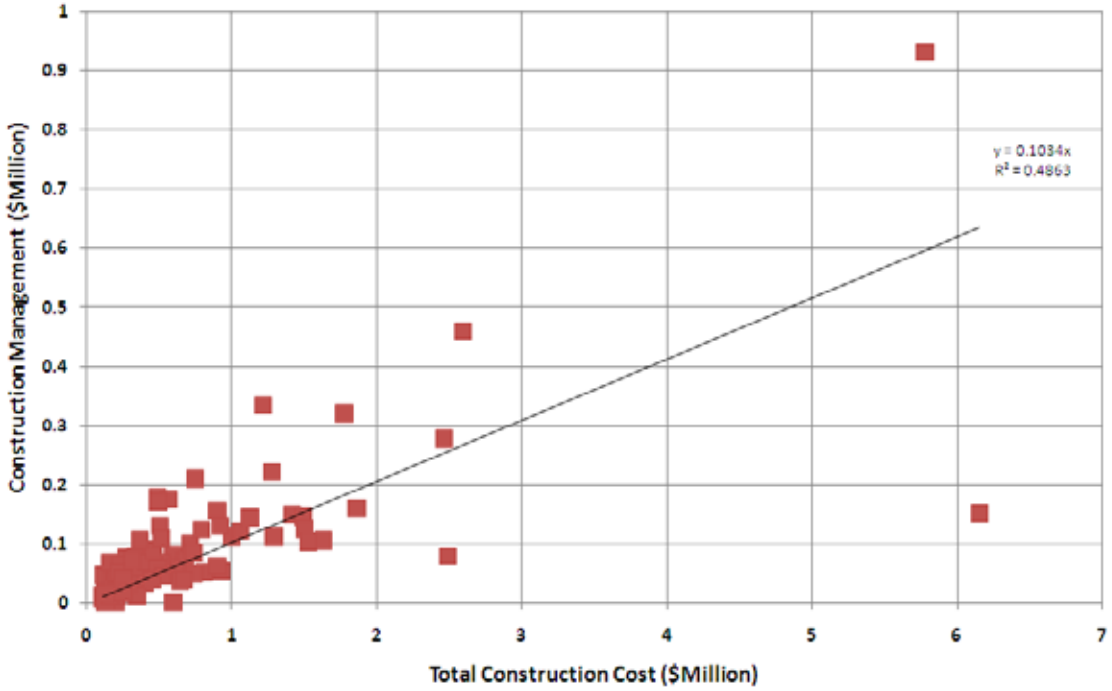
All Projects
Pipe Systems - Pump Stations
Construction Management Versus Total Construction Cost (N=13)



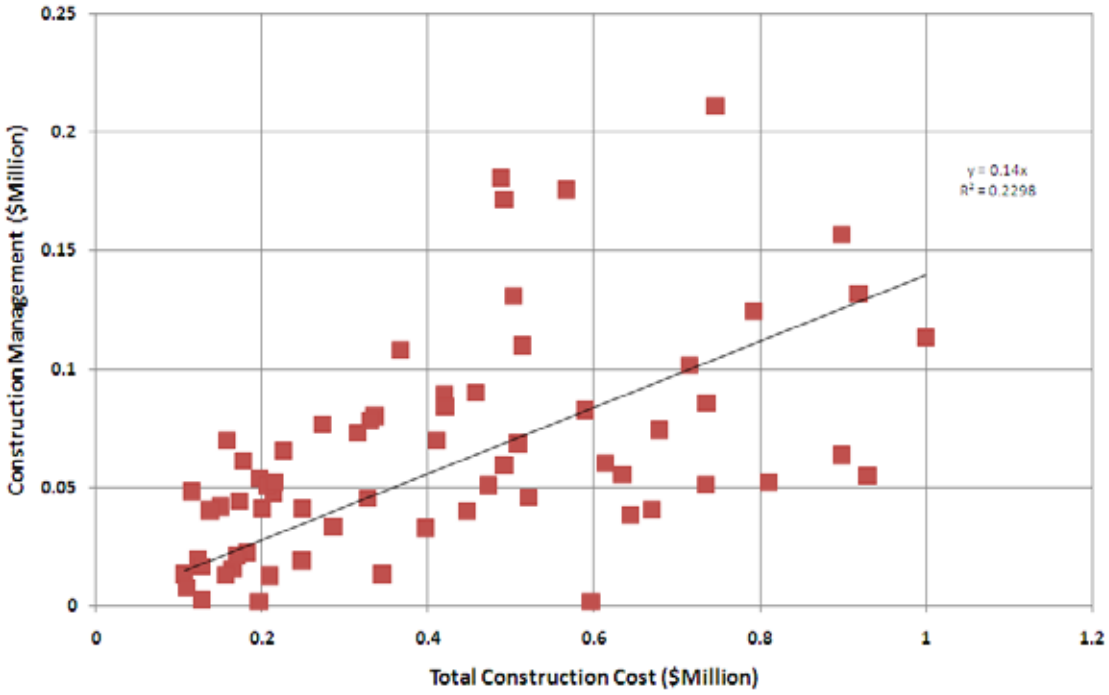
Smaller Projects
Pipe Systems - Pump Stations
Construction Management Versus Total Construction Cost (N=10)



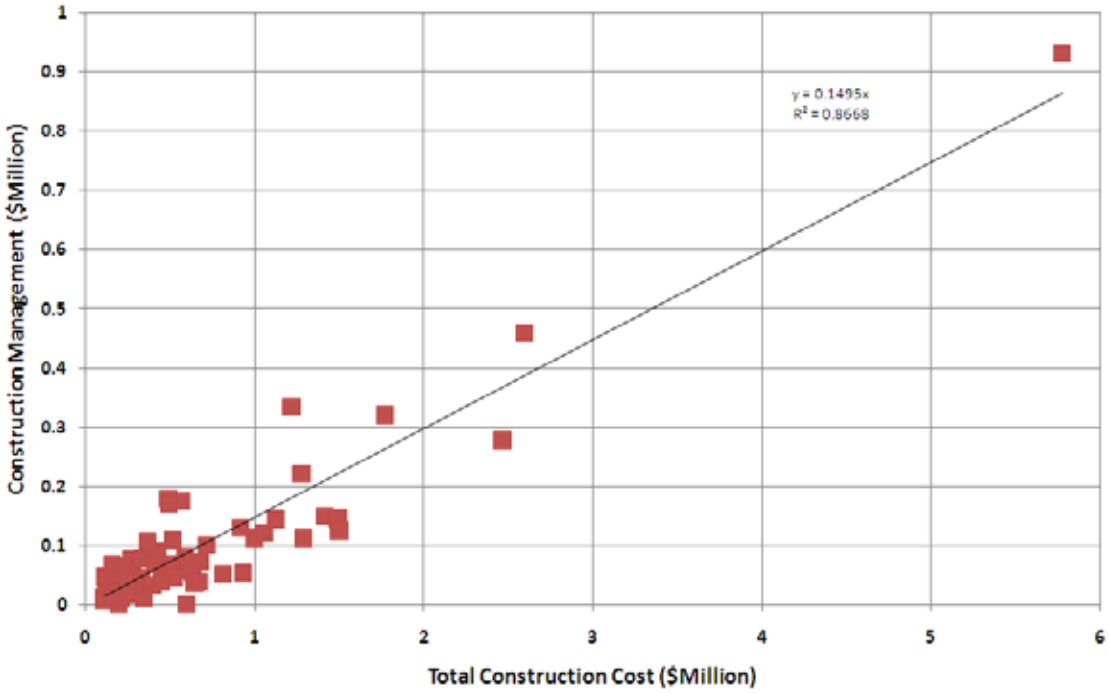
All Projects
Parks - All Classifications
Construction Management Versus Total Construction Cost (N=83)



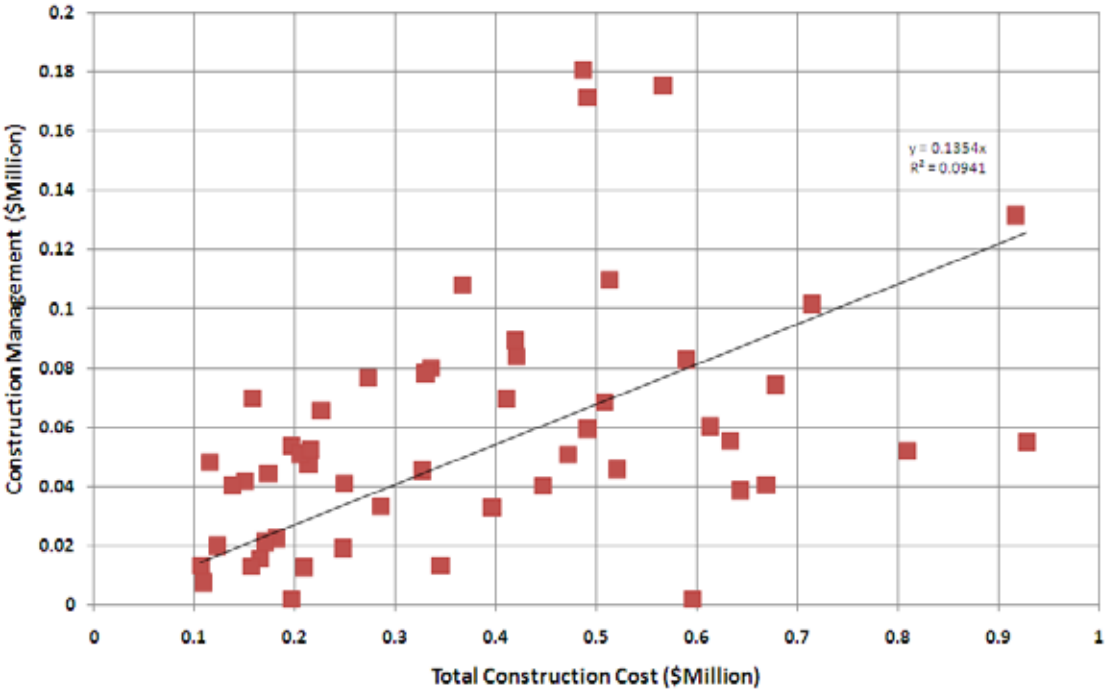
Smaller Projects
Parks - All Classifications
Construction Management Versus Total Construction Cost (N=66)



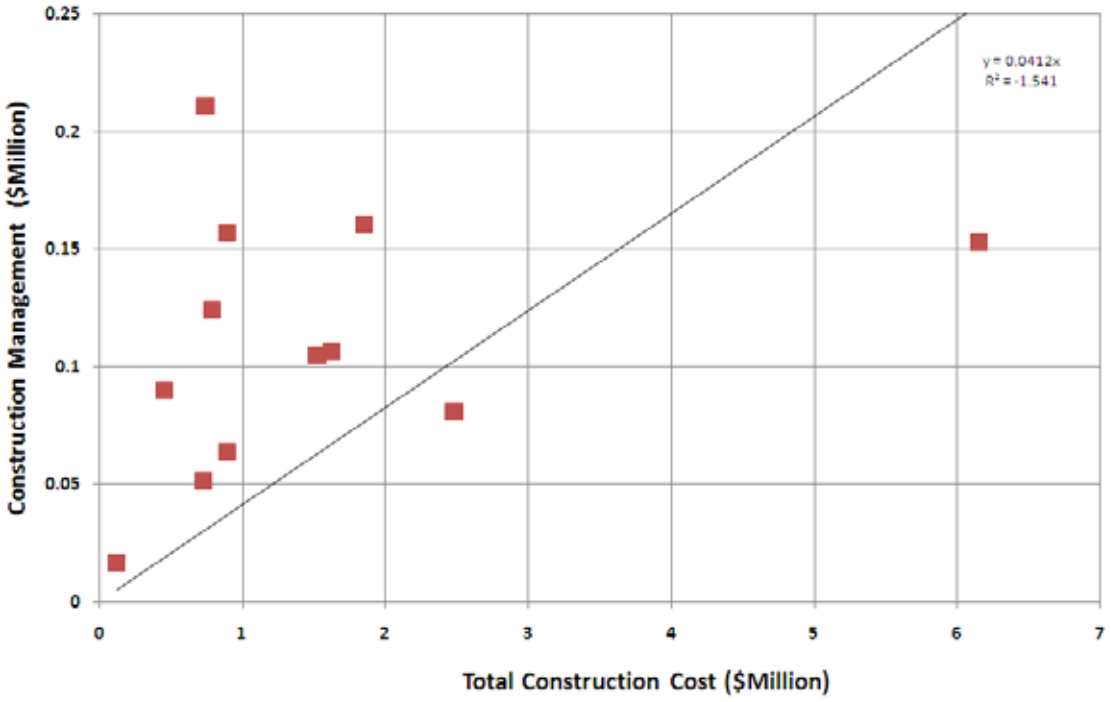
All Projects
Parks - Playgrounds
Construction Management Versus Total Construction Cost (N=65)



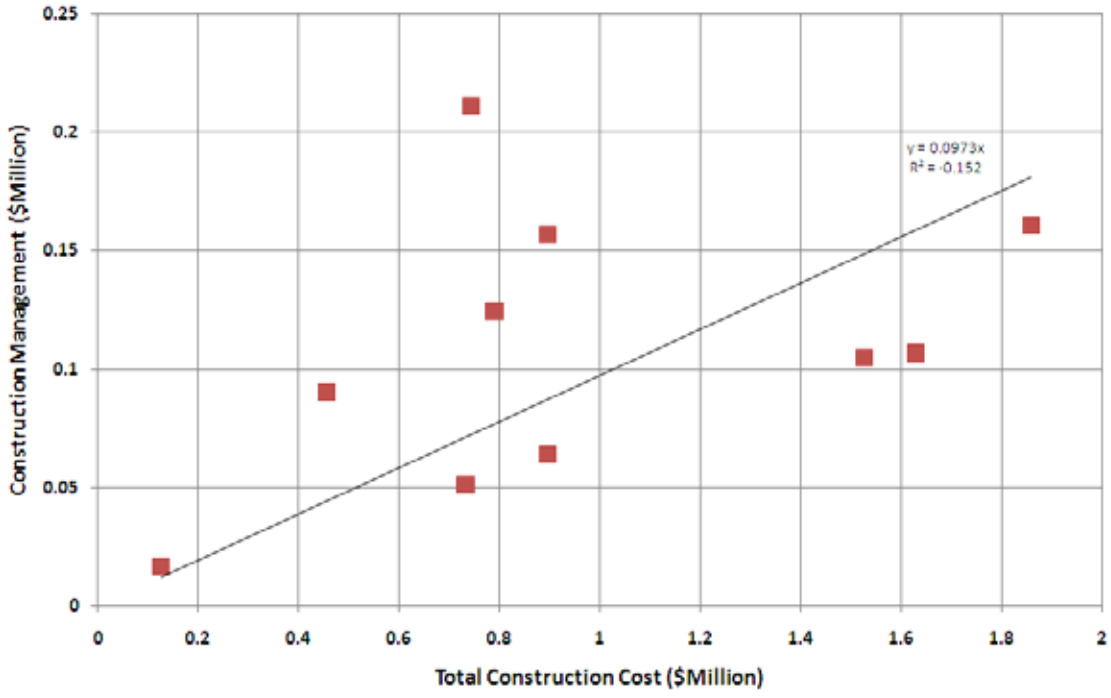
Smaller Projects
Parks - Playgrounds
Construction Management Versus Total Construction Cost (N=52)



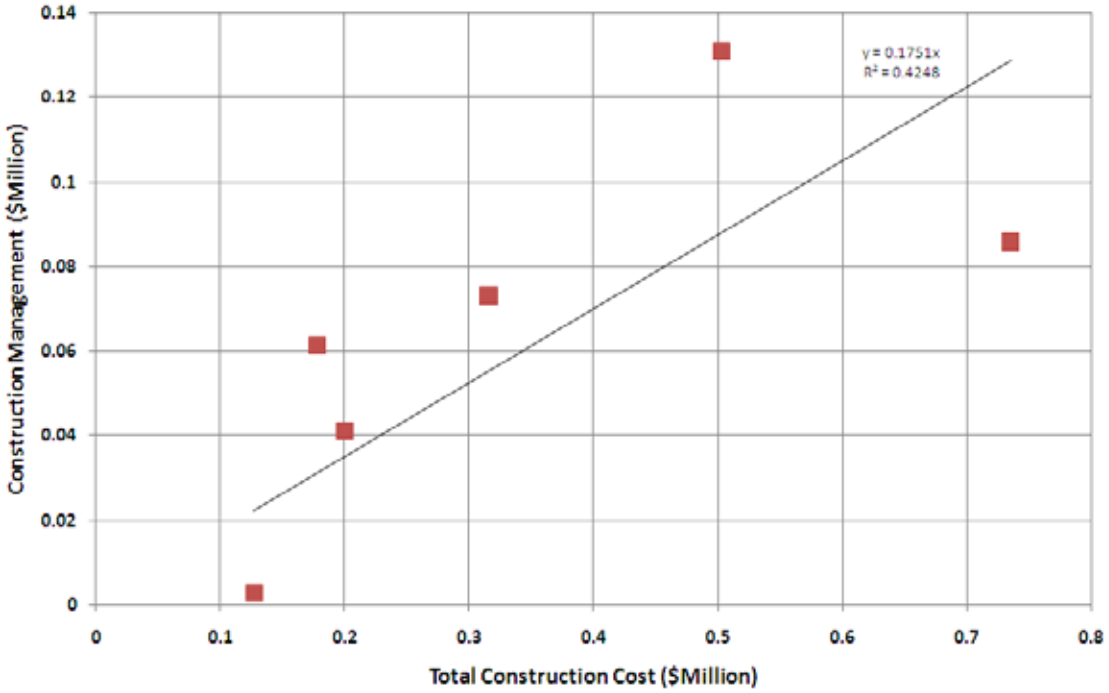
All Projects
Parks - Sportfields
Construction Management Versus Total Construction Cost (N=12)



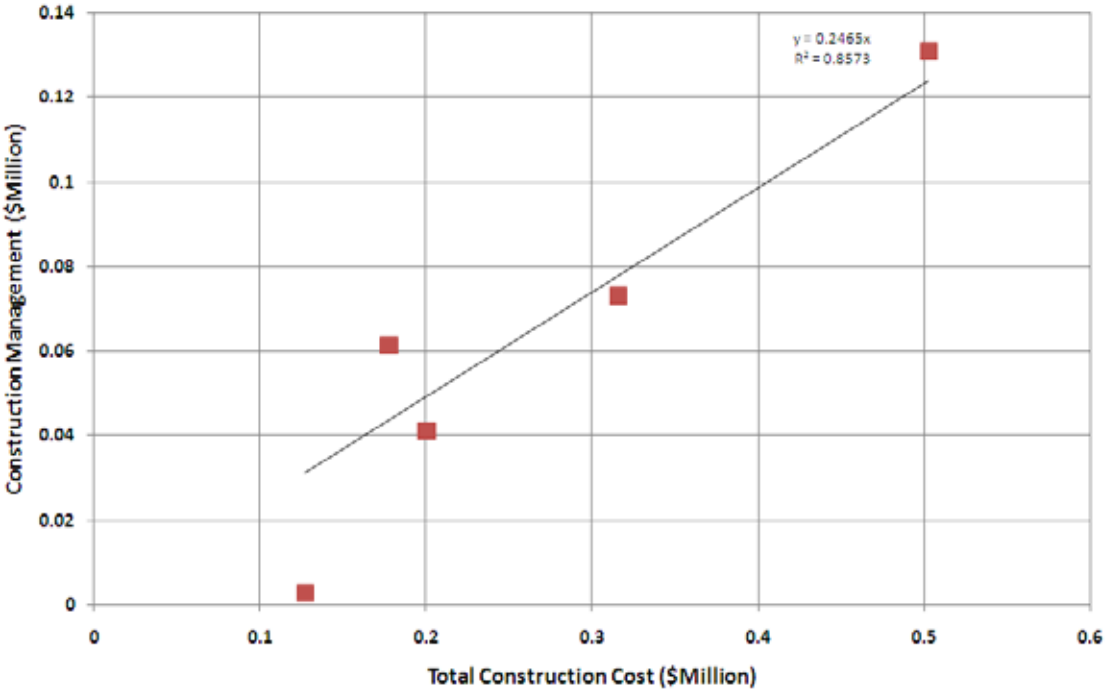
Smaller Projects
Parks - Sportfields
Construction Management Versus Total Construction Cost (N=10)



All Projects
Parks - Restrooms
Construction Management Versus Total Construction Cost (N=6)



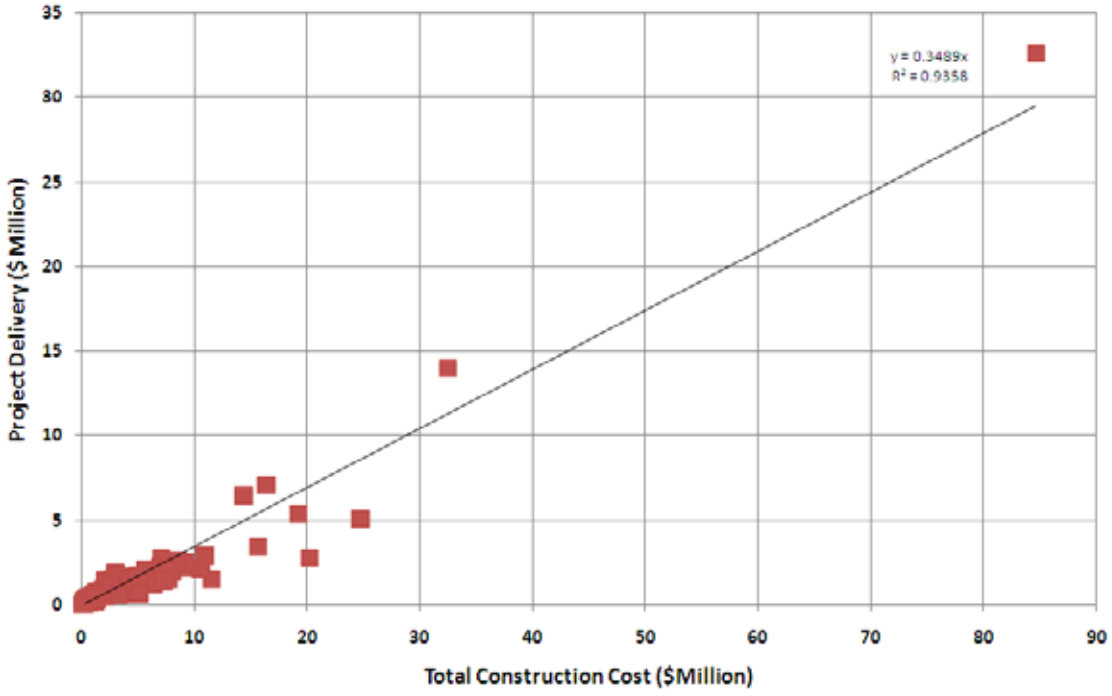
Smaller Projects
Parks - Restrooms
Construction Management Versus Total Construction Cost (N=5)



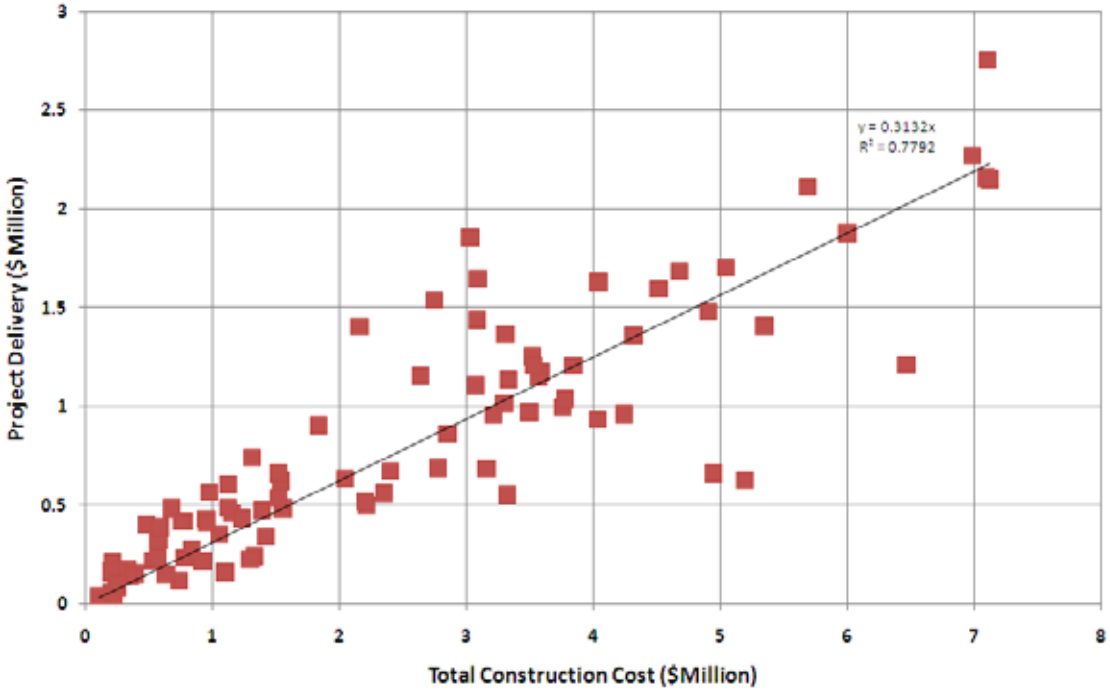
CURVES GROUP 3

Project Delivery Cost
vs
Total Construction Cost

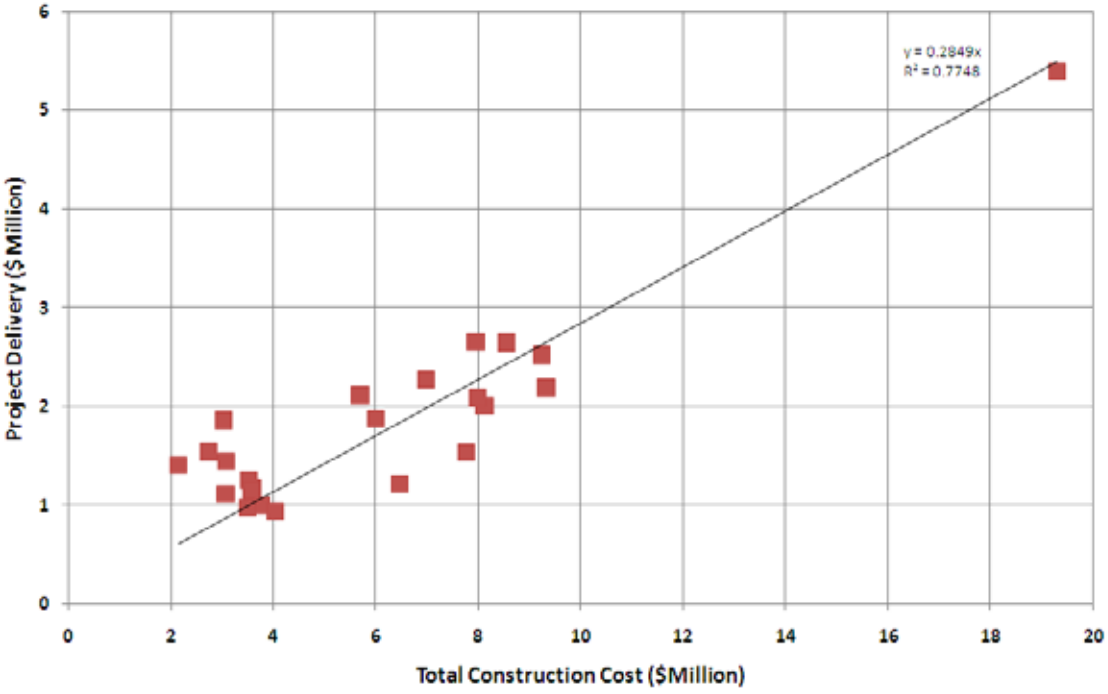
All Projects
Municipal Facilities - All Classifications
Project Delivery ($ Million) Versus Total Construction Cost (N=116)



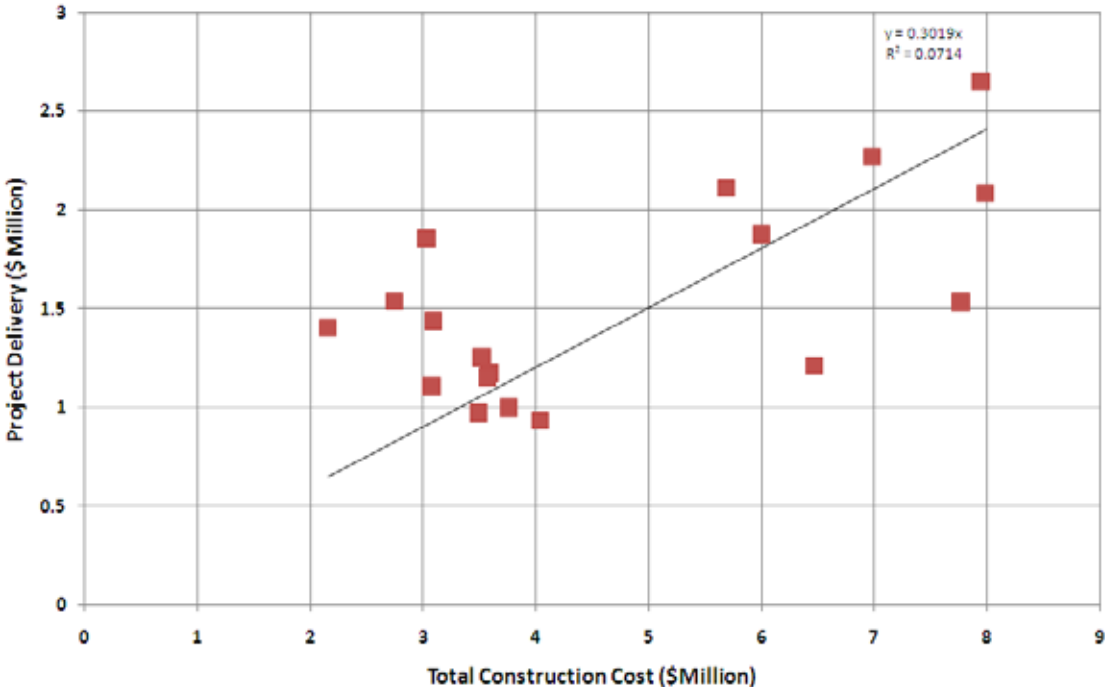
Smaller Projects
Municipal Facilities - All Classifications
Project Delivery ($ Million) Versus Total Construction Cost (N=93)



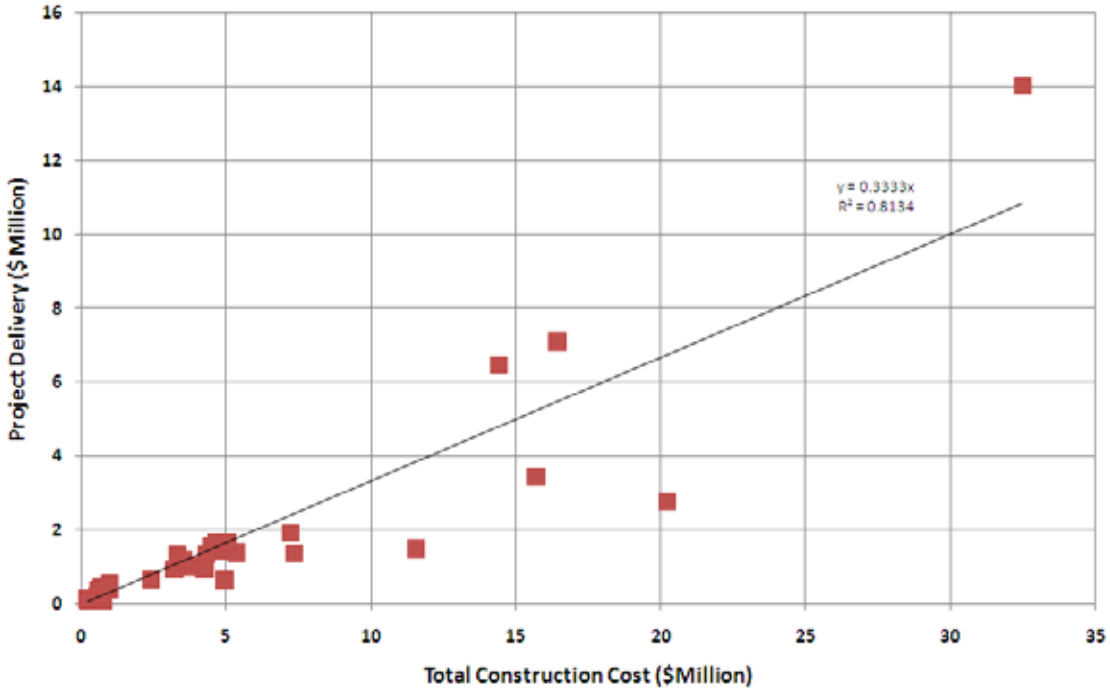
All Projects
Municipal Facilities - Libraries
Project Delivery ($ Million) Versus Total Construction Cost (N=23)



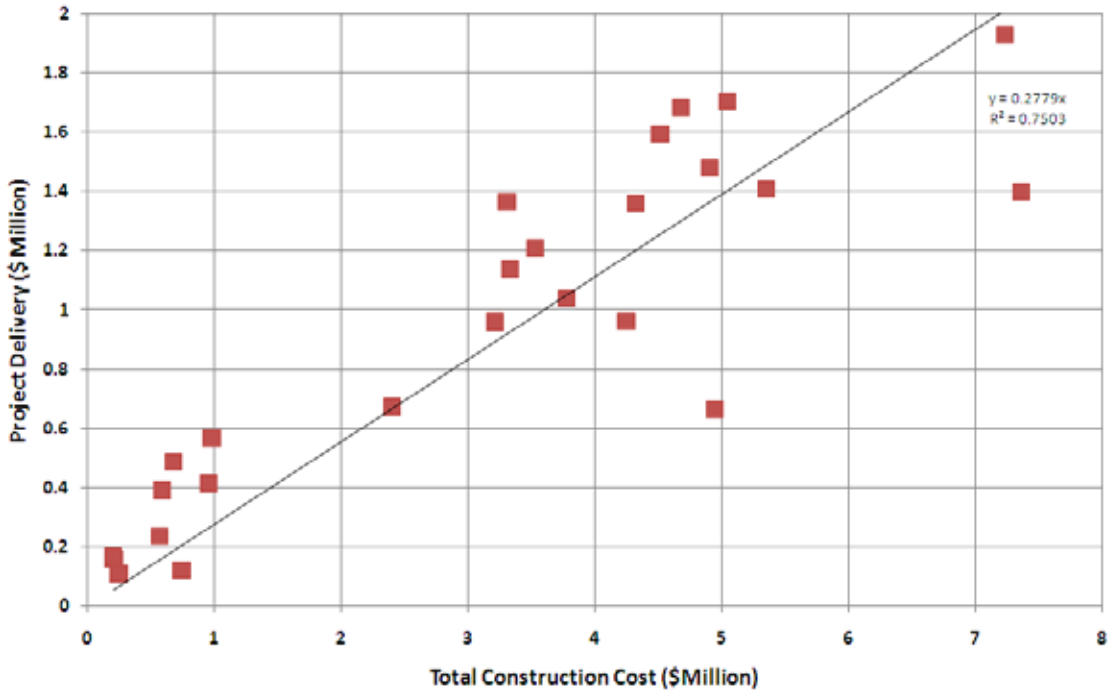
Smaller Projects
Municipal Facilities - Libraries
Project Delivery ($ Million) Versus Total Construction Cost (N=18)



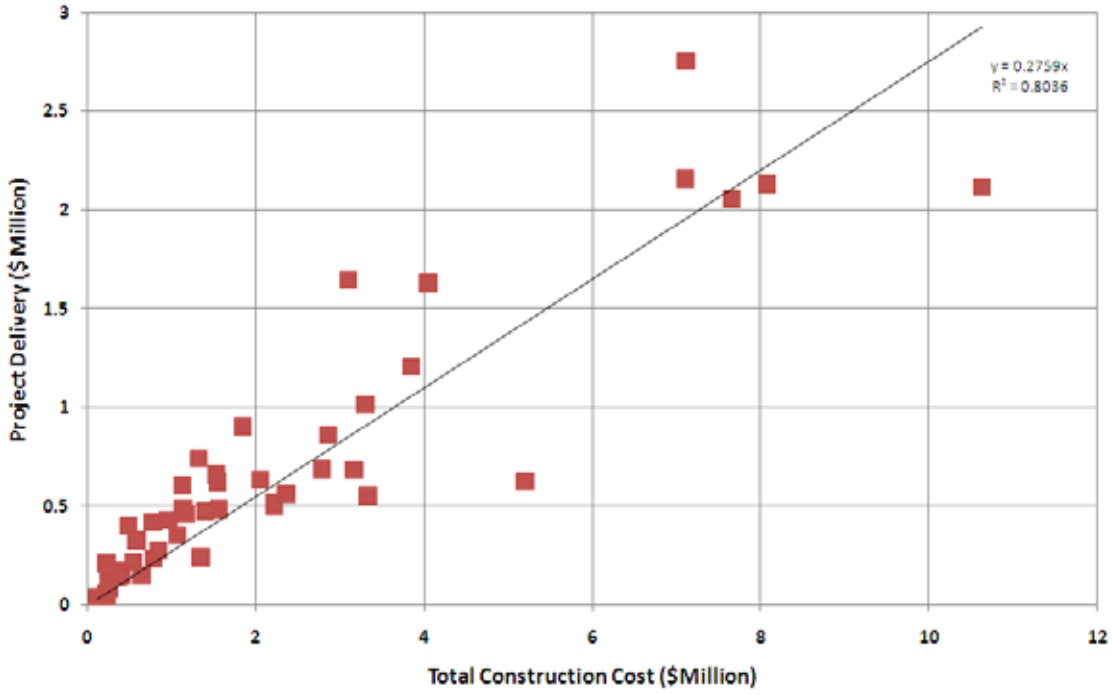
All Projects
Municipal Facilities - Police/Fire Stations
Project Delivery ($ Million) Versus Total Construction Cost (N=31)



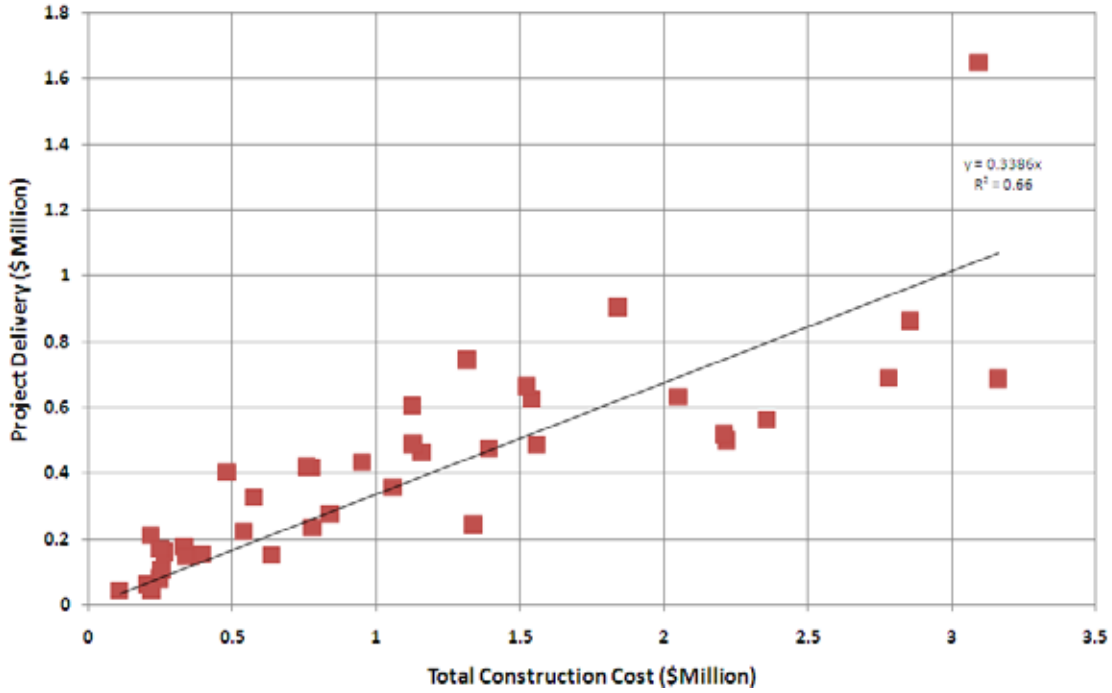
Smaller Projects
Municipal Facilities - Police/Fire Stations
Project Delivery ($ Million) Versus Total Construction Cost (N=25)



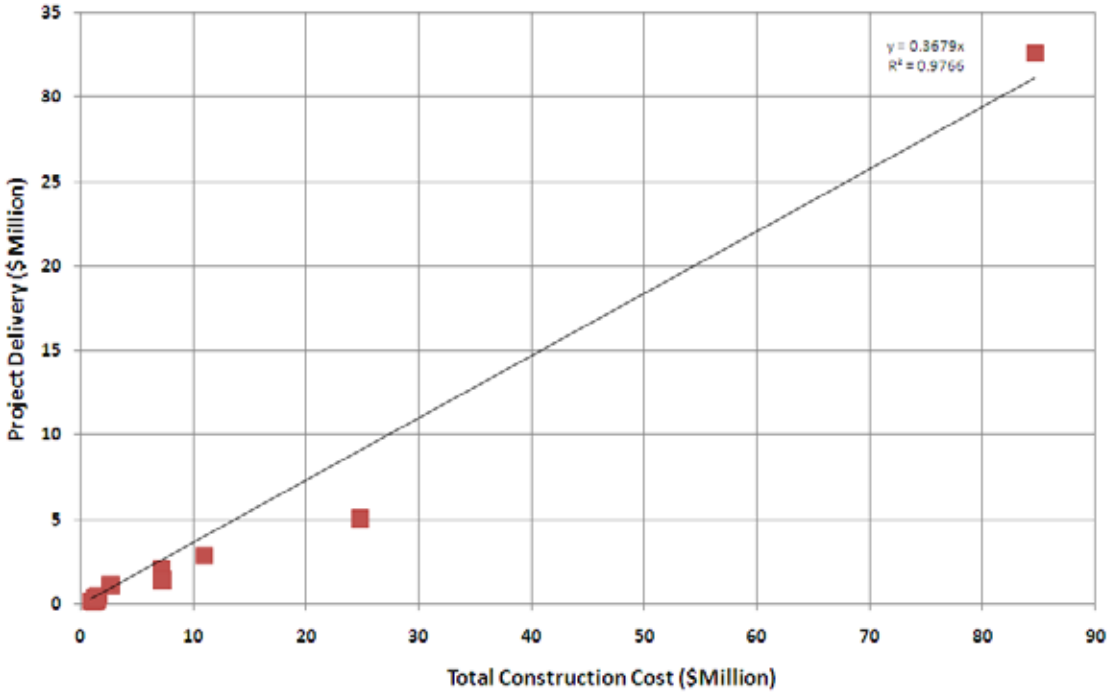
All Projects
Municipal Facilities - Comm./Rec. Center/Child Care/Gyms
Project Delivery ($ Million) Versus Total Construction Cost (N=50)



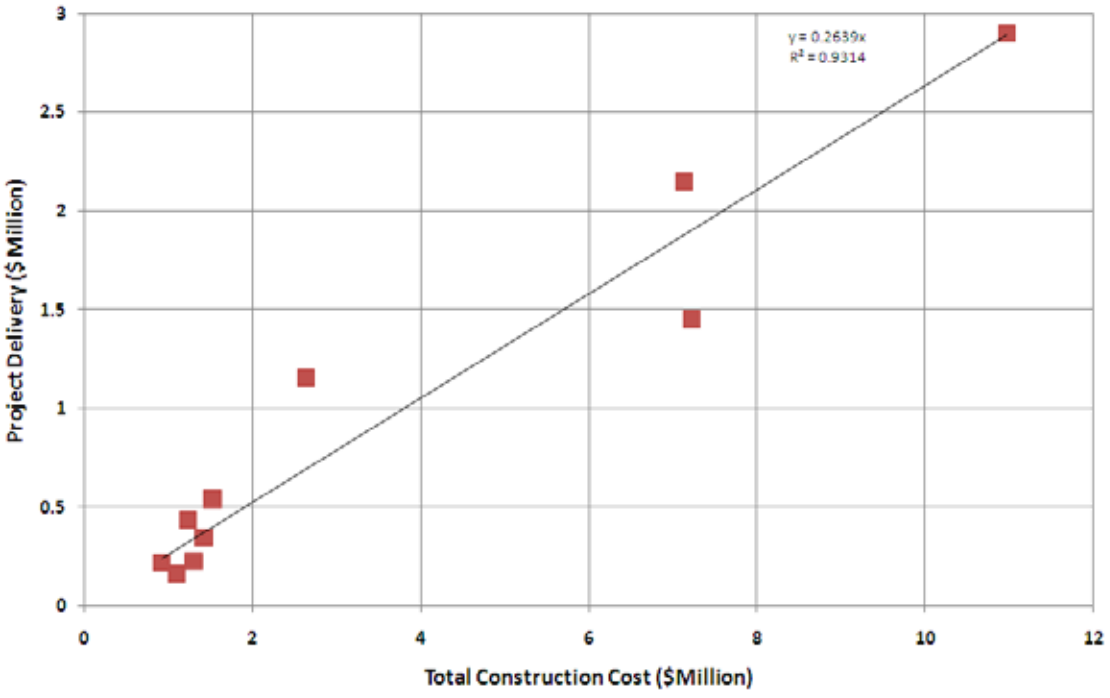
Smaller Projects
Municipal Facilities - Comm./Rec. Center/Child Care/Gyms
Project Delivery ($ Million) Versus Total Construction Cost (N=40)



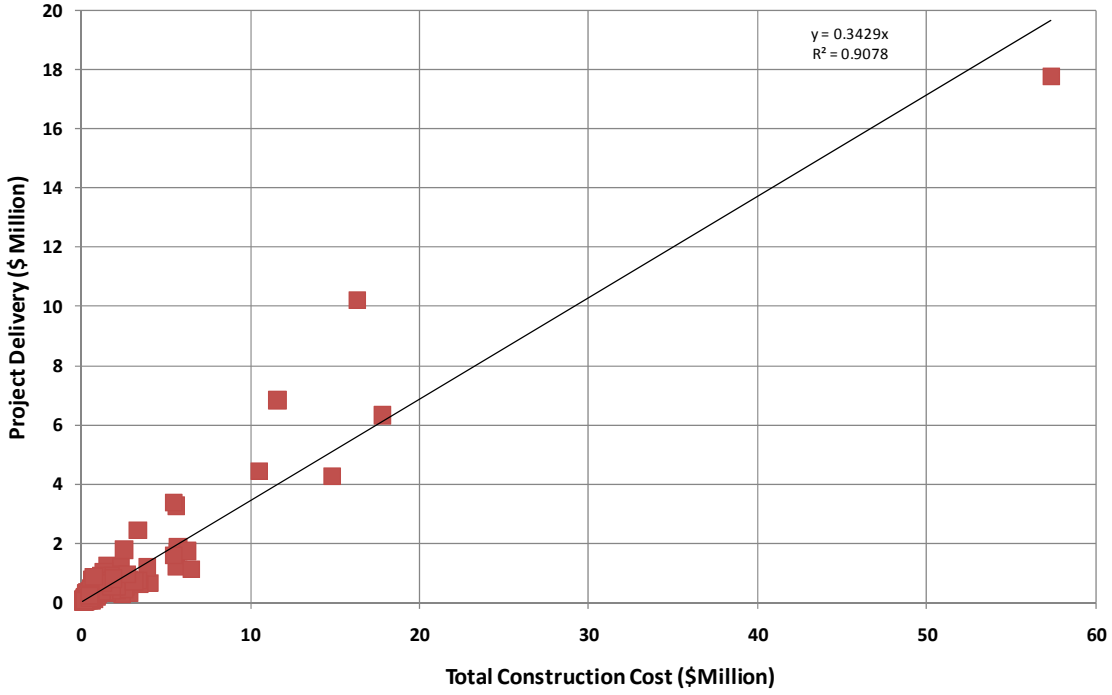
All Projects
Municipal Facilities - Other Municipal Facilities
Project Delivery ($ Million) Versus Total Construction Cost (N=12)



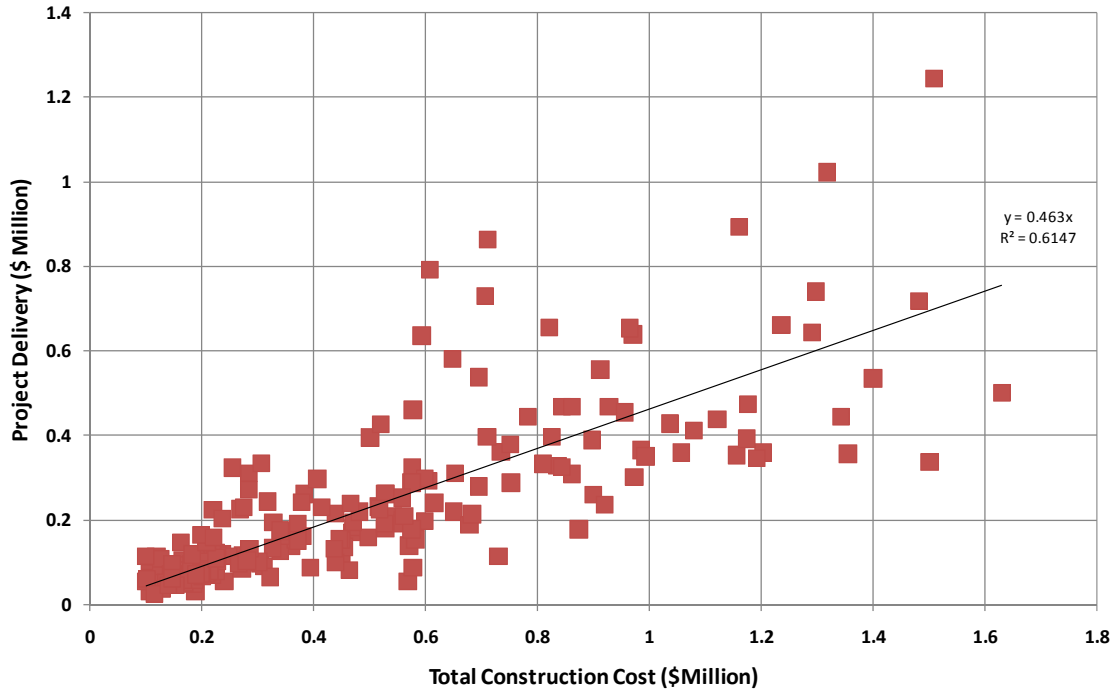
Smaller Projects
Municipal Facilities - Other Municipal Facilities
Project Delivery ($ Million) Versus Total Construction Cost (N=10)



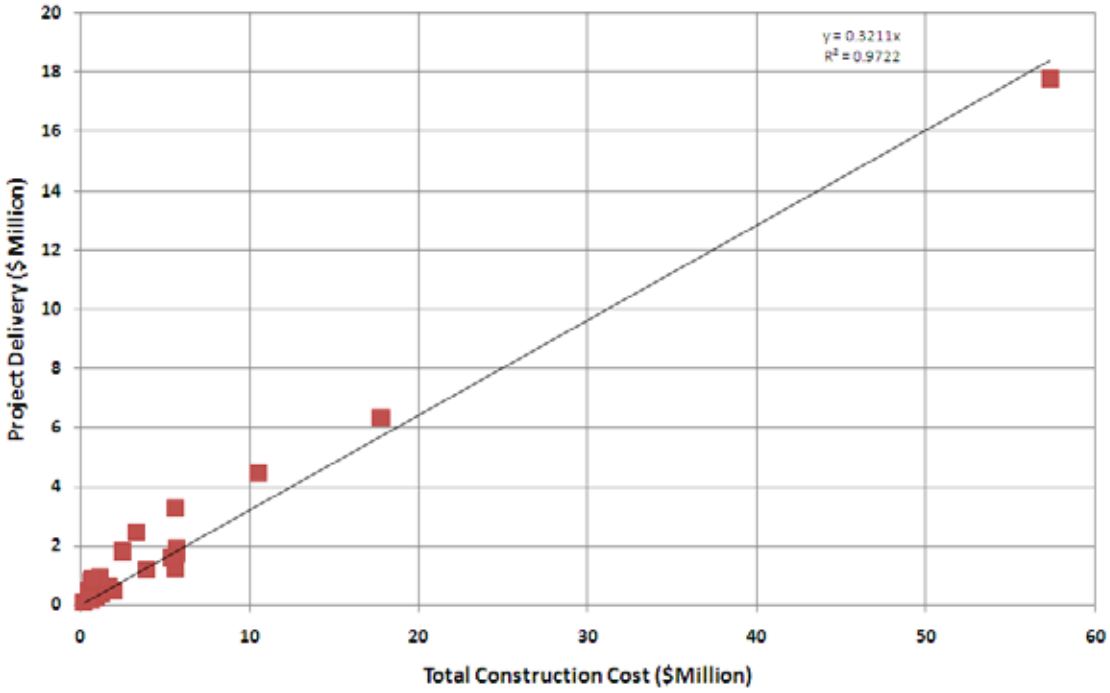
All Projects
Streets - All Classifications
Project Delivery ($ Million) Versus Total Construction Cost (N=263)



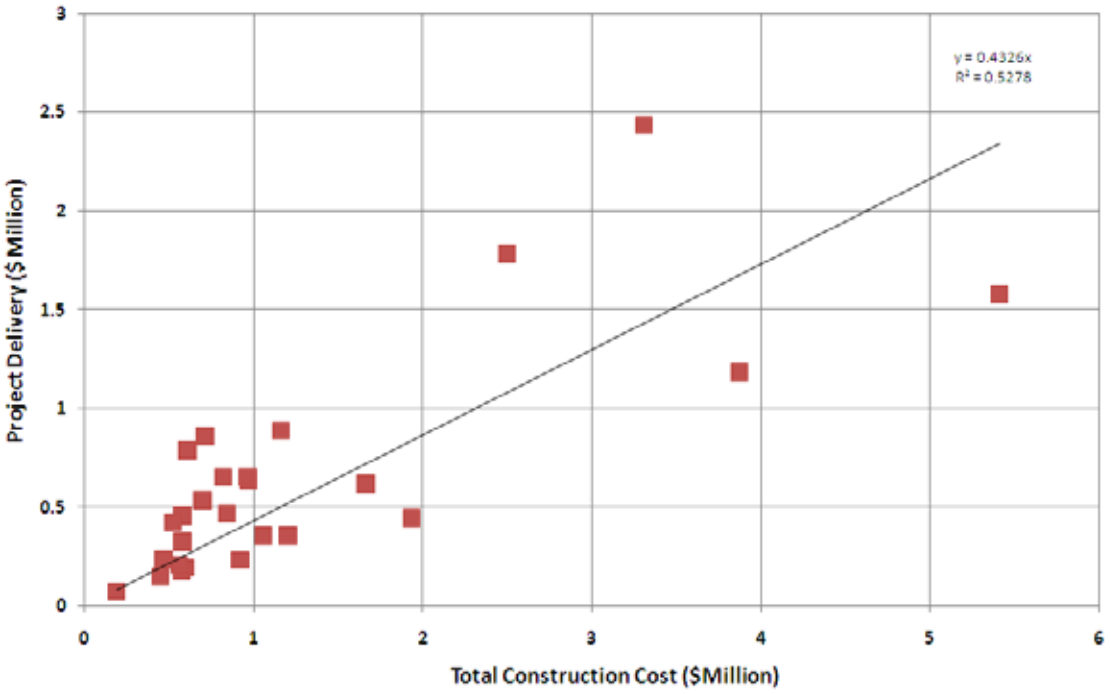
Smaller Projects
Streets - All Classifications
Project Delivery ($ Million) Versus Total Construction Cost (N=208)



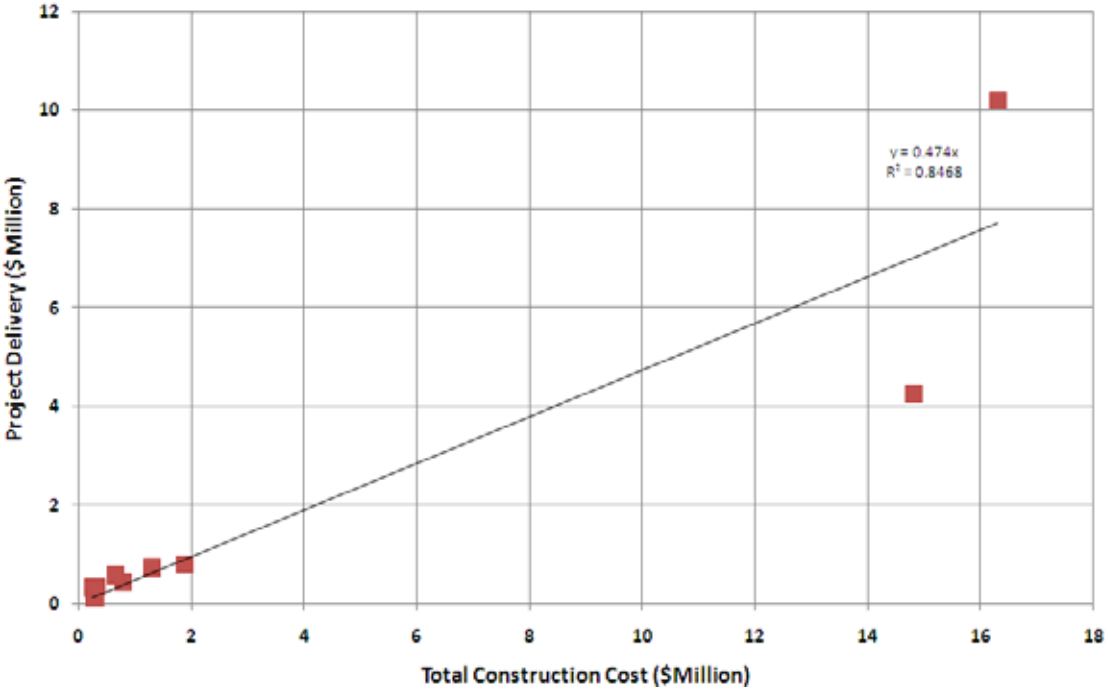
All Projects
Streets - Widening/New/Grade Separations
Project Delivery ($ Million) Versus Total Construction Cost (N=33)



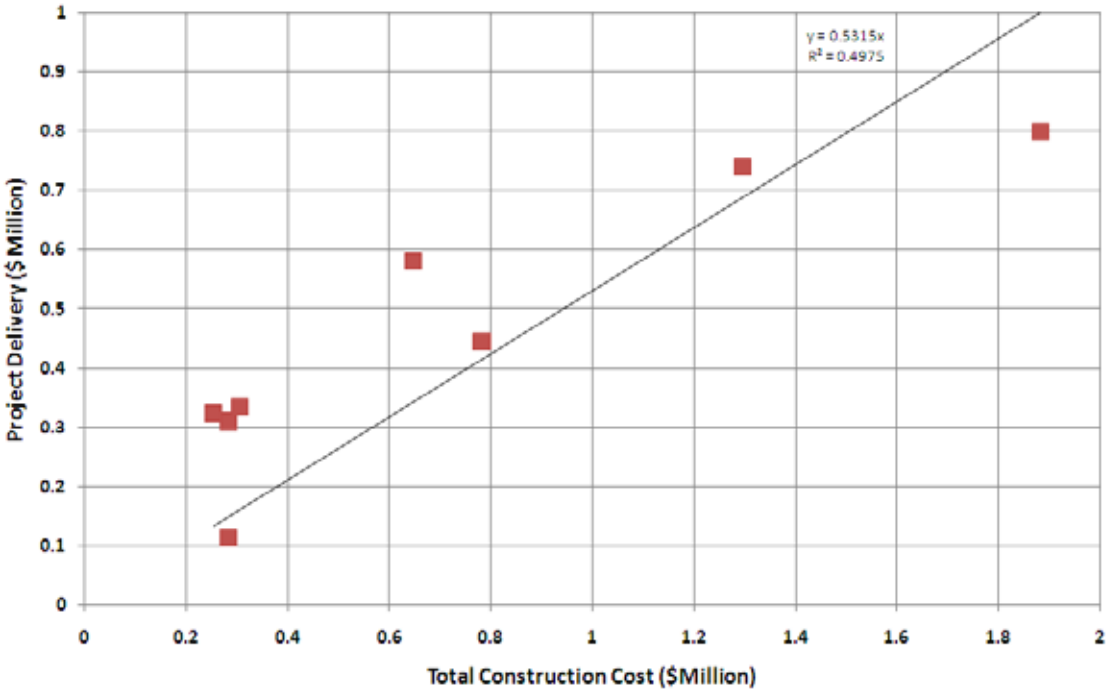
Smaller Projects
Streets - Widening/New/Grade Separations
Project Delivery ($ Million) Versus Total Construction Cost (N=26)



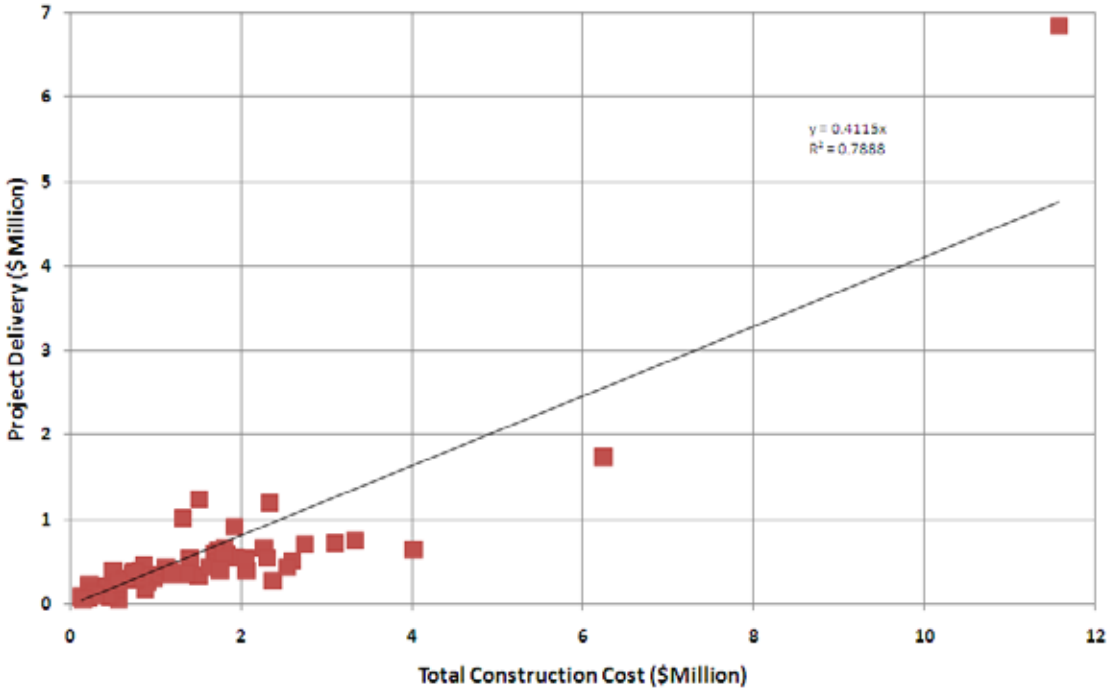
All Projects
Streets - Bridges (New/Retrofit)
Project Delivery ($ Million) Versus Total Construction Cost (N=10)



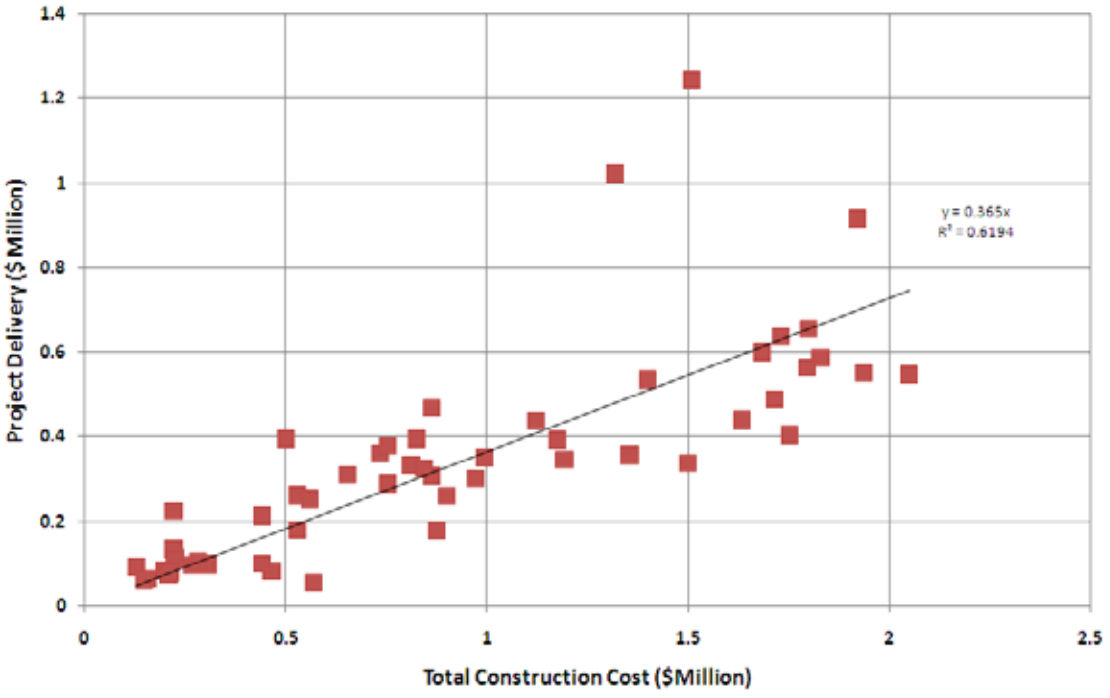
Smaller Projects
Streets - Bridges (New/Retrofit)
Project Delivery ($ Million) Versus Total Construction Cost (N=8)



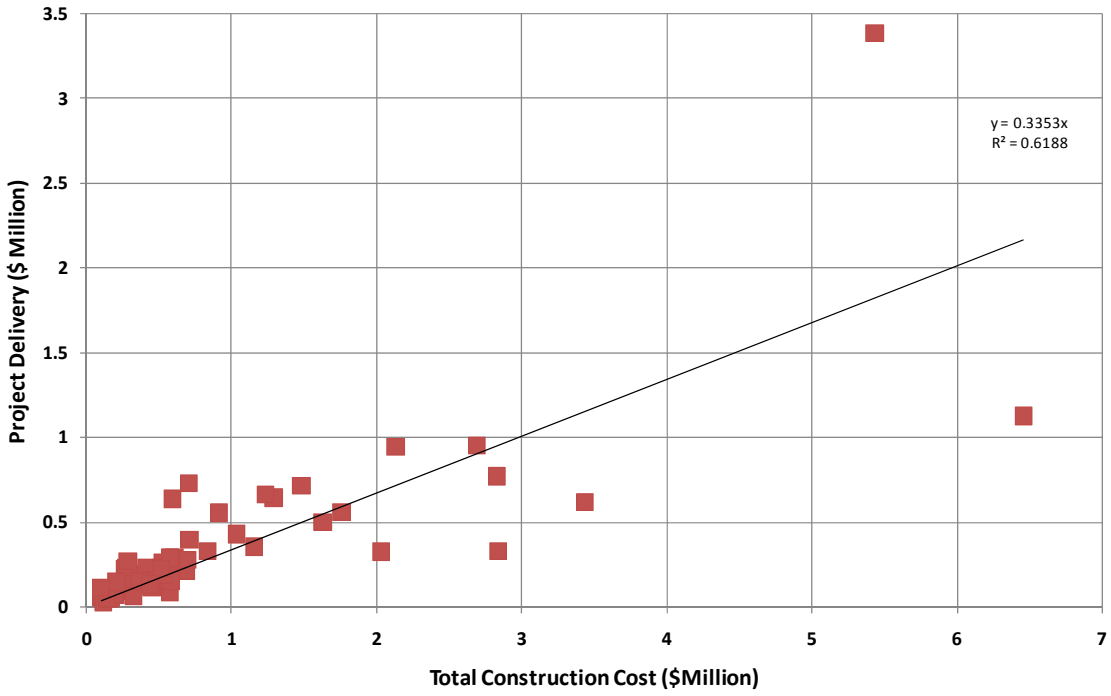
All Projects
Streets - Reconstructions
Project Delivery ($ Million) Versus Total Construction Cost (N=69)



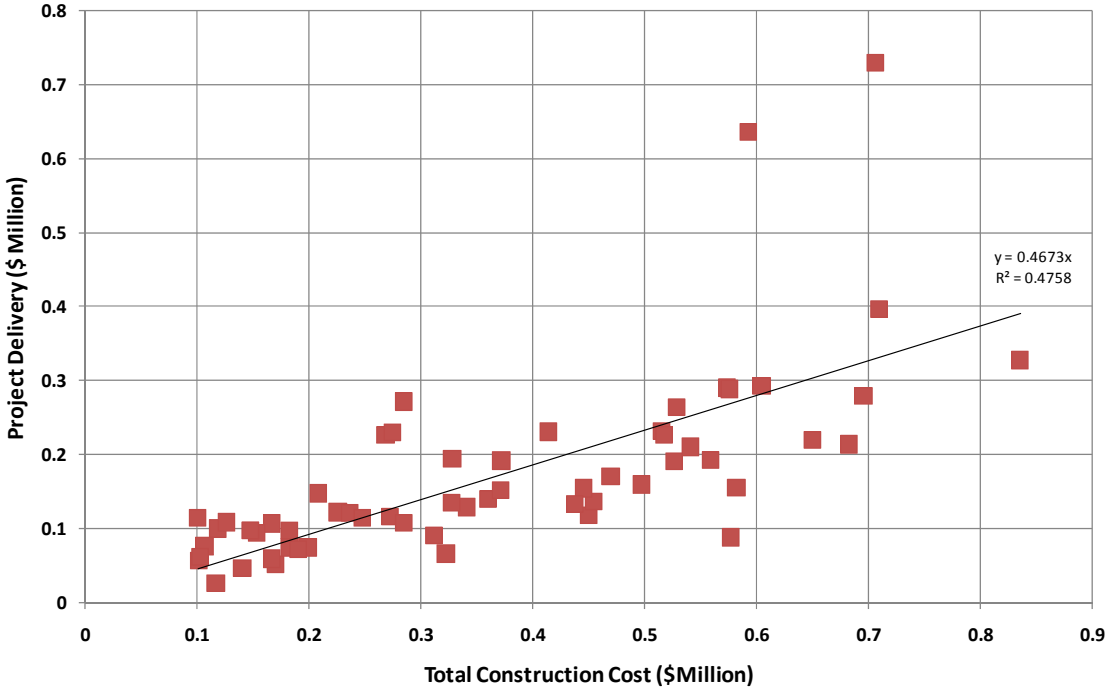
Smaller Projects
Streets - Reconstructions
Project Delivery ($ Million) Versus Total Construction Cost (N=55)



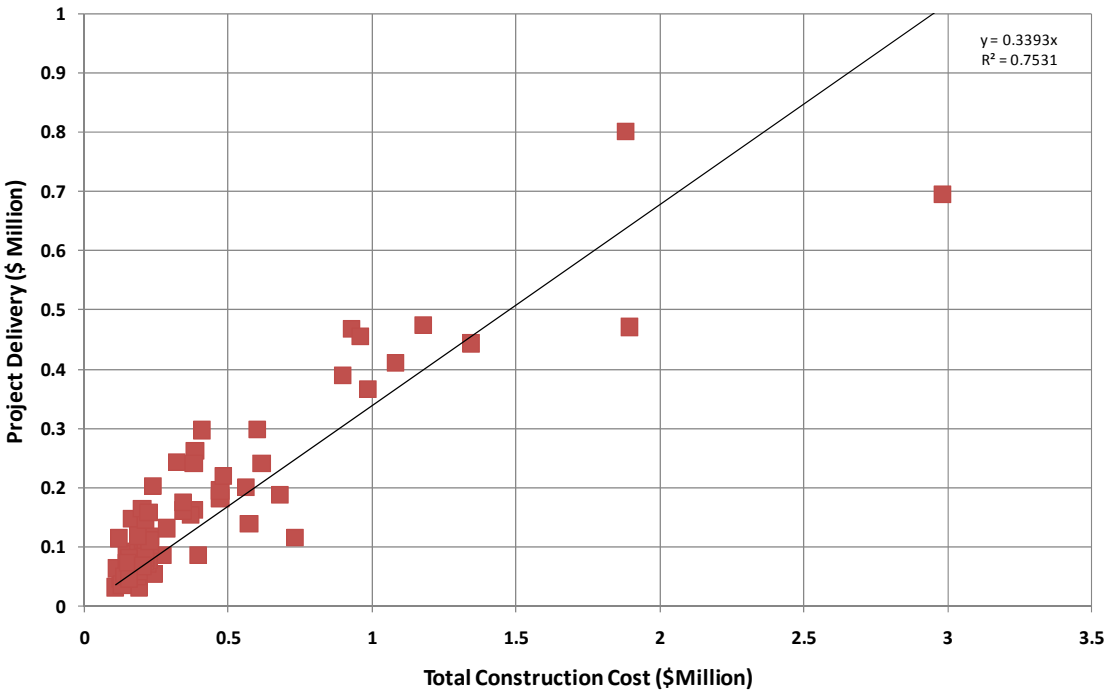
All Projects
Streets - Bike/Pedestrian/Streetscapes
Project Delivery ($ Million) Versus Total Construction Cost (N=78)



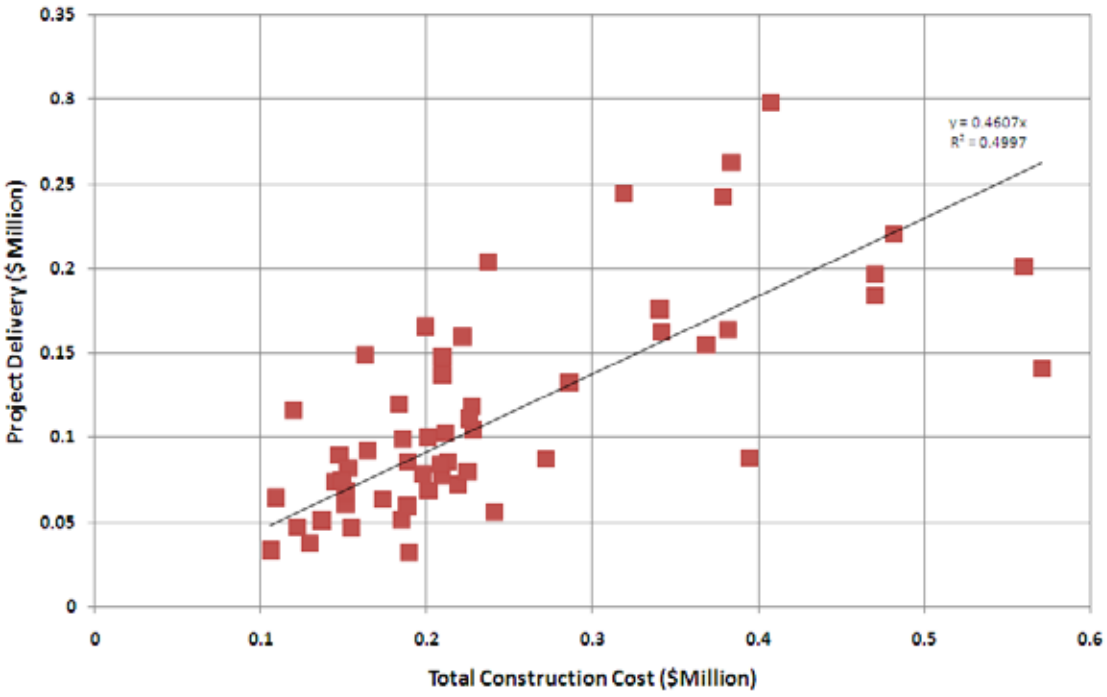
Smaller Projects
Streets - Bike/Pedestrian/Streetscapes
Project Delivery ($ Million) Versus Total Construction Cost (N=61)



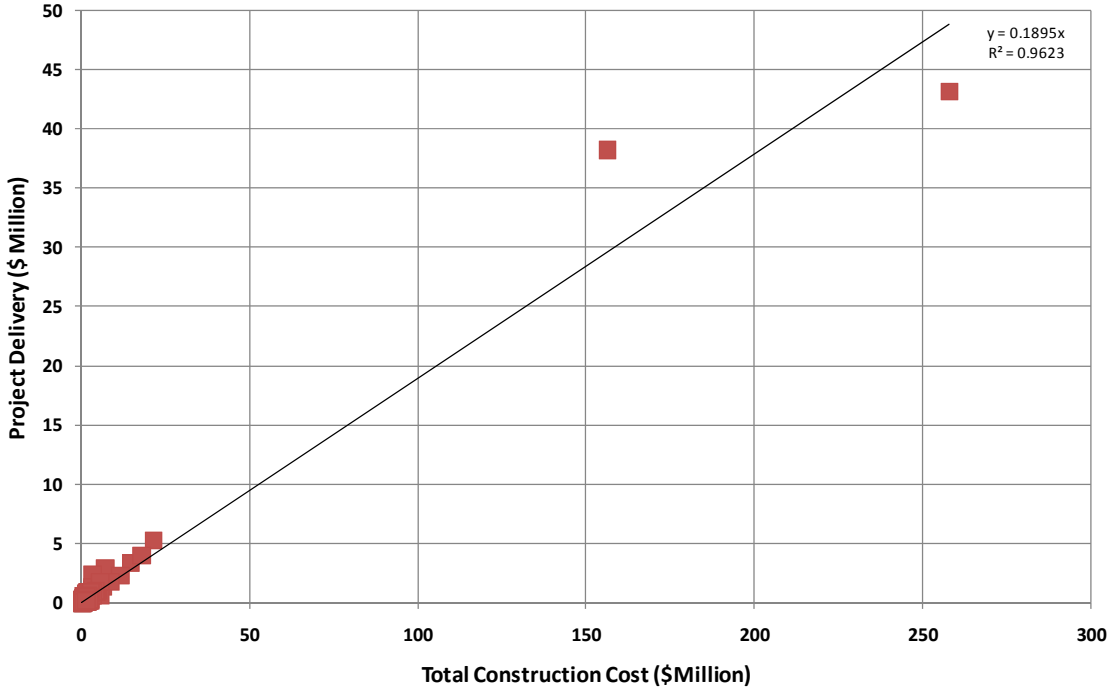
All Projects
Streets - Signals
Project Delivery ($ Million) Versus Total Construction Cost (N=73)



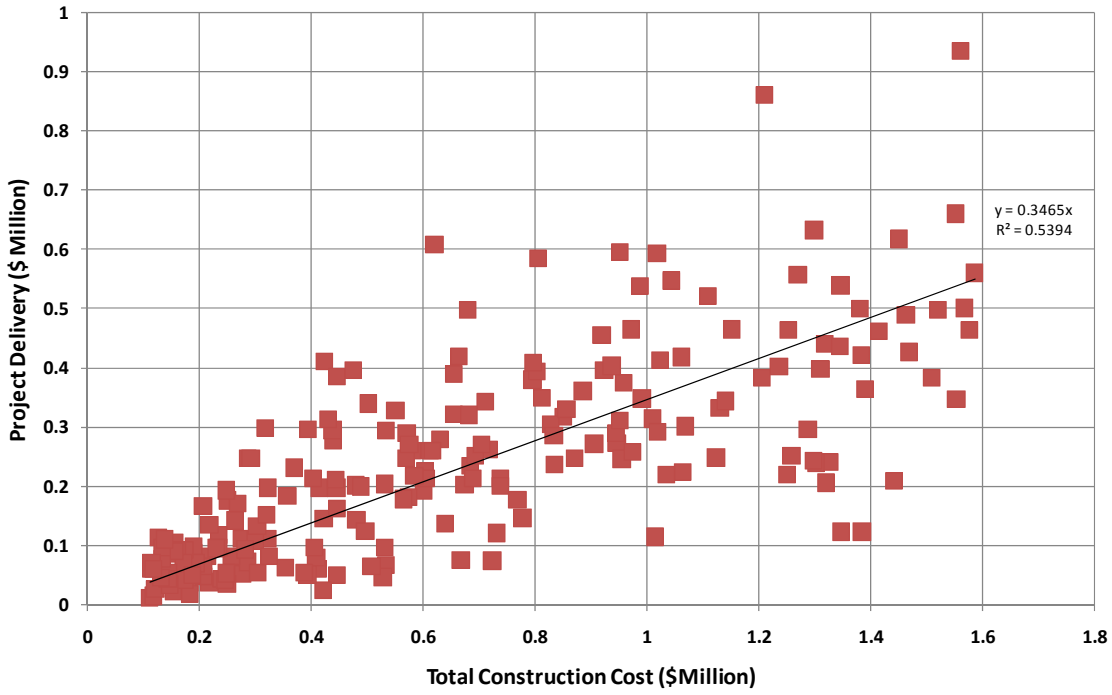
Smaller Projects
Streets - Signals
Project Delivery ($ Million) Versus Total Construction Cost (N=58)



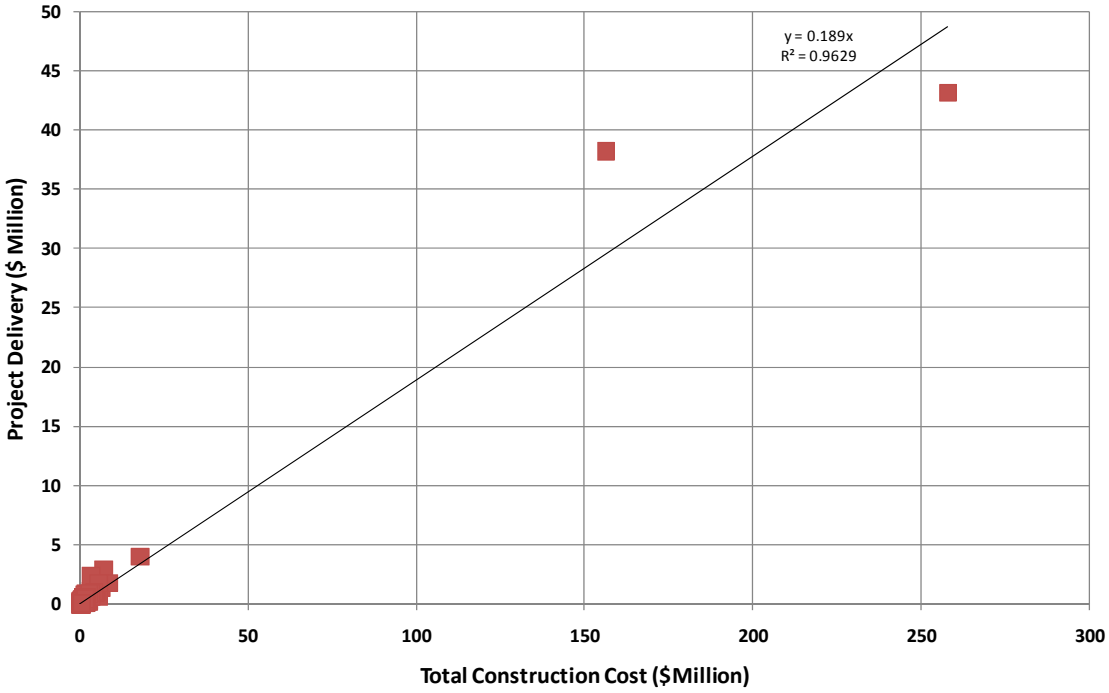
All Projects
Pipe Systems - All Classifications
Project Delivery ($ Million) Versus Total Construction Cost (N=267)



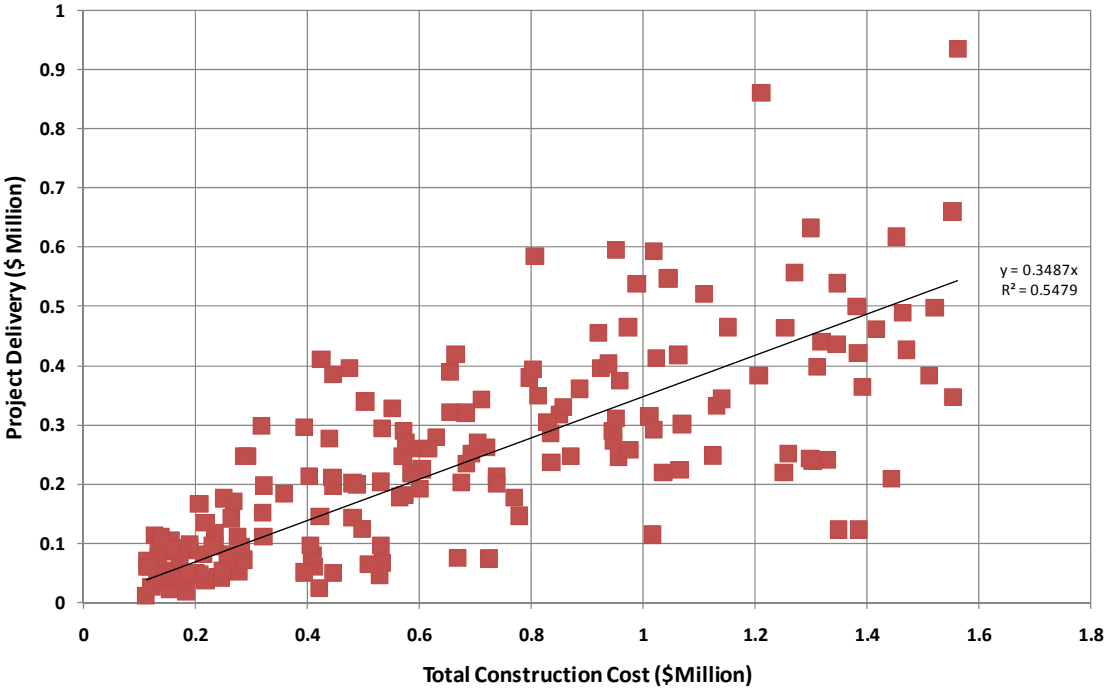
Smaller Projects
Pipe Systems - All Classifications
Project Delivery ($ Million) Versus Total Construction Cost (N=214)



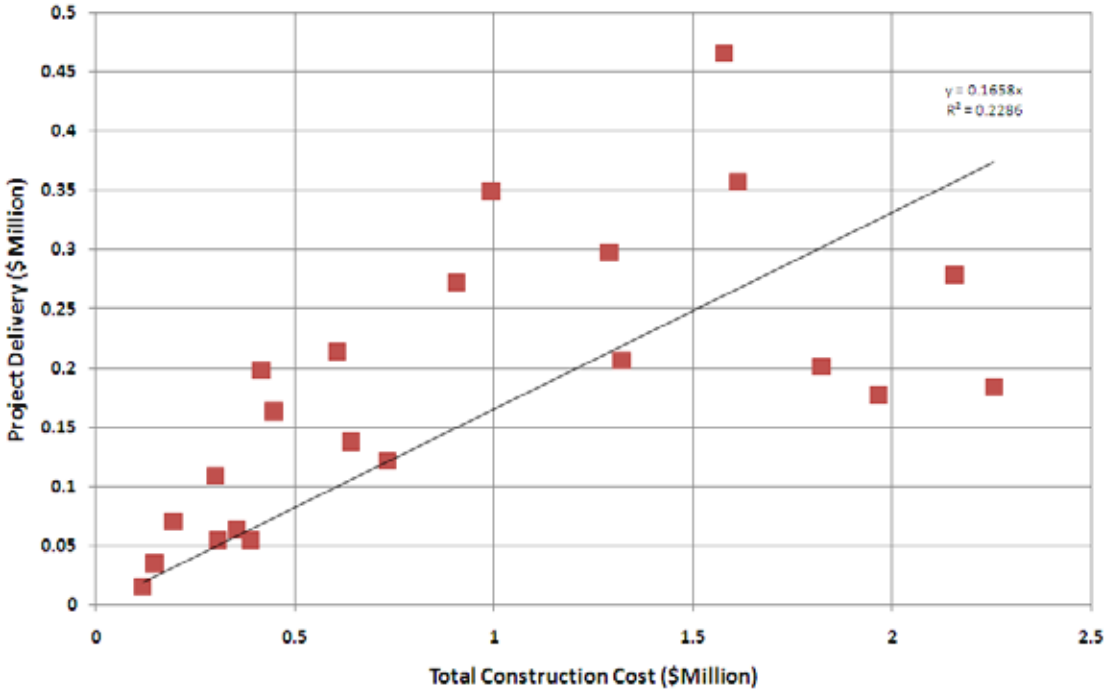
All Projects
Pipe Systems - Gravity Systems (Storm Drains/Sewers)
Project Delivery ($ Million) Versus Total Construction Cost (N=227)



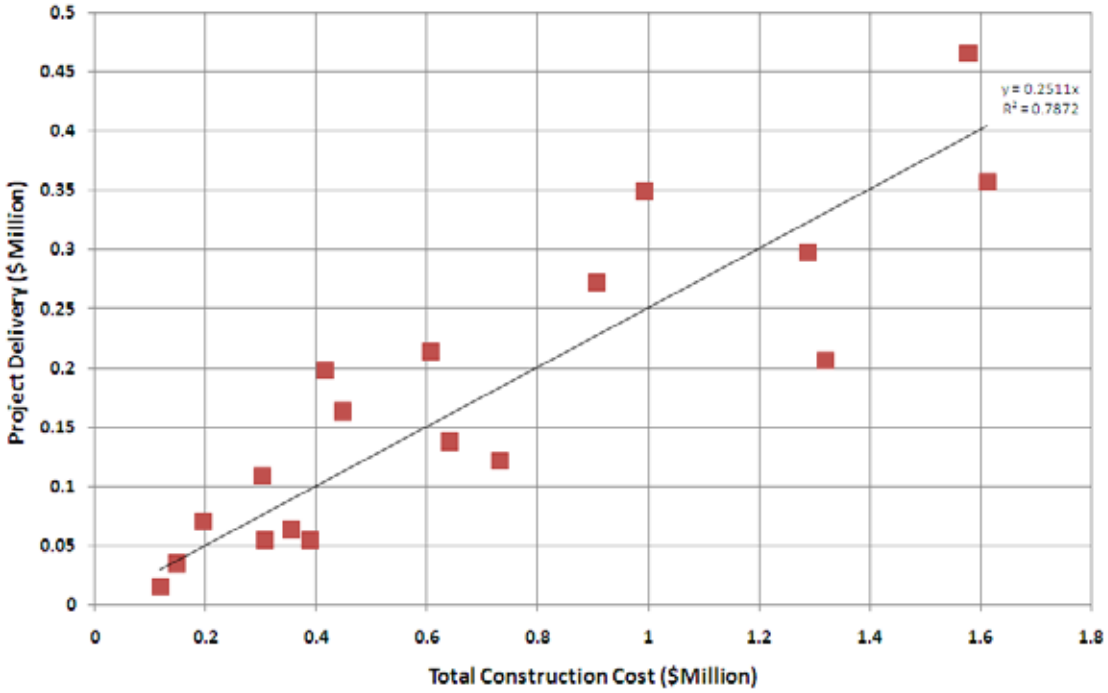
Smaller Projects
Pipe Systems - Gravity Systems (Storm Drains/Sewers)
Project Delivery ($ Million) Versus Total Construction Cost (N=182)



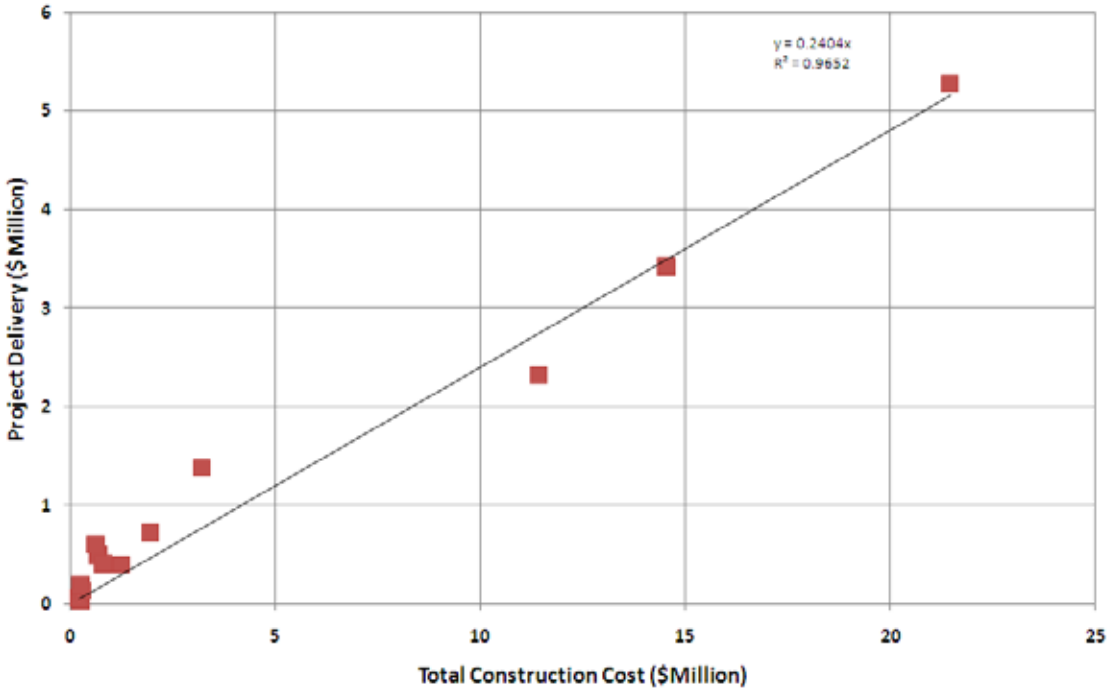
All Projects
Pipe Systems - Pressure Systems
Project Delivery ($ Million) Versus Total Construction Cost (N=22)



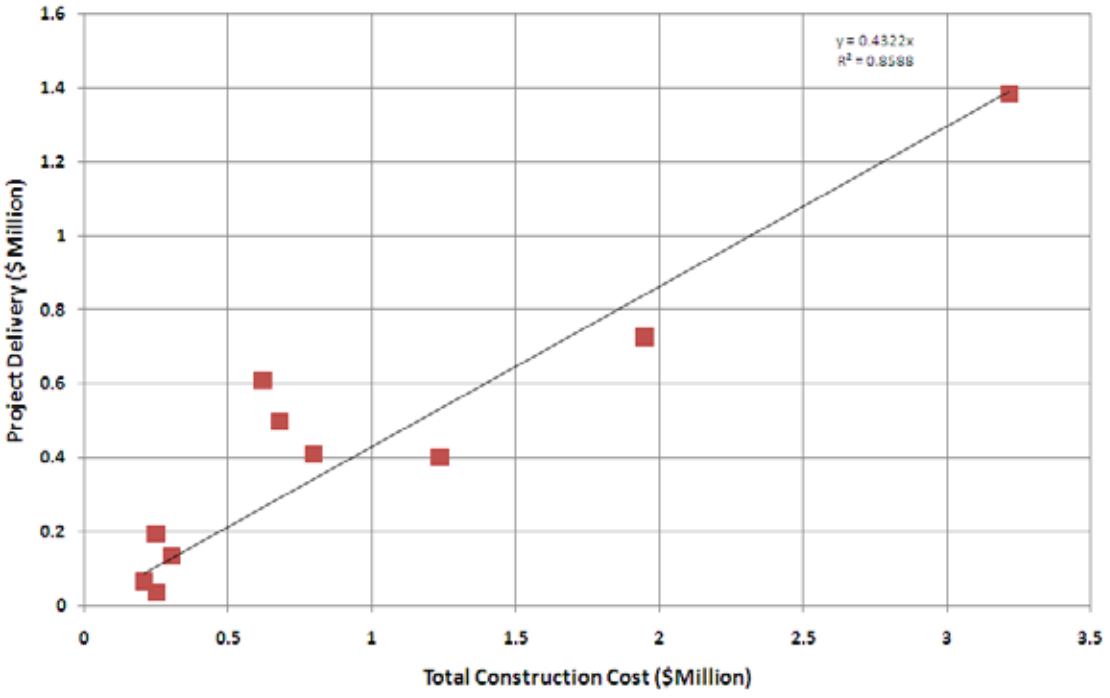
Smaller Projects
Pipe Systems - Pressure Systems
Project Delivery ($ Million) Versus Total Construction Cost (N=18)



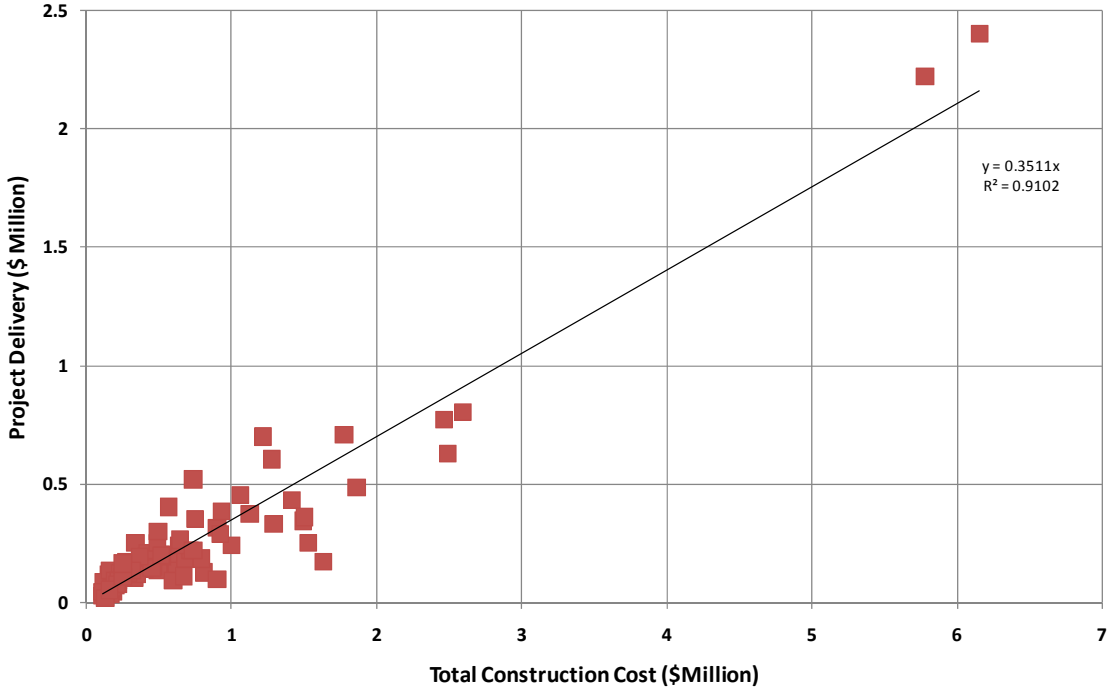
All Projects
Pipe Systems - Pump Stations
Project Delivery ($ Million) Versus Total Construction Cost (N=13)



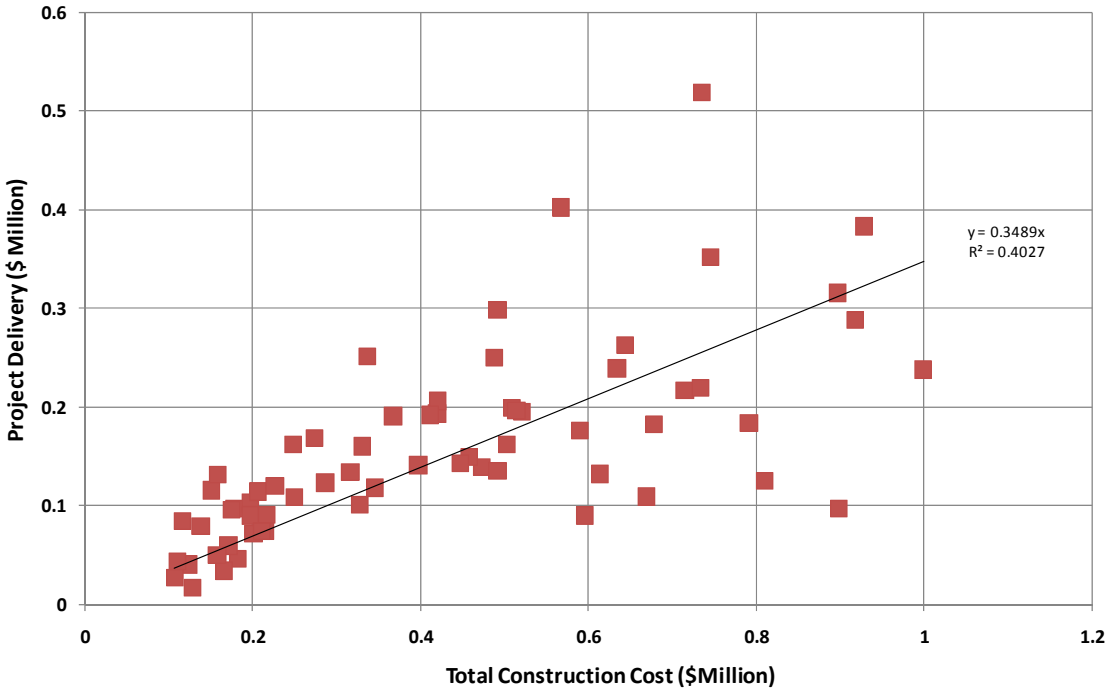
Smaller Projects
Pipe Systems - Pump Stations
Project Delivery ($ Million) Versus Total Construction Cost (N=10)



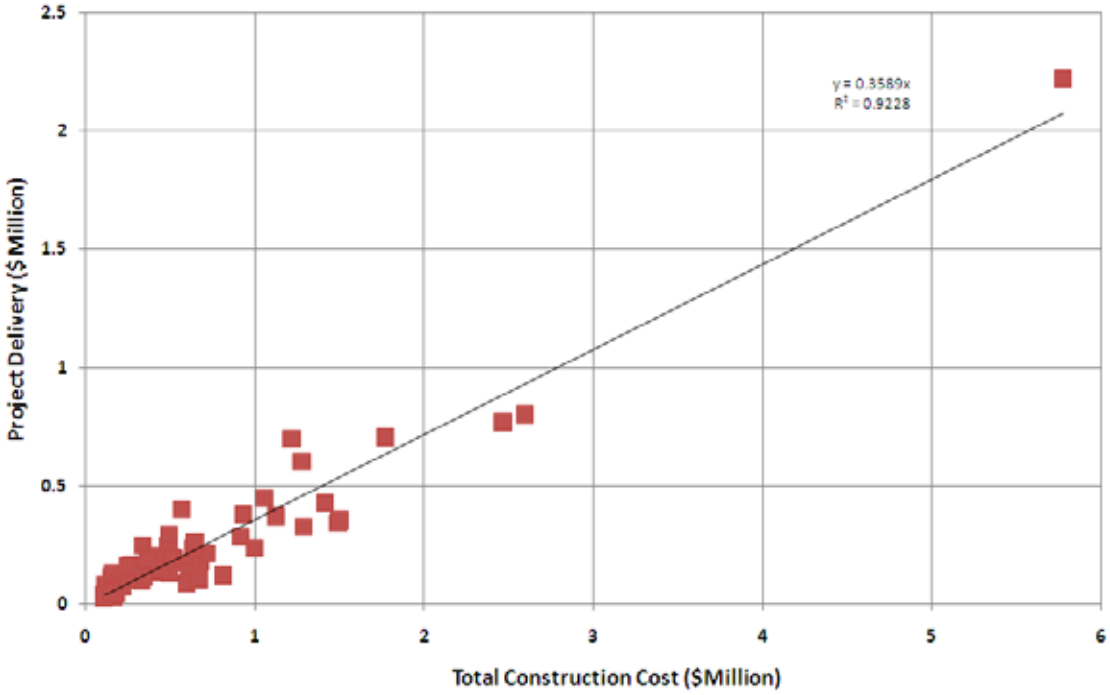
All Projects
Parks - All Classifications
Project Delivery ($ Million) Versus Total Construction Cost (N=83)



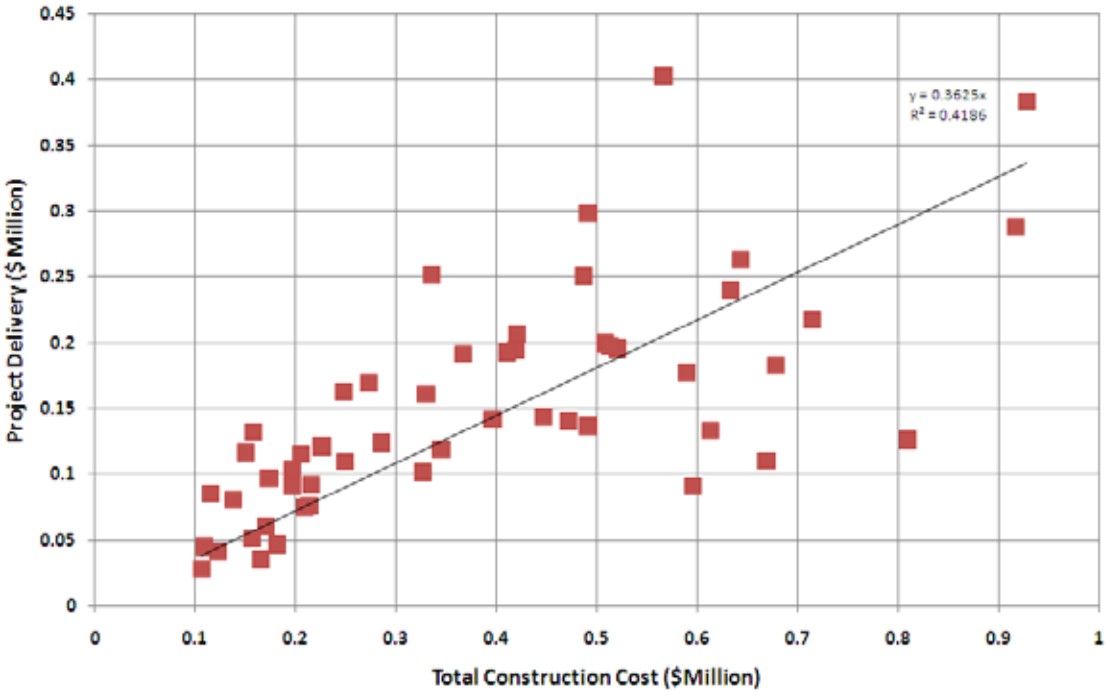
Smaller Projects
Parks - All Classifications
Project Delivery ($ Million) Versus Total Construction Cost (N=66)



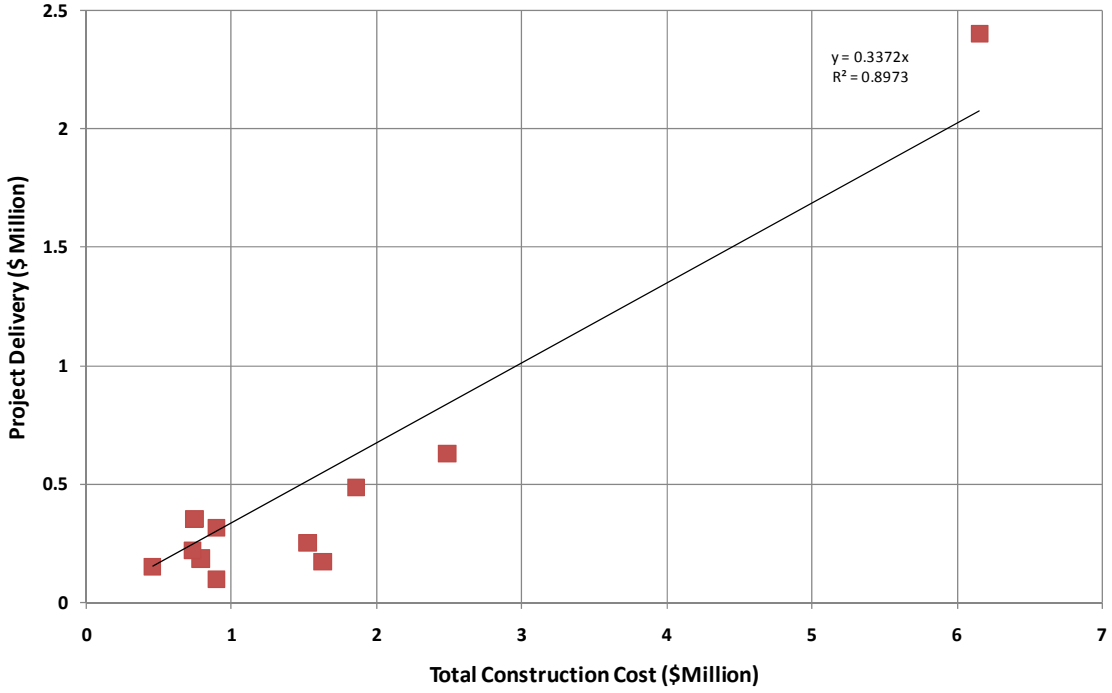
All Projects
Parks - Playgrounds
Project Delivery ($ Million) Versus Total Construction Cost (N=65)



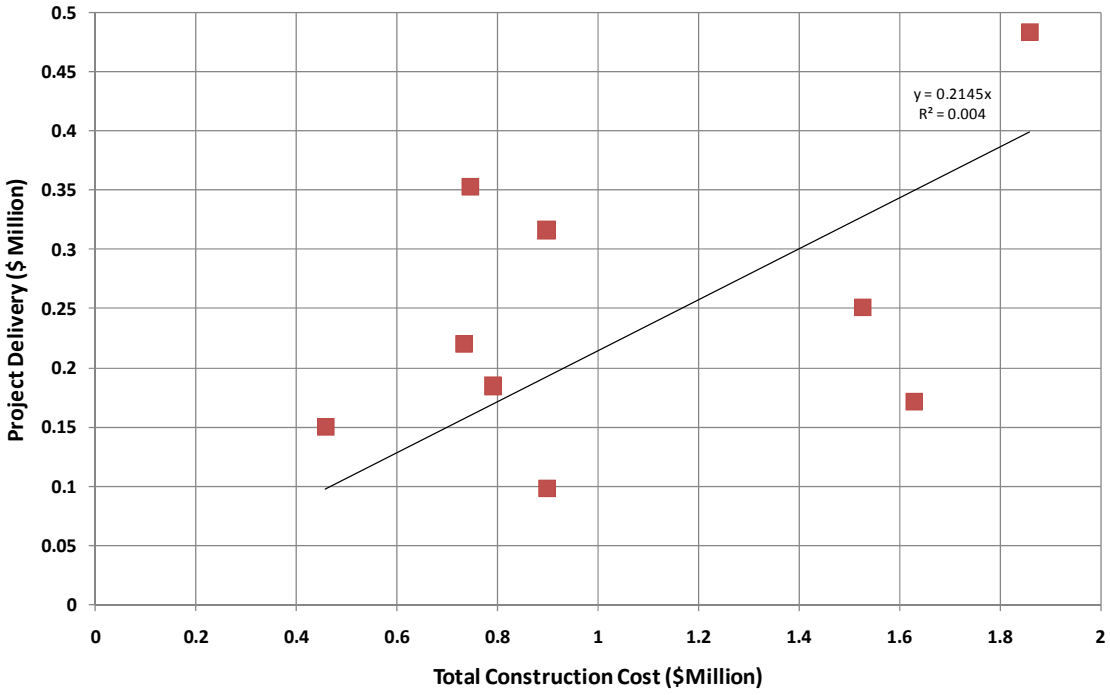
Smaller Projects
Parks - Playgrounds
Project Delivery ($ Million) Versus Total Construction Cost (N=52)



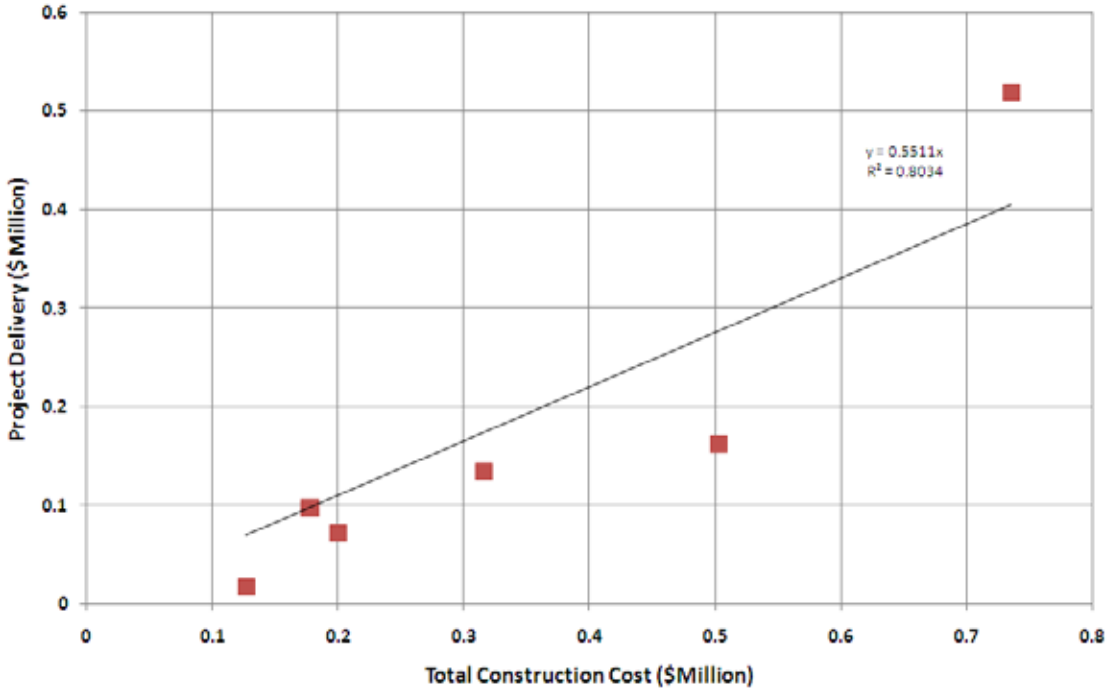
All Projects
Parks - Sportfields
Project Delivery ($ Million) Versus Total Construction Cost (N=12)



Smaller Projects
Parks - Sportfields
Project Delivery ($ Million) Versus Total Construction Cost (N=10)



All Projects
Parks - Restrooms
Project Delivery ($ Million) Versus Total Construction Cost (N=6)



Smaller Projects
Parks - Restrooms
Project Delivery ($ Million) Versus Total Construction Cost (N=5)

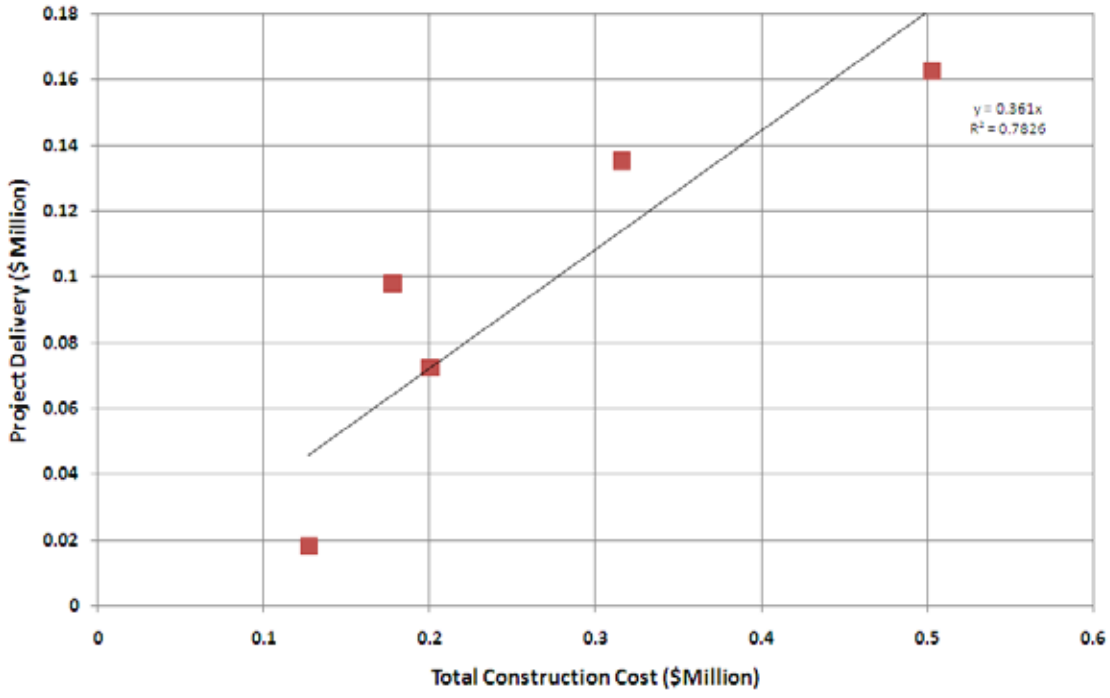
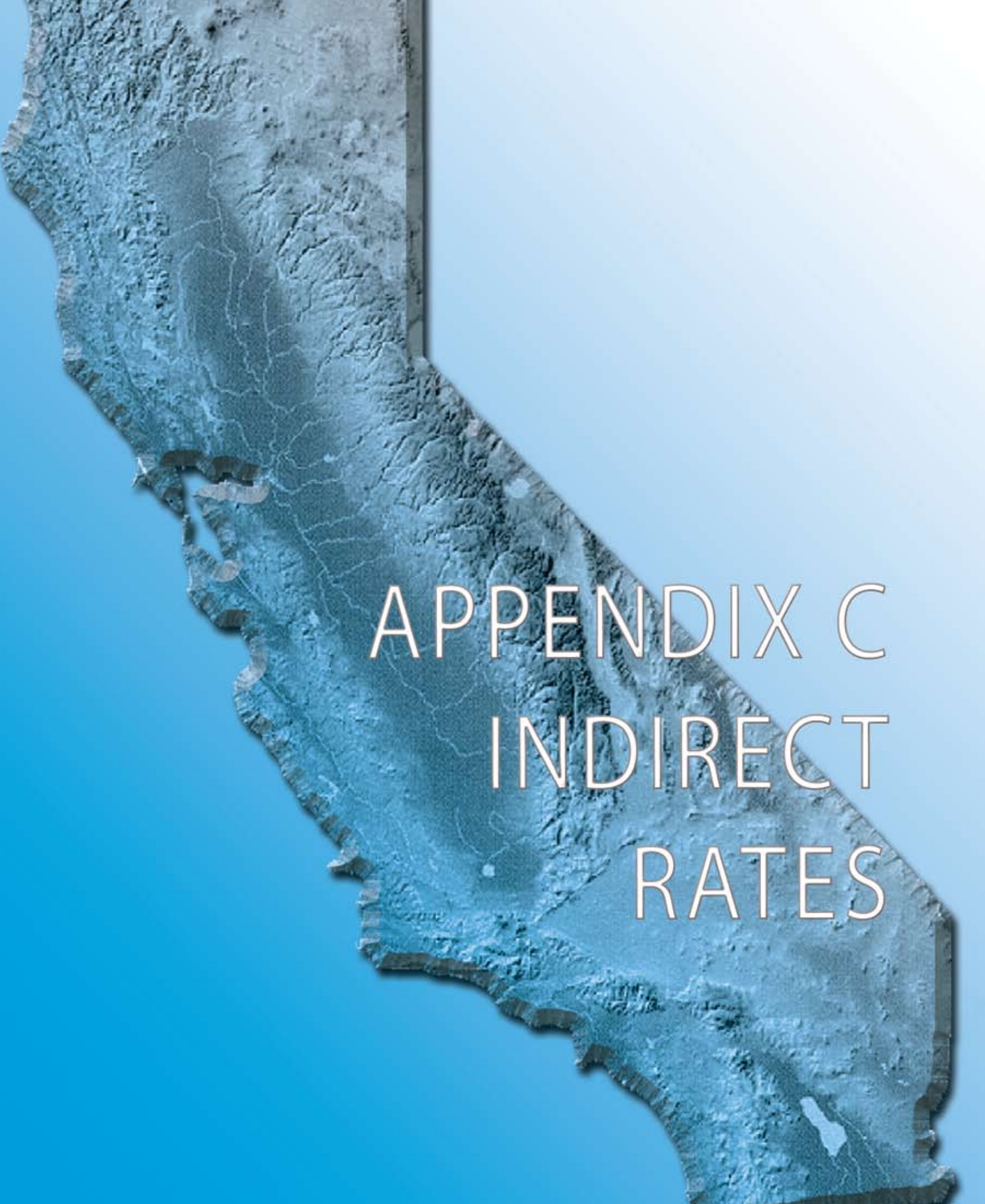


Table B-1
Summary of Regression Equations

Project Type or Classification	Design Cost ($) vs. TCC($) Full Range of TCC	Design Cost ($) vs. TCC($) Smaller Project Subset of TCC	CM Cost ($) vs. TCC($) Full Range of TCC	CM Cost ($) vs. TCC($) Smaller Project Subset of TCC	Project Delivery Cost ($) vs. TCC($) Full Range of TCC	Project Delivery Cost ($) vs. TCC($) Smaller Project Subset of TCC
Municipal Projects	y=0.1726x	y=0.1689x	y=0.1763x	y=0.1444x	y=0.3489x	y=0.3132x
Libraries	y=0.1612x	y=0.1824x	y=0.1238x	y=0.1195x	y=0.2849x	y=0.3019x
Police/Fire Stations	y=0.1703x	y=0.1426x	y=0.163x	y=0.1355x	y=0.3333x	y=0.2779x
Comm./Rec.Center/ Child Care/Gyms	y=0.1671x	y=0.194x	y=0.1088x	y=0.1446x	y=0.2759x	y=0.3386x
Other Municipal	y=0.1754x	y=0.1675x	y=0.1925x	y=0.0964x	y=0.3679x	y=0.2639x
Streets Projects	y=0.1648x	y=0.2738x	y=0.1782x	y=0.1886x	y=0.3429x	y=0.463x
Widening/New/ Grade Separations	y=0.1338x	y=0.2586x	y=0.1873x	y=0.1741x	y=0.3211x	y=0.4326x
Bridges	y=0.3536x	y=0.3678x	y=0.1204x	y=0.1637x	y=0.474x	y=0.5313x
Reconstructions	y=0.2374x	y=0.2267x	y=0.174x	y=0.1382x	y=0.4115x	y=0.365x
Bike/Pedestrian/ Streetscapes	y=0.2004x	y=0.2799x	y=0.135x	y=0.1871x	y=0.3353x	y=0.4673x
Signals	y=0.1631x	y=0.2473x	y=0.1749x	y=0.2146x	y=0.3393x	y=0.4607x
Pipes Projects	y=0.0935x	y=0.1732x	y=0.096x	y=0.1733x	y=0.1895x	y=0.3465x
Gravity Mains	y=0.093x	y=0.1737x	y=0.096x	y=0.175x	y=0.189x	y=0.3487x
Pressure Systems	y=0.068x	y=0.1119x	y=0.0978x	y=0.1392x	y=0.1658x	y=0.2511x
Pump Stations	y=0.1413x	y=0.2124x	y=0.0992x	y=0.2198x	y=0.2404x	y=0.4322x
Parks	0.2477x	y=0.209x	y=0.1034x	y=0.14x	y=0.3511x	y=0.3489x
Playgrounds	y=0.2094x	y=0.227x	y=0.1495x	y=0.1354x	y=0.3589x	y=0.3625x
Sportfields	y=0.296x	0.1173x	y=0.0412x	y=0.0973x	y=0.3372x	y=0.2145x
Restrooms	y=0.376x	y=0.1144x	y=0.1751x	y=0.2465x	y=0.5511x	y=0.361x

Notes:
m = slope of the regression trendline which is the project delivery percentage.



APPENDIX C
INDIRECT RATES

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	39.24%	19.40%	0%	5.68%	42.0%	106.32%	YES
City of Los Angeles Department of Public Works Bureau of Engineering[2]	37.04%	19.61%	21.55%	18.01%	70.78%	166.98%	YES
City of Oakland Department of Engineering & Construction	73.85%	20.79%	32.40%	0%	21.57%	148.61%	NO
City of Sacramento Department of General Services[3]	32.00%	18.70%	0%	0%	73%	131.9%	NO
Department of Transportation	33.26%	18.70%	11.90%	12.00%	63.00%	138.86%	
Department of Utilities	37.17%	18.70%	100.36%			156.23%	
City of San Diego Architectural Engineering & Contract Services	46.93%	20.50%	0%	0%	88.05%	155%	NO
Transportation Engineering Division	47.32%	18.30%	0%	0%	55.80%	121%	
Water & Wastewater Facilities Division	49.76%	18.40%	0%	0%	88.05%	156%	
City and County of San Francisco Department of Public Works Bureau of Engineering Bureau of Construction Management Bureau of Architecture	21.85%	23.99%	0%	36.55%	63.92%	146.31%	NO
City of San Jose Department of Public Works	36.90%	33.11%	37.83% 9.27%[4]	32.70%	Included	149.81%	NO

Notes:

[1] This value may be different from the sum of overhead values since the compounding formula may vary by agency.

[2] Based on averages of all Bureau program overhead rates provided under CAP 28.

[3] Year 2008 Rates.

[4] 37.83% is the rate applied to Capital Project labor charges; 9.27% is the rate applied to Compensated Time Off

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/