FILED
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INDIANA UTILITY
REGULATORY COMMISSION

STATE OF INDIANA

INDIANA UTILITY REGULATORY COMMISSION

IN THE MATTER OF THE PETITION OF	**)**	
THE TOWN OF CHANDLER, INDIANA,	**)**	
FOR APPROVAL OF A NEW SCHEDULE	**)**	
OF RATES AND CHARGES FOR WATER	**)**	
UTILITY SERVICE AND FOR	**)**	
AUTHORITY TO ISSUE REVENUE	**)**	**CAUSE NO. 45062**
BONDS TO PROVIDE FUNDS FOR THE	**)**	
COSTS OF THE ACQUISITION AND	**)**	
INSTALLATION OF IMPROVEMENTS	**)**	
AND EXTENSIONS TO THE	**)**	
WATERWORKS OF THE TOWN	**)**	

PETITIONER'S EXHIBIT NO. 2-R

Prepared Rebuttal Testimony and Attachments of

J. Christopher Kaufman Jr.

Water Resources Department Manager for

Beam, Longest and Neff, LLC

Sponsoring Petitioner's Attachment Nos. JCK-1R through JCK-3R

VERIFIED REBUTTAL TESTIMONY OF CHRIS KAUFMAN

Q. Please state your name, employer, and business address.

A. My name is J. Christopher Kaufman Jr. and I am the water resources department manager at Beam, Longest and Neff, LLC ("BLN"), an engineering consulting firm. My business address is 8320 Craig Street, Indianapolis, Indiana 46250.

Q. Are you the same Christopher Kaufman who provided direct testimony in this Cause on behalf of the Waterworks Utility of the Town of Chandler, Indiana ("Petitioner" or "Chandler")?

A. Yes, I am.

Q. What is the purpose of your rebuttal testimony?

A. The purpose of my rebuttal testimony is to respond to positions taken by the Office of Utility Consumer Counselor ("OUCC") through the testimony of witness James Parks regarding Chandler's allowances for contingencies and engineering costs in the acquisition, construction, installation, and equipping of a road relocation project, line replacement, an additional transmission line, and related waterworks improvements (collectively, the "Project").

Capital Improvement Projects

Q. Did the OUCC question the need for Chandler's Project?

4841-1203-1856.v1
4841-1203-1856.v2
4841-1203-1856.v3

A. No. The OUCC did not question the need for the Project, and, in fact, OUCC James Parks agreed that "the three water main projects are necessary . . . ." Pub. Ex. 2 (Parks Direct Testimony), at p. 11, lines 23-24. He also highlights Chandler's leaking aged water mains that Chandler seeks to replace in this case. Pub. Ex. 2 (Parks Direct Testimony), at p. 4, lines 10-14.

Q. Excluding contingencies and engineering costs, did the OUCC question Chandler's cost components of the Project?

A. No. OUCC Witness Parks concluded "[t]he average unit costs per foot of water main shown in Petitioner's Detailed Project Cost Estimates are reasonable. Furthermore, Petitioner's cost estimates are detailed and appear to have identified all major cost components." Pub. Ex. No. 2 (Parks Direct Testimony), at p. 12, lines 21-22 through p. 13, lines 1-2.

Q. What criticisms did Mr. Parks raise about Chandler's Project in his testimony?

A. The OUCC considered Chandler's allowances for 20% contingencies and 30% engineering costs as both overestimated. Mr. Parks reduced the project contingencies to 10% (from 20%) and the engineering costs to 15% (from 30%). Mr. Parks also suggested inspection services at no more than 5% of the estimated construction costs.

Q. Do you agree with the OUCC's adjustment to project contingencies? If not, why?

A. No, I do not agree with the OUCC's adjustment to project contingencies because it fails to consider (1) this Project's early stage, (2) this Project's size and scope, and (3) industry standards.

Q. What about the Project's early stage and size and scope contributed to contingency costs?

A. Contingency factors are allowances included in a cost estimate to account for risks. Contingency costs usually begin at 30% and are then reduced throughout design development to 10% when construction bids are ready. The contingency accounts for things like underground utility conflicts, rocky or problematic soil conditions, changes due to updated permitting and funding requirements, easement acquisition, escalating material prices, etc. For example, some contingencies relate to escalating prices of oil or a company acquisition. These involve escalating prices that are more drastic than simple inflation. The price for a barrel of oil directly affects the price for PVC pipe, an oil byproduct. The new price per gallon of gas for the fleet has increased 28% for next year over this year, and I expect the price of PVC pipe to follow suit once new prices are established by the suppliers. Further, a recent acquisition of the crushed stone material supplier to Chandler has resulted in a 25% increase in the cost of crushed limestone rock for a current project, and we expect this to have a similar impact on utility projects in the near future. Crushed stone is used in backfill in asphalt restoration and in concrete curb and sidewalk – essentially every portion of our restoration in a water line replacement project.

Traditionally, cost contingency estimation relies heavily on expert judgment based on various cost-engineering standards. For an estimate used at this early stage of project development, where the design is not complete, we recommend a contingency ranging from 15% to 30%. Moreover, the Project involves the addition of a large transmission line over substantial territory. Taking all these factors into account, as well as the industry standards addressed below, we applied a 20% contingency for Chandler's estimated construction costs.

Q. Please explain why Chandler's contingency costs are consistent with industry standards.

A. The contingency factor Chandler applied to the estimate is consistent with industry guidelines. Both the American Association of Cost Estimators ("AACE") and the Electric Power Research Institute ("EPRI") provide recommended ranges of contingency costs when establishing a control budget, as Chandler has done here. AACE recommends 20% contingency and EPRI recommends a range of 15% to 30%.[1]

In the Construction Management Standards of Practices, included as Petitioner's Attachment JCK-1R, the Construction Management Association of America ("CMAA") suggests a contingency of 15 to 25 percent at the budget estimate stage.

[1] See Geoffrey Rothwell, Stanford Institute for Economic Policy Research, *Cost Contingency as the Standard Deviation of the Cost Estimate for Cost Engineering*, SIEPR Discussion Paper No. 04-05 (Feb. 9, 2004), available at: https://siepr.stanford.edu/sites/default/files/publications/04-05_0.pdf

The U.S. Army Corps of Engineers provides its approach to contingency cost estimates in Regulation No. 1110-2-1302, "Civil Works Cost Engineering," included as Petitioner's Attachment JCK-2R. The Army Corps of Engineers bases its contingency costs on various class stages. The basis of an estimate can range from no technical information (very high cost risk and contingencies for uncertainties, considered Class 5) to complete plans and specifications (very low-cost risk and lower contingencies for uncertainties, Class 1). Chandler's Project falls within the Class 4 and Class 3 stages. There remains substantial lack of technical information and scope clarity for the Project resulting in major estimate assumptions in technical information and quantities, heavy reliance on cost engineering judgment, cost book, parametric, historical, and little specific crew-based costs. For these class stages the U.S. Army Corps of Engineers recommends a contingency range of 20 percent on the low end to 100% on the high end.

Chandler used these various industry guidelines from AACE, EPRI, CMAA, and the U.S. Army Corps of Engineers to help determine the appropriate level of contingency costs. Chandler's estimated allowance for 20% contingency costs falls well within the recommended guidelines.

Q. Do you agree with the OUCC's adjustment to engineering costs? If not, why?

A. No, I do not agree with the OUCC's adjustment to engineering costs. Chandler needs to include engineering costs for construction oversight and administration to ensure the Project is installed in accordance with Chandler's intent and in general conformance to the plans and specifications prepared by Chandler or its outside consultant. Chandler based its engineering cost estimates on historical data collected by BLN. In the case of the Bell Road relocation portion of the Project, these costs are based in many situations on the actual cost of service under Chandler's current engagement with BLN. While Mr. Parks may view this cost as high, it does not change the fact that this is the market price Chandler is paying for the services. Mr. Parks also errors by using an average of $125 per hour billable charge, which is far below market pricing. It appears that Mr. Parks wrongly used the rates of an office intern at $60 per hour and a project engineer at $155 per hour. In reality, however, the average billing rates will include other ranges such as $215 per hour for project managers and $280 per hour for department managers. By arbitrarily reducing engineering costs and failing to use market rates for many portions of the Project, Mr. Parks restricts Chandler's ability to properly acquire, construct, install, and equip the Project.

Mr. Parks also seems to ignore the soft costs and unique challenges posed by the transmission line aspect of the Project. The transmission line portion of the Project involves corridor work like a transportation corridor project. During the early phases of planning (alternatives analysis or preliminary engineering), a transit project is only conceptually defined, as are the soft costs. At these early stages, transportation planners usually identify a single corridor for construction but develop a range of options for more specific details such as mode, alignment, station locations, and, as a result, construction costs. Therefore, soft costs are usually treated as percentage add-ons to estimates of hard construction costs. In a report titled *Estimating Soft Costs for Major Public Transportation Fixed Guideway Projects*, included as <u>Petitioner's Attachment JCK-</u>

3R, the Transit Cooperative Research Program ("TCRP") recommends that soft cost percentages be set at around 25 to 35 percent. The TCRP reviewed transportation projects similar to linear projects like Chandler's water transmission line. As noted by the TCRP, "the construction industry's current approach to estimating soft costs in early project phases corresponds fairly well to actual historical soft costs in past projects." (p. 18). Exhibit 8 in the TCRP's report found soft costs of 25%-35% in early stages such as Chandler's Project.

The largest engineering cost component on a percentage basis originates from construction observation and administration. Mr. Parks suggests that construction observation and administration should be capped at 5% of the construction cost. This percentage is not line with industry standards. To reiterate, transportation projects are similar in nature to a drinking water project from a construction standpoint. The federal government's approach to highways allows 12.5% or more of the construction cost to be used for construction-phase services when the project is funded with an 80/20% match.

Table 1 below provides a breakdown of projected engineering costs for the (1) transmission line, (2) Bell Road relocation, and (3) downtown main replacement.

Table 1-R – Proposed Engineering Costs

Transmission Line			Vendor Type	Vendor
Geotech	$ 60,925.06	0%	Soil Scientist	TBD
Design, Permits, Meetings	$ 1,064,304.13	8%	Engineer	TBD
Construction	$ 2,147,299.54	16%	Engineer	TBD
Bid	$ 17,186.58	0%	Engineer	TBD
R/W	$ 492,326.17	4%	Engineer	TBD
Survey	$ 361,858.52	3%	Surveyor	TBD
	$ 4,143,900.00	30%		
Bell Road				
Geotech	$ 9,163.76	1%	Soil Scientist	TBD
Design, Permits, Meetings	$ 108,556.82	7%	Engineer	BLN
Construction	$ 198,042.85	13%	Engineer	BLN
Bid	$ 16,686.00	1%	Engineer	BLN
R/W	$ 131,050.57	8%	Engineer	BLN
Survey	$ -	0%	Surveyor	BLN
	$ 463,500.00	30%		
Downtown				
Geotech	$ 24,015.10	0%	Soil Scientist	TBD
Design, Permits, Meetings	$ 422,751.78	7%	Engineer	TBD
Construction	$ 763,716.61	13%	Engineer	TBD
Bid	$ 33,372.00	1%	Engineer	TBD
R/W	$ 262,111.71	4%	Engineer	TBD
Survey	$ 243,032.81	4%	Surveyor	TBD
	$ 1,749,000.01	30%		
Totals	$ 6,357,000.00	30%		

Q. Does the OUCC question other non-construction costs proposed by Chandler?

A. No. Mr. Parks recommends allowing Chandler's other proposed non-construction costs, including $1,500,000 in land acquisition costs and $226,00 in bond issuance costs. Mr. Parks also recommends an additional $13,317 for general project contingencies and rounding. Pub. Ex. 2 (Parks Direct Testimony), p. 14, lines 18-21.

Q. Does this conclude your rebuttal testimony in this cause?

A. Yes, at this time.

Petitioners’ Attachment No. JCK-1R

Petitioner's Attachment JCK-1R

2010 Edition

Construction Management

Standards of Practice

CMAA

Construction Management Standards of Practice

2010 Edition

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Preface

Construction Management Standards of Practice is intended to establish industry standards of service and to serve as a guide to the range of services that constitute professional Construction Management. By issuing this document, CMAA seeks to define Construction Management services without limiting the methods and procedures by which a professional CM may provide those services for a particular project or program.

The scope and types of services a CM actually provides to a specific project or program may vary from those described in this document. This document is intended to provide a menu of services: Not every project/program will require every service, and a particular project/program may require unique services not listed in this document. Whatever service is provided, this document prescribes an industry standard of practice, which the CM will meet or exceed. CMAA does not intend that this document be used by courts or others to create contractual or legally enforceable duties or requirements, as such duties and requirements are established by terms of the CM's contract and the laws of the jurisdiction in which the CM is practicing. The *Construction Management Standards of Practice* is related to the Standard Forms of Agreement and Contracts published by CMAA. The standard services may change to the extent the provisions of such agreements are modified or altered.

CMAA makes no warranty or representation, including as to accuracy and completeness, regarding the Standards of Practice. CMAA disclaims all liability for any harm to persons or property or other damages of any nature whatsoever directly or indirectly resulting from the use of, or reliance on, this document. Adherence to the Standards of Practice is not a requirement of CMAA membership or a condition of receipt of any CMAA offering, and CMAA has no authority, nor does it undertake, to monitor or enforce compliance with the Standards of Practice. In issuing and making this document available, CMAA is not undertaking to render professional or other services for or on behalf of any person or entity, nor is CMAA undertaking to perform any duty owed by any person or entity to someone else.

Development of this document involved participation by a broad spectrum of the Association's membership. Input was gratefully received from industry groups other than CMAA.

Construction Management Standards of Practice is an evolving document, open to scrutiny and critique by the industry. The publication of the 2009 edition of *Construction Management Standards of Practice* reflects that intention. CMAA's leadership is committed to updating and refining the manual to meet the changing needs of CMs and their clients in the years to come.

Code of Professional Ethics

Since 1982, the Construction Management Association of America (CMAA) has taken a leadership role in regard to critical issues impacting the CM industry, including setting ethical standards of practice for the Professional Construction Manager.

The CMAA Board of Directors has adopted the following *Code of Professional Ethics of the Construction Manager* and recommends that it be accepted and supported by the CM industry and the membership of the CMAA as a guide to the execution of the individual CM's professional duties.

Corporate and individual practitioner members of Construction Management Association of America make a commitment to conduct themselves and their practice in accordance with the Code of Professional Ethics of the Construction Manager.

Code of Professional Ethics of the Construction Manager

As a professional engaged in the business of providing Construction Management services, and as a member of the CM profession, I agree to conduct myself in my business in accordance with the following:

1. **Client Service.** I will serve my clients with honesty, integrity, competence, and objectivity, establishing a relationship of trust and confidence and furnishing my best skills and judgment consistent with the interests of my client.

2. **Representation of Qualifications.** I will only accept assignments for which I am qualified by my education, training, professional experience and technical competence, and I will assign staff to projects in accordance with their qualifications and commensurate with the services to be provided.

3. **Standards of Practice.** I will furnish my services in a manner consistent with the established and accepted standards of the profession and with the laws and regulations which govern its practice.

4. **Fair Competition.** I will build my professional reputation on the basis of my direct experience and service provided, and I will compete fairly and respectfully with my professional colleagues.

5. **Conflicts of Interest.** I will seek to avoid any and all conflicts of interest and will immediately acknowledge any influences and offer to withdraw from any assignment when any actual conflict exists which may impair my objectivity or integrity in the service of my clients.

6. **Fair Compensation.** I will negotiate fairly and openly with my clients in establishing a basis for compensation, and I will charge fees and expenses that are reasonable and commensurate with the services to be provided and the responsibilities and risks to be assumed.

7. **Release of Information.** I will release public statements that are truthful and objective, and I will keep information and records confidential when appropriate and protect the proprietary interests of my clients and professional colleagues.

8. **Public Welfare.** I will not participate in any racial, sexual or political discrimination related to any assignment I may undertake. I will avoid any conduct that would be considered unethical or will interfere or conflict with any laws, statutes or regulations, and I will uphold the safety, health and welfare of the public in the performance of my professional duties.

9. **Professional Development.** I will continue to develop my professional knowledge and competency as a practitioner, and I will contribute to the advancement of CM practice as a profession by fostering research and education and through the encouragement of subordinates and fellow practitioners.

10. **Integrity of the Profession.** I will avoid actions which promote my own self-interest at the expense of the profession, and I will uphold the standards of the Construction Management profession with honor and dignity.

Chapter 1: Introduction and Definitions

Introduction

Construction Management is the practice of professional management applied to the planning, design, and construction of projects from inception to completion for the purpose of controlling time, scope, cost, and quality.

As used in this document, Construction Management refers to the application of integrated systems and procedures by a team of professionals to achieve the owner's goals. These systems and procedures are intended to bring each team member's expertise to the project/program in an effective and meaningful manner. The desired result is to achieve a greater benefit from the team's combined expertise than could be realized from each individual's separate input.

Program and project organization molds the elements of the process to achieve the desired results. These elements are addressed in detail in this manual. It should be emphasized that if proper attitudes, goals, commitments, and philosophies are in place, along with an understanding of the expected standards of practice, the procedures required for successful, smoothly executed projects should follow.

The essence of good Construction Management is professionalism and teamwork. The CM, as a member of the team, should assume a position of leadership beginning with the establishment of a management plan. This should not be a position of dominance, but rather of service which integrates the individual elements of the project delivery process into a cohesive program.

This manual has been developed by addressing ten (10) distinct functions:

- Project Management
- Cost Management
- Time Management
- Quality Management
- Contract Administration
- Safety Management
- Program Management
- Sustainability
- Risk Management
- Building Information Modeling

These functions are not mutually exclusive, but are related and integral components of the Construction Management process. For ease of reference, each function is presented in the following phases:

- Pre-Design
- Design
- Procurement
- Construction
- Post Construction

These phases are consistent with the CMAA suggested scope of services and with established usage in the construction industry. The scope of services rendered by the CM encompasses a broad range of professional skills, management knowledge and experience. The fact that a CM is certified or licensed in any other profession does not necessarily establish them as a qualified CM. Individuals and firms practicing and rendering Construction Management services should be knowledgeable and experienced in the technical disciplines and management areas described in this manual. CMAA has developed an industry consensus concerning the qualifications and experience that identify a professional CM through its certification program.

Construction Management is a management approach that focuses on the delivery of professional services. There are several different forms and variations of the Construction Management practice. Each has its own definition, characteristics and menu of services. All variations can be placed in either the "agency" or "at risk" forms of Construction Management.

Under the CMAA A-1 Standard Agreement, the CM acts as the owner's principal agent. The agency CM does not perform design or construction work. The services provided may depend on the in-house resources of the owner and the services being provided by the designer and other consultants. All contracts for design, construction, equipment, etc., are directly with the owner. The use of fast-tracking, phased construction or multiple-prime contracts is common, but not required.

When the CM's role includes a construction performance function, it is known as "CM-at-Risk." In this approach, which can often occur under a guaranteed maximum price (GMP) contract form, the CM will assume additional obligations and will undertake construction responsibilities during the construction phase. At that time, the CM is typically placed in a legal position similar to that of a general contractor entering into a traditional construction agreement that provides for the completion of the construction work for an established price.

Regardless of the form of contract agreement, the CM is performing professional tasks throughout all the phases of program/project implementation. A contract agreement will establish the scope of services and will also define the relationship of the parties. The term agency infers, as is intended, a delegation of function to the CM by the owner. As a consequence, it is possible that certain tasks and responsibilities place the CM in a legal agent relationship with the owner.

Definitions

The terms contained in these definitions are intended to convey a specific meaning as utilized in these standards. All other technical terminology herein may be presumed to follow accepted industry usage. To the extent possible, the defined terms are consistent with their use in the Standard Forms of Agreement and Contract Documents issued by CMAA.

Addendum
A supplement to documents, issued prior to taking receipt of bids, for the purpose of clarifying, correcting, or otherwise changing bid documents previously issued.

Additional Services
Services provided in addition to those specifically designated as basic services in the agreement between the owner and CM. Also known as supplemental services.

Agency
A legal relationship by which one party is empowered and obligated to act on behalf of another party.

Agency Construction Management
A form of Construction Management performed in a defined relationship between the CM and owner. The agency form of Construction Management establishes a specific role of the CM acting as the owner's principal agent in connection with the project/program.

Agreement
A document setting forth the relationships and obligations between two parties, as the CM and owner or Contractor and owner. It may incorporate other documents by reference.

Apparent Low Bidder
The bidder who has submitted the lowest bid for a division of work described in bid documents, a proposal form, or proposed contract.

Approved Bidders List
The list of contractors that have been prequalified for the purpose of submitting responsible, competitive bids.

Approved Changes
Changes in the contract documents that have been subjected to an agreed upon change approval process and have been approved by the party empowered to approve such changes. See "Change Order."

As-Built Drawings
Drawings (plans) that show the work, as actually installed. Also known as record drawings.

At-Risk Construction Management
A delivery method that entails a commitment by the Construction Manager to deliver the project within a Guaranteed Maximum Price (GMP). The Construction Manager acts as consultant to the owner in the development and design phases, but as the equivalent of a general contractor during the construction phase. When a construction manager is bound to a GMP, the most fundamental character of the relationship is changed. In addition to acting in the owner's interest, the Construction Manager also protects him/herself.

Basic Services
Scope of service as defined in the original agreement between the owner and CM as basic services.

Beneficial Occupancy
The use of the constructed facility by the owner prior to final completion of the construction.

Bid
An offer to perform the work described in contract documents at a specified cost.

Biddability
The degree to which a set of bid documents could be reasonably expected to permit a bidder to establish a competitive price to perform the work as defined in the bid documents.

Biddability Review
A formal review of the contract documents, addendum, and reference documents to be accomplished with respect to the local construction marketplace and the bid packaging strategy so as to eliminate ambiguities, errors, omissions, and contradictions, for the purpose of minimizing bid prices in the procurement phase and disputes during construction.

Bid Documents
The documents issued to the contractor(s) by the owner which describe the proposed work and contract terms. Bid documents typically include drawings, specifications, contract forms, general and supplementary general conditions, proposal or bid forms, and other information.

Bid Bond
A pledge from a surety to pay the bond amount to the owner in the event the bidder defaults on its commitment to enter into a contract to perform the work described in the bid documents for the bid price.

Bond
A pledge from a surety guaranteeing the performance of the obligation defined in the bond, including the completion of work or payment of the bond amount to the obligee (owner or contractor) in the event of a default, or non-payment by a principal (contractor or subcontractor), as with bid, performance and labor and material bonds.

Bonus
Additional compensation paid or to be paid to the contractor by the owner as a reward for accomplishing predetermined objectives that are over and above the basic requirements of the contract between the owner and contractor.

Budget
The dollar amount allocated by the owner for a project/program.

Budget Estimate
An estimate of the cost of work based on preliminary information, with a qualified degree of accuracy.

Changed Conditions
Conditions or circumstances, physical or otherwise, which differ from the conditions or circumstances on which the contract documents were based.

Change Order
A written agreement or directive between contracted parties which represents an addition, deletion, or revision to the contract documents, identifies the change in price and time and describes the nature (scope) of the work involved. Also known as a contract modification.

Claim
A formal demand for compensation, filed by a contractor or the owner with the other party, in accordance with provisions of the contract documents.

Code of Accounts
The owner's written description of the cost elements of the project, used for the owner's accounting purposes.

Commissioning
Start up, calibration, and certification of a facility.

CM Fee
A form of contractual payment for services, where the CM is paid a fee for services performed.

Contingency
An amount of money reserved by the owner to pay for unforeseen changes in the work or increases in cost.

Constructability
The ease with which a project can be built, based upon the clarity, consistency, and completeness of the contract documents for bidding, administration, and interpretation to achieve overall project objectives.

Constructability Reviews
The process of evaluating the construction documents for clarity, consistency, completeness, and ease of construction to facilitate the achievement of overall project objectives.

Construction Budget
The sum established, normally during the pre-design or design phase, as available for construction of the project.

Construction Cost
See "Cost of Construction."

Construction Management
A professional management practice applied to construction projects from project inception to completion for the purpose of controlling time, cost, scope and quality.

Construction Management Plan
The written document prepared by the CM, which clearly identifies the roles, responsibilities and authority of the project team and the procedures to be followed during construction.

Construction Manager (CM)
An organization or individual with the expertise and resources to provide Construction Management services.

Construction Schedule
A graphic, tabular or narrative representation or depiction of the time of construction of the project, showing activities and duration of activities in sequential order.

Contract Administration
The function of implementing the terms and conditions of a contract, based upon established systems, policies, and procedures.

Contractor
The organization or individual who undertakes responsibility for the performance of the work, in accordance with plans, specifications and contract documents, providing and controlling the labor, material and equipment to accomplish the work.

Construction Contract Documents
The documents which provide the basis for the contract entered into between parties. They typically include the bid documents updated to reflect the agreement between the owner and the contractor(s).

Cost Control
The function of limiting the cost of the construction project to the established budget based upon owner-approved procedures and authority.

Cost Management
The act of managing all or partial costs of a planning, design, and construction process to remain within the budget.

Cost of Construction
All costs attributed to the construction of the project, including the cost of contracts with the Contractor(s), construction support items, general condition items, all purchased labor, material and fixed equipment.

Critical Path Method (CPM)
A scheduling technique used to plan and control a project. CPM combines all relevant information into a single plan defining the sequence and duration of operations, and depicting the interrelationship of the work elements required to complete the project. The critical path is defined as the longest sequence of activities in a network which establishes the minimum length of time for accomplishment of the end event of the project. Arrow Diagramming Method (ADM) and Precedence Diagramming Method (PDM) are both common forms of CPM scheduling.

Critical Date Schedule
See "Milestone Schedule."

Design-Build
A project delivery method which combines architectural and engineering design services with construction performance under one contract agreement.

Designer
The individual or organization that performs the design and prepares plans and specifications for the work to be performed. The designer can be an architect, an engineer, or an organization which combines design services with other professional services.

Design – Schematic
Traditionally the first stage of the designer's basic services. In the schematic stage, the designer ascertains the requirements of the project and prepares schematic design studies consisting of drawings and other documents illustrating the scale and relationships of the project.

Design – Preliminary
The transition from the schematic stage to the completion of design development. During this stage ancillary space is developed and dimensions are finalized. Outline specifications are developed into technical specifications; sections are delineated and elevations are defined. Also known as design development.

Design – Final
The stage of the design process when drawings and specifications are completed for construction bid purposes. It is preceded by the preliminary design stage, and followed by the procurement phase. The designation used by designers for the last part of the design process prior to procurement.

Direct Costs
The field costs directly attributed to the construction of a project, including labor, material, equipment, subcontracts and their associated costs.

Drawings
Graphic representations showing the relationships, geometry and dimensions of the elements of the work.

Estimated Cost to Complete
The current estimate of the remaining costs to be incurred on a project at a specific point in time.

Estimated Final Cost
The anticipated cost of a project or project element when it is complete. The sum of the cost to date and the estimated cost to complete.

Fast Track
The process of dividing the design of a project into sub-phases in such a manner as to permit construction to start before the entire design phase is complete. The overlapping of the construction phase with the design phase.

Field Order
An order issued at the site by the owner or CM to clarify and/or require the contractor(s) to perform work not included in the contract documents. A field order normally represents a minor

change not involving a change in contract price or time and may or may not be the basis of a change order.

Final Completion
The date on which all the terms of the construction contract have been satisfied.

Float
Contingency time that exists on a scheduled activity. It represents the amount of time that activity may be delayed without effecting the end date of the schedule. It is measured by comparing the early start and late start, or early finish and late finish dates, of an activity.

Force Account
Directed work accomplished by the contractor outside of the contract agreement usually paid for on a time and material basis.

General Conditions
A section of general clauses in the contract specifications that establish how the project is to be administered. Included are obligations such as providing temporary work, insurance, field offices, etc.

Guarantee
A legally enforceable assurance by the contractor and/or a third party of satisfactory performance of products or workmanship during a specific period of time stated and included in the contract.

Guaranteed Maximum Price
A contractual form of agreement wherein a maximum price for the work is established based upon an agreed to scope.

Lien
A claim, encumbrance, or charge against or an interest in property to secure payment of a debt or performance of an obligation.

Life Cycle Cost
All costs incident to the planning, design, construction, operation, maintenance and demolition of a facility, or system, for a given life expectancy, all in terms of present value.

Liquidated Damages
An amount of money usually set on a per day basis, which the contractor agrees to pay the owner for delay in completing the work in accordance with the contract documents.

Long Lead Item
Material or equipment having an extended delivery time. Such items may be considered for early procurement and purchase under separate contract to facilitate on time completion of the project.

Long Lead Time
The extended time interval between purchase and delivery of long lead items.

Low Bidder
The responsible bidder who has submitted the lowest bid, which is determined to be responsive to the request for bids for a division of work described in a bid document, proposal form or contract.

Lump Sum Fee
A fixed amount that includes the cost of overhead and profit paid, in addition to all other direct and indirect costs of performing work.

Master Schedule
An executive level summary schedule identifying the major components of a project, their sequence and durations. The schedule can be in the form of a network, milestone schedule, or bar chart.

Milestone Schedule
A schedule representing important events along the path to project completion. All milestones may not be equally significant. The most significant are termed "major milestones" and usually represent the completion of a group of activities.

Multiple Prime Contracts
Separate Contractors contracting directly with the owner for specific and designated elements of the work.

Non-Conforming Work
Work that does not meet the requirements of the contract documents.

Notice of Award
A formal document informing an individual or organization of successfully securing a contract.

Notice to Proceed
A formal document and/or point in the project's life cycle authorizing an individual or organization to commence work under its contract. The issuance of the notice to proceed typically marks the end of the Procurement Phase.

Owner Construction Management
A form of Construction Management that does not use an independent Construction Management organization as a team member. The owner performs all required Construction Management services with in-house staff.

Owner's Representative
The individual representing the owner on the project team.

Penalty
A punitive measure, usually associated with failure to fulfill a contractual obligation.

Performance Bond
A pledge from a surety guaranteeing the performance of the work or payment of the bond amount to the obligee (owner or contractor) in the event of a default in performance of contractual obligations.

Phased Construction
An incremental approach to construction or design and construction. Each overlapping or sequential phase or element has a defined work scope and is considered as a separate project.

Plans
See "Drawings."

Post Construction Phase
The period following substantial completion.

Pre-Design Phase
The period before schematic design commences during which the project is initiated and the program is developed; the planning and conceptual phase.

Prime Contract
A direct contract with an owner. It can be a single contract and/or include the work specified for several contracts depending upon division of work.

Prime Contractor
A contractor who has a contract with an owner.

Professional Services
Services provided by a professional or by an organization that has specific competence in a field of endeavor that requires professional (and technical) knowledge and capabilities and that meets recognized standards of performance.

Program Management
The practice of professional Construction Management applied to a capital improvement program of one or more projects from inception to completion. Comprehensive Construction Management services are used to integrate the different facets of the construction process—planning, design, procurement, construction and activation—for the purpose of providing standardized technical and management expertise on each project.

Progress Meeting
A meeting dedicated to the subject of progress during any phase of project delivery.

Progress Payment
Partial payment of the contract amount periodically paid by the owner, upon approval by the CM, verifying that portions of the work have been accomplished.

Project
The total effort required in all phases from conception through design and construction completion to accomplish the owner's objectives.

Project Budget
The sum or target figure established to cover all the owner's costs of the project. It includes the cost of construction and all other costs such as land, legal and consultant fees, interest, and other project-related costs.

Project Cost
The actual cost of the entire project.

Project Management
As applied to a construction project, the use of integrated systems and procedures by the project team to accomplish design and construction. Project management is an integral function of Construction Management.

Project Management Plan
A document prepared by the CM, and approved by the owner, which defines the owner's goals and expectations including scope, budget schedule, and quality and the strategies to be used to fulfill the requirements of the project.

Project Team Meeting
A meeting dedicated to all aspects of the project, involving the project team members [owner, designer, CM, contractor(s)].

Project Procedures Manual
A detailed definition of the project team responsibilities and authority, project systems, and procedures to be used for all phases of the project.

Project Team
Initially consists of the owner, designer, and CM. Thereafter, as prime contractors are engaged for construction they are added to the team.

Punch List
A list made near the completion of the construction work indicating items of work that remain unfinished, do not meet quality or quantity requirements as specified or are yet to be performed and which must be accomplished by the contractor prior to completing the terms of the contract.

Quality
The degree to which the project and its components meet the owner's expectations, objectives, standards, and intended purpose; determined by measuring conformity of the project to the plans, specifications, and applicable standards.

Quality Assurance (QA)
The application of planned and systematic methods to verify that quality control procedures are being effectively implemented.

Quality Control (QC)
The continuous review, certification, inspection, and testing of project components, including persons, systems, materials, documents, techniques, and workmanship to determine whether or not such components conform to the plans, specifications, applicable standards, and project requirements.

Quality Management
The process of planning, organization, implementation, monitoring and documenting of a system of

policies and procedures that coordinate and direct relevant project resources and activities in a manner that will achieve the desired quality.

Record Drawings
Drawings (plans), prepared after construction is complete, that represent the work accomplished under the contract.

Recovery Schedule
The schedule that depicts action(s) and special effort(s) required to recover lost time in the approved schedule. It can depict activities of any member of the project team.

Request for Change Proposal
A written document issued by the CM to the contractor that describes a proposed change to the contract documents for purposes of establishing cost and time impacts. May also be known as a bulletin or request for quote.

Schedule of Values
A list of basic contract segments, in both labor and material, where each line item consists of a description of a portion of work and a related cost and the sum of the line items equals the total contract price. Generally used to determine progress payments to the Contractor(s).

Scope
Identification of all requirements of a project or contract.

Scope Changes
Changes that expand or reduce the requirements of the project during design or construction.

Shop Drawings
Drawings typically prepared by the contractor, based upon the contract documents and provided in sufficient detail that indicate to the designer that the contractor intends to construct the referenced work in a manner that is consistent with the design intent and the contract documents.

Short Term Construction Activity Plan
The planning and scheduling of prime contractor(s) activities on site, for the short duration or "foreseeable future" usually developed on a week-by-week basis using milestones for planning intervals coordinated by the CM. Also known as a rolling schedule, "look ahead" schedule, or short interval schedule.

Special Conditions (of the Contract for Construction)
See "Supplementary General Conditions."

Special Consultants
The designation for various professionals, including engineers, architects, designers and other experts, who provide expertise in specialized fields.

Specifications
The detailed written descriptions of materials, equipment, systems, and required workmanship and other qualitative information pertaining to the work.

Start-Up
The period prior to occupancy when systems are activated and checked out, and the owner's operating and maintenance staff assumes the control and operation of the systems.

Subcontractor
A contractor who has a contract with a prime contractor to perform work.

Substantial Completion
The date, certified by the designer or CM or both, that the contractor has reached that stage of completion when the facility may be used for its intended purposes, even though all work is not completed.

Submittals
Transmittals of information as required by the contract documents.

Supplementary General Conditions
Additions and/or modifications to the general conditions, which are part of the bid documents and/or contract documents.

Testing
The application of specific procedures to determine if work has been completed in the prescribed manner and at the required levels of workmanship. See "Non-Conforming Work."

Trade Contractors
Construction contractors who specialize in providing and/or installing specific elements of the overall construction requirements of a complete project.

Trade-Off Study
The study to define the comparative values and risks of a substitution or exchange of a design component. The trade-off can identify both monetary and functional values. Also known as an alternatives analysis.

Value Analysis
See "Value Engineering."

Value Engineering
A specialized cost control technique, which utilizes a systematic and creative analysis of the functions of a project or operation to determine how best to achieve the necessary function, performance, and reliability at the minimum life cycle cost.

Warranty
Assurance by a party that it will assume stipulated responsibility for its own work.

Work
The construction, to include all labor, material and equipment, required by the contract documents.

Chapter 2: Project Management

Introduction

This section discusses the broad subject of project management, which is defined by CMAA as "The use of integrated systems and procedures by a team of professionals during project design and construction." The section focuses on the key components of a Project Management Plan and its development throughout the various project phases. In general terms it outlines key goals and elements of managing a project under the Construction Management format. The general approach addressed here is expanded upon in subsequent Standards of Practice sections on Cost, Time and Quality Management, Contract Administration, Risk Management, Sustainability and Safety.

Pre-Design Phase

Project Organization
During this phase of the project the owner must assemble and organize a project team composed of design and Construction Management professionals as well as other key professional, technical and administrative staff necessary to assure the success of the project. This project team must organize its activities to deliver a project that meets the owner's requirements.

The project team should include representatives of the owner, the Construction Manager (CM), the design professional, and any specialty professionals that may be required. In some delivery systems, the general contractor is part of the pre-design team. Basic project purposes, goals and parameters of performance – particularly cost, time, and quality – should be determined and documented by the owner and provided to the project team at the earliest opportunity.

The CM and the design professionals should be hired as early as possible. In situations where the CM is hired first, the CM should assist the owner in developing a list of qualified design firms. Additionally, the CM should assist the owner in developing and transmitting the requests for proposals, reviewing the proposals, conducting interviews, evaluating candidates and making recommendations for the award of the design contract. When the design professional is hired first, he may assist the owner in a similar manner in the selection of a CM.

The organization of the project should be guided by the following principles:

- The owner, design professional and CM must establish a relationship of mutual trust and respect. The design professional and CM, while clearly having different roles and responsibilities, should function as equals and be so treated by the owner in order to gain the full benefit of the team's collective effort.

- It is recommended that the procedures outlined in the CMAA document "How to Select a CM" be used in the CM selection process.
- Each team member must know and understand the other members' responsibilities, in addition to the overall project requirements, prior to signing individual contracts. The best way to accomplish this is by all parties performing a joint review of their respective contracts. The owner, CM, and design professional should then create a responsibility matrix which documents all tasks, action items and authority of all team members.

Project Management Plan

The CM should work with the owner and the design professional to define the project requirements in the Project Management Plan (PMP). This document, prepared by the CM, should outline the strategies for fulfilling the requirements of the project. The owner should review and approve the PMP before the project proceeds. This document may then be used to measure the performance of the project team and the overall success of the project. Therefore, it is critical that it be understood at the outset by all team members.

The PMP typically establishes the scope, budget, schedule, environmental conditions, and the basic systems to be utilized. It also defines the methods and procedures to be followed as well as the basis for claims avoidance on the project. Many conceptual design and estimating iterations may be required before a project meets the owner's time, cost and performance requirements. Once these requirements are established and approved by the owner, the team must be committed to completing the project within those requirements. The PMP and the commitment of all stakeholders to meet its requirements form the foundation for a successful project.

Typically, the scope of a project is documented by a combination of conceptual drawings, descriptive narratives, performance parameters, and the budget for the project. The type of information and amount of detail may vary considerably based upon the type of project. Documentation of overall cost and time is the CM's responsibility, with input from the other team members. The establishment of basic systems and procedures by the CM links the task elements of the Plan.

A typical PMP may include the following basic components. Some of the components may be developed in later phases of the project as part of the Construction Management Plan:

- Project description
- Scope of work
- Milestone schedule
- Master schedule
- Quality management approach
- Safety management plan
- Reference to project documents
- Project organization chart and staffing plan
- Explanation of roles, responsibilities and authority of team members
- Project budget/work breakdown structure
- Certification under the LEED® program (Leadership in Energy and Environmental Design)
- Logistics including temporary construction support requirements, i.e. laydown or marshalling area

- Environmental/archeological considerations
- Reference to project procedures manual
- Management information system
- Communications protocol
- Bid packaging and contracting strategy, and delivery system evaluation
- Site mobilization and utilization phase

Project Procedures Manual
The Project Procedures Manual should be developed as a team effort, assembled and edited by the CM. It should be written so that the responsibilities of the team, levels of authority, communication protocol and the systems, methods and procedures to be followed for project execution are clearly defined and understood.

The Manual should address:

- Cost controls and the systems required for monitoring and controlling project costs
- Quality control and quality assurance program established by the Team and how it is to be implemented
- The project schedule and how it is to be developed, implemented and maintained
- Document control and specific project systems, methods and procedures (i.e., bidding, payments, change orders, submittals, correspondence, reports, performance records, claim resolutions, etc.)
- Functional responsibilities and limits of authority
- Correspondence distribution matrix
- Safety program
- Check lists
- Listing of meetings (i.e. type, frequency)
- Sample forms to be used
- Detailed bidding and construction phase procedures
- Coordination among various prime contractors
- LEED requirements

Pre-Design Project Conference
The CM should plan, conduct and document a pre-design project conference which addresses the Project Management Plan with respect to the design phase. The conference purpose is to achieve commitment to the project goals and procedures from the owner, the design professional, and the CM.

Management Information System
The CM should establish a management information system that will inform the team about the overall project status and forecast compared to the Project Management Plan. This system should address team information needs, data sources and control elements for time and cost. The system should provide a sound basis for managing the project and identifying and evaluating problem areas and variances. Distribution, frequency of reports, and the policy for record retention should also be established.

A comprehensive account of the project can be achieved with record keeping systems such as:

- General correspondence files (in and out)
- Periodic reports (daily, weekly, monthly)
- Drawing schedules, submittals (shop drawings, payments, samples)
- Transmittals
- Change requests and authorizations
- Procurement
- Material control
- Meeting minutes
- Confirmation of oral instructions and field directives
- Controlled inspections
- Notice of non-conforming contract work
- Weather conditions
- Scheduling records
- Progress photographs

The financial status reports must enable both the owner and the CM to control the available funds in the project. The format of reports should accommodate a continuing input of data. This data should serve as a budgeting and cost control tool on a contract phase and total project basis.

Financial reporting should cover budgeted, authorized and committed funds, expenditures to date, cost to complete, invoices, payments and retention, change orders, projected total costs and projected cash flow.

The CM should coordinate with the owner's and the design professional's staff to determine the format and frequency of reports required by the team members. Information should include schedule and progress reporting, drawing schedules, budget versus cost of services, and change requests (approved and pending) for design services. The first reports should be issued during the pre-design phase and on an agreed frequency thereafter.

Design Phase

During the design phase the team must continually communicate and consult on all substantive issues. As the process proceeds from schematic through final design, the team must consider the issues critical to each particular phase, moving from general decisions in the early phase to detailed decisions as design progresses. There should be periodic constructability reviews by the CM. The owner and the CM should agree on the scope and number of constructability reviews required. The CM should also coordinate with any needed Value Engineering and alternative studies. The goal is to complete a set of documents defining a project which can be bid in the current local marketplace within the owner's budget and time requirements.

The design professional has total responsibility for design implementation and execution. The role of the CM during this phase should be to assist the team by carrying out the activities listed below. Although the designer is responsible for design decisions to meet the project requirements, the owner as well as CM and other stakeholders can also have decision making responsibility.

Design Document Review
The CM should review the design documents periodically, focusing on the need for clarity, constructability, consistency and coordination among the trades and contractors as appropriate.

Document Distribution
The CM should coordinate the distribution of information among all team members and the transmittal of all documents to regulatory agencies.

Contract Agreements
The CM should develop and/or review appropriate construction contract agreements for inclusion in the bid documents.

General and Supplementary General Conditions
The CM should develop or review general and special conditions consistent with project requirements.

Public Relations
The CM should assist the owner in public relations activities, particularly those with respect to the owner's organization and community relations. The CM should assist the owner in developing interest among bidders for the project(s) also.

Project Funding
The CM should assist the owner in preparation of documents necessary to secure funding for the overall project.

Meetings
The CM should conduct periodic project meetings to assess progress, verify adherence to the PMP, document performance, plan for completion, and take action to resolve current problems. At a minimum, these meetings should be held at the end of each design phase. A final team review should be conducted prior to release of each bid package. Recommended subjects for each project meeting include:

- Review of the project budget and a current estimate of what construction costs the drawings and specifications currently represent, making allowances and assumptions for detail not shown or known
- Review of the Master Schedule, Milestone Schedule and any additional detailed sub schedules for the project
- Discussion and resolution of any issues which have become evident through previous review of documents and/or team discussion and have not been addressed

Cost Control
During the design process the CM develops and maintains cost control procedures to monitor and control project expenditures, both current and projected, within the allocated budget.

Schedule Control
During the design process the CM develops, implements, and modifies the master schedule and the milestone schedule, periodically updating them to reflect actual performance to date. The CM also

establishes forecast dates for the completion of the project and advises the owner and designer relative to performance against that baseline.

LEED Compliance
Either the CM or the LEED Professional shall provide guidance and oversight during design to assure the established LEED goals are being addressed. The CM should have a LEED accredited professional on staff.

Ongoing Consulting Activities
The CM makes recommendations to team members regarding constructability, cost, phasing and sequencing of construction, construction duration, impact of alternative construction methods and separation of contract categories.

At the end of the design phase, designated representatives of each team member review all design documents and concur that they are complete, coordinated, adequately representative of the owner's needs, and suitable for construction.

Procurement Phase

The goal in this phase is to secure bidders for each bid package who are qualified, competitive, interested in the work, and capable of doing the work within the project time requirements.

Bidding and Contracting Process
The bidding and contracting process is a key element in the success of the project. The CM is responsible for performing or assisting the owner with the following procurement phase activities:

- Solicitation and pre-qualification of bidders and guidelines by which bidders will be evaluated
- Notices and advertisements
- Bidders' interest campaign
- Delivery of bid documents
- Information to bidders
- Issuance of addenda
- Bid opening and evaluation
- Monitoring compliance with and execution of construction contracts
- Arrangement for owner purchased equipment and materials
- Provision for permits, insurance and labor affidavits

Meetings
The following meetings may be part of the bid and award process:

- Pre-bid meetings
- Bid openings
- Pre-award conferences

Each of the above tasks and meetings are described in more detail in Chapter 6: Contract Administration.

Construction Phase

The goal in this phase is to expedite and improve the efficiency of the construction process through professional planning and execution of project activities, all focused upon fulfilling the owner's scope, cost, quality, and time requirements.

Prior to construction, the CM should develop a project specific Construction Management Plan that clearly identifies the roles, responsibilities and authority of the project team and the procedures to be followed during construction.

Below is an outline of key construction phase activities. A detailed identification of separate elements is presented in Chapter 6: Contract Administration.

On-Site Facilities
The CM should verify that office facilities and site work required for general access and utilities to all on-site organizations are provided. The cost of the work may be paid directly by the owner or by the CM as a reimbursable cost. Alternatively, some or all of the work may be included in individual construction contracts.

Coordination
The CM provides coordination and leadership of the individual professionals and contractor(s) in meeting the project requirements. To help accomplish this, all communications with professionals and contractor(s) are either through the CM or with his prior knowledge. There is no circumventing of formally established lines of communication by the owner, design professional or individual contractor(s).

Meetings
There are three (3) basic categories of meetings involved in the construction phases: pre-construction, progress, and special meetings.

The purpose of pre-construction meetings is to orient all on-site contractors to project procedures and site utilization requirements and to review near term and long term activity plans. The CM will discuss a comprehensive list of contract communication, administrative and coordination requirements including the lines of communication, shop drawing procedures, and general written communication protocol.

Progress meetings are designed to monitor compliance with schedules and the requirements of the contract documents to coordinate the contractor(s) efforts and to allow short- and mid-term planning and problem solving. The CM organizes, conducts, and records regularly scheduled progress meetings involving the CM, contractor's principal personnel, the design professional, and the owner, as required. Meetings may be conducted weekly, bi-weekly or at least once a month.

Special meetings are called, as necessary, to resolve issues of an immediate or short term planning nature that cannot wait until the regularly scheduled progress meetings, or to discuss issues requiring detailed discussions not suitable for the progress meeting. Although the CM has primary responsibility for determining the need for these meetings, the owner, design professional or contractor may call a special meeting through the CM.

Time Management
The CM establishes procedures for planning and monitoring compliance with the project time line, which relates to the master and detailed construction schedules. This procedure involves the owner and design professional at appropriate time intervals.

It is important that this process also involve the on-site contractors in the development and updating of project schedules. The CM should generate cooperation and obtain commitment from each contractor to complete the project within the owner's time requirements and as required by the contract documents.

The CM should also look for opportunities to recover schedule slippages as appropriate. The time management process also forms the basis for evaluating and resolving time related contract claims.

Budget and Cost Monitoring
For the benefit of the owner, the CM maintains responsibility for tracking, projecting, and monitoring costs through the construction phase. As contracts are awarded, the individual line item estimates are replaced with actual committed amounts, plus cost estimates for any unknowns or contingencies. The goal is to manage the incurred costs, estimated costs and costs to complete in order to stay within the budget.

Payment Requests
The CM should implement procedures for processing contractor's payments in conformance with contract requirements. Monthly meetings should be scheduled to review and discuss the pay request.

Change Orders
The specific, documented procedures for initiating and approving contractor change orders are implemented by the project team. The CM should take the lead in administering this procedure.

Claims Management
The CM establishes methods and procedures to minimize the impact of claims through prompt and equitable resolution with minimal disruption to the ongoing construction effort. Procedures should address receiving and disposition of claims submitted, merit evaluation, entitlement evaluation, negotiation and settlement procedures, handling of disputes, and appeal procedures. All claims and potential claims should be discussed weekly at the progress meetings.

Quality Management
The CM monitors contractor compliance with the quality level expected for the project.
The CM develops procedures for monitoring the quality of work being performed. The CM's responsibilities for quality control or quality assurance should be clearly spelled out in the CM's contract.

In most cases the construction contractor is responsible for the quality control function and compliance with the quality required by the contract documents.

The CM arranges for and coordinates field testing which is not a part of individual contractor's work scope.

Acceptance and Performance Testing
If so required by the contract, the CM will monitor the acceptance and performance testing to see that it is conducted in accordance with contract requirements. The contractor will need to provide opportunity for observation of these tests by the CM as well as filing all appropriate test reports.

Final Inspection and Punch Lists
After receiving written requests from the contractor, the inspection staff will consider whether the contract work is substantially complete and will conduct a final inspection with the contractor, project staff and owner's representatives. During the final inspection, the CM develops the project punch list of remaining contract work. If the remaining items are not critical to occupancy or use, the contract will be declared substantially complete. The CM must monitor the completion of the remaining punch list items which should be completed by the time frame specified in the bid documents. Upon completion of the punch list, the CM will issue a final inspection report.

Owner Occupancy (Partial Acceptance/Beneficial Occupancy)
Upon declaring the contract substantially complete, the CM will assist the owner in taking beneficial occupancy of the project. This may include filing of the appropriate reports and approvals before governing boards or other owner representatives. In certain circumstances, partial acceptance can be taken for project elements that are substantially complete.

Owner Purchased Materials and Equipment
Prior to construction, the CM should identify long lead materials and equipment for pre-purchasing, and other materials and equipment, which could be direct purchased to the owner's advantage. During construction, the CM coordinates scheduling, on-site delivery and storage, and installation and start-up requirements for these materials and equipment.

Record Drawings
Record drawings should be provided by the contractor(s) doing the work and, minimally, be in the form of a dedicated set of contract drawings and specifications marked up as the work is installed. The CM should monitor the record drawing process monthly during construction in conjunction with review of contractor application for payment, and should receive these drawings at the completion of construction for transmittal to the owner, together with a set of specifications.

Record Keeping
A smooth, efficient and expeditious flow of paperwork is critical to project operations. The CM should establish systems for flow of all project related paperwork.

Management Reporting
The CM has a responsibility for establishing a management reporting system to keep the various team members informed on project status.

The CM should determine the type, format, frequency and distribution of information and reports required in accordance with the Construction Management Plan and the Project Procedures Manual.

LEED Management
The CM shall establish a tracking system to monitor compliance with the established LEED goals for the project. Closely associated with acceptance and performance testing is commissioning for the purposes of LEED certification. The CM should be familiar with these requirements and is referred

to in the United States Green Building Council publications for reference. The CM, in coordination with the project designer, oversees the commissioning process when an independent commissioning agent is retained. Otherwise, the CM will be responsible for the commissioning process. While commissioning is underway, the CM must complete and submit all LEED documentation for certification of points obtainable during the construction process and in accordance with contract documents. It is strongly recommended that, for a LEED project, the CM have a LEED Accredited Professional on staff as an integral part of the project management team.

Post-Construction Phase

Expeditious and effective project close-out is a critical element of a successful project. The CM's responsibility in this phase typically consists of the following:

- Obtaining LEED certification
- Completion of punch list items not required for substantial completion
- Facilitating owner occupancy
- Assembling record drawings for as-built documentation
- Warranty, guaranty, and operation and maintenance manuals
- Pursuing resolution of warranty items
- Documentation of final pay quantities and costs
- Preparing contract files for transfer to owner
- Final payment and contract acceptance

Assembling Record Drawings for As-Built Documentation
As indicated in the previous section, record drawings are maintained by the contractor and should be inspected monthly during the construction process to ensure the timely submittal of complete documentation to the owner at project completion. These record drawings are then submitted to the owner or design team for generation of the as-built documentation. The CM must ensure that accurate and timely as-built drawings and specifications are provided to the owner as soon after completion of construction as possible.

Warranty, Guaranty, and Operation and Maintenance Manuals
Prior to project close-out, the CM must gather all warranty, guaranty and O&M manuals, ensure that all comply with contract requirements and submit these to the owner. If specialized training is required, the CM oversees training by the contractor, which usually must occur before formal acceptance of the project.

Warranty Administration
If requested by the owner, the CM should manage the resolution of all issues identified as warranty issues, including evaluating whether the issue is in fact a warranty issue, notification of the prime contractor and appropriate sales and suppliers, and verification that warranty work is satisfactorily completed.

Documentation of Final Pay Quantities and Costs
The CM must compile documentation to support final quantities and final payment of unit price items and change order work. Documentation must be sufficient for audit purposes.

Preparing Contract Files for Transfer to Owner
The CM must prepare the contract files in accordance with the owner's requirements to facilitate their transfer to the owner for archiving.

Final Payment and Contract Acceptance
The CM should support the owner to accept the contract as complete and process the final payment.

Final Payment and Closing the Contract
The CM assembles all documents relating to final payment, including retention, unresolved change orders and unpaid invoices, for approval by the owner. Once approval is received for the final payment, which resolves all outstanding financial obligations with the contractor, the payment is processed and the contract closed. If there are any claims or adjustments requested by the contractor, the contract cannot be closed until these are completely resolved.

For further information:
CMAA's Cost Management Guidelines; CMAA's Time Management Guidelines; CMAA's Contract Administration Guidelines

Chapter 3: Cost Management

Introduction

This section presents guidelines for the CM to assist the team members in managing, controlling, and monitoring project costs during all phases of a project through an integrated and comprehensive cost management system.

Effective cost management involves the establishment of a realistic project budget, within the owner's cost limitations, and the application of cost management skills and techniques to ensure the project is planned, designed, procured, and constructed in the most economical way, respecting the original project requirements and supporting the project's life cycle cost plan.

The cost management system should be aligned with the project work breakdown structure and compatible, where practical, with the owner's code of accounts. It should reflect the owner's and CM's need to obtain cost data in a usable format and timely manner.

Preliminary Cost Investigation
A cost management plan, including all cost components, is assembled by the CM for review and approval by the owner and the design professional. Each party approves the cost plan, which then becomes the basis and framework within which the costs of the project are controlled through the entire design and construction process.

Pre-Design Phase

Prior to developing any construction cost data, the CM becomes familiar with the site of the proposed project and thoroughly investigates factors likely to affect construction operations and project costs.

In addition, the CM assesses the construction economy and investigates the potential project risks. The CM conducts a local market survey to determine current costs, availability of labor, materials, and equipment, current and future bidding climates, local code requirements, and other related factors. An initial analysis of risk issues that may potentially threaten the project along with opportunities that may exist should also be conducted by the CM.

An important tool for the CM is a construction cost database for similar projects which serves to provide the basis for parametric cost modeling. This should be compiled by or obtained from a reputable source. A database of historical cost information coupled with site specific knowledge and an understanding of local construction economics enables the CM to begin to forecast construction costs of the project.

Project and Construction Budget(s)
Based on the owner's project goals in terms of performance, quality, and time constraints, the CM develops an estimate of the cost of construction. If possible the CM should also compile an estimate of total project cost, specifying the basis of each estimate. This information is incorporated into the Project Management Plan.

Since the level of definition at the budget estimate stage is typically general, a design contingency as high as 15 to 25 percent should be considered (depending on data available) and added to the total of the estimated construction costs. The CM makes the owner aware that the ultimate cost of the proposed project depends upon the quantity and quality of systems yet to be defined and the current estimated construction cost is based on data available at this stage of the project.

The estimates of construction and project costs are developed into project and construction budgets in formats based upon work breakdown structures that are consistent with project components and acceptable to the project team.

The CM reviews the budget for comprehensiveness, compatibility with any established cost limitations, and attainability; the CM reviews the findings with the owner and the design professional in order to make necessary design, program, schedule, and/or budget adjustments to conform to owner requirements.

It is of critical importance that a basis-of-estimate document be prepared to accompany the budget. Any assumptions, clarifications, and exclusions made in the preparation of the project and construction budgets should be clearly identified. This is also a good point to start documenting risks and opportunities inherent in the project.

Cost Analysis
At the pre-design phase of a project, the owner may request the design professional to develop conceptual design alternatives based on different site locations and/or project schemes. The CM prepares cost estimates for these alternatives for review by the owner and the design professional. Preferably any alternatives that will be included in bidding documents should be structured as add alternatives as opposed to deduct alternatives; this typically enables better procurement value for the project.

When different sites are being considered, it is important to recognize fully the cost differentials for utilities, soil conditions, topography, access, location, market conditions, labor, etc. The owner at this stage may also request other studies, including life cycle cost studies, energy studies, and preliminary cash flows. All such studies should be presented in reports issued by the CM and reviewed with the owner and the design professional.

Design Phase

The approach to managing costs during the design process should be proactive not reactive. The active participation and coordination of the CM with the design team in providing timely cost advice can significantly reduce the need for redesign because of cost overruns.

Estimates
Following the approval of the construction budget, the CM provides ongoing cost management services to ensure that the budget is adhered to as the design is developed by the design professional.

A uniform cost estimating framework is established and maintained from inception through the pre-design, design, bid and award, and construction phases of the project. The application of a uniform framework facilitates consistent cost reporting and the ready identification of cost changes as the design develops.

Generally, estimates should be prepared by the CM to the level of detail available on the drawings and specifications, supplemented by notes and verbal data provided by the owner and/or the design professional. All verbal data should be confirmed in writing and noted in the estimate.

At the conceptual, schematic, and design development stages, cost data on a parameter basis by element and project type is usually appropriate. Since these data are usually historical, they should be adjusted or normalized for time, location, scale, and other factors influencing costs.

At preliminary design and final design document phases, a deterministic estimate with cost data at a unit price level is many times more appropriate. This involves quantity takeoff and unit pricing of the individual components of the trade or element (i.e., concrete, reinforcing steel, forms, etc.). These data should be reviewed, verified and adjusted as necessary before use.

Unit prices are often presented as composite rates inclusive of labor, materials, and equipment. However, many projects also require quantities to be presented with labor, material and equipment pricing separated. CM's utilize modern spreadsheet programs and estimating databases to facilitate the organization, sorting, and presentation of cost estimates.

When developing estimates of construction cost during the design phase, the CM refers to all available documents including the design specifications. Specifications need to be carefully studied since they can provide critical supplemental information which may not be depicted on the drawings and may have significant cost implications.

Unit costs should reflect current market pricing, with escalation addressed as a separate and distinct line item. Estimates of escalation in construction costs should be computed based on a monthly rate from the date of the estimate to the midpoint of construction. As the project moves into construction document phase, the escalation may be refined by escalating major components of the project in accordance with the procurement schedule. There are a variety of industry sources that provide cost escalation rates and forecasting data. It is important that escalation data be carefully reviewed especially on large or long term projects.

Cost Verification Stages
To verify that the project remains within the construction and project budgets, it is recommended that (as a minimum) estimates be prepared by the CM at the following stages of the design process:

- Completion of schematic design
- Completion of preliminary design

- In-progress final design (may vary from 60% to 90% complete)
- Completion of bid documents (including any issued addenda)

Each project must be evaluated based on its unique conditions and the above-named characteristics. Design contingencies should be set for each of the cost verification stages.

The design contingency level reflects the levels of accuracy it is reasonable to expect from estimates at various stages of the project's development. The project team determines the percentage allowable for design and construction contingencies on an individual project basis.

Schematic Design Estimate
The CM prepares a schematic design cost estimate based on measurement of parameter quantities from the design professional's schematic design stage submittal. It may also be possible to measure approximate quantities for certain elements of the project.

Preliminary Design Estimate
The CM prepares a preliminary design cost estimate based on measurement of approximate or parameter quantities from the design professional's preliminary design submittal. As the mechanical/electrical designs typically lag behind the architectural/structural designs, preliminary design estimates often contain approximate quantities for the architectural/structural/civil works and parameter quantities for the mechanical/electrical components.

In-Progress and Final Design Document Estimates
Cost estimates prepared from working drawings and specifications are based on quantity estimates for all major components. Any alternatives to be called for in the bid documents should be quantified and estimated.

Value Analysis/Value Engineering Studies
Value analysis or value engineering studies are used for the purpose of optimizing value in project designs.

During the design, the CM provides value analysis studies taking into account capital, operating, and maintenance costs to verify that the most cost effective design solution has been achieved. If the studies are conducted before the design data are developed, the reports could be too conceptual to be of value. However, if the studies are delayed, redesign may be necessary to reflect the recommendations of the study. Therefore, these studies are best completed during the initial preliminary design stage. If necessary, the CM should bring in independent expertise such as Certified Value Specialist (CVS) for these analyses.

Cost Monitoring and Reporting
The CM provides ongoing cost monitoring as may be necessary to assist the design professional in maintaining compliance with the construction budget.

In addition to cost reporting provided by the submission of estimates, the CM provides other cost reporting as may be required by the owner. It is recommended that all cost monitoring performed by the CM between the various estimate submittal stages be recorded and forwarded to the owner as part of the cost management system outlined in the Project Procedures Manual

The CM constantly monitors the design to identify changes in scope, evaluate the time and cost impacts of those changes, and report the impacts to the Project Team.

The number of estimates to be submitted and the extent of ongoing cost management services, value analysis, trade-off studies, and other similar activities should be determined with the owner at the time the Construction Management services are negotiated.

Procurement Phase

Estimates for Addenda
The CM should price in detail all proposed addenda. The quantification and pricing methodology should be the same as that used in the final estimate of construction cost submitted to the owner for approval at the end of the design phase.

Bid Analysis and Negotiation
The CM should tabulate all bids received and prepare a bid analysis, including the evaluation of all alternate bids and unit prices, compared with the final estimate of construction cost based on the bid documents. The bid tabulation method should be consistent with previously prepared cost estimates.

The CM's cost management role during this stage is to tabulate bids and establish that they are fully responsive to the requirements of the construction documents and meet the expectations of the construction budget.

Construction Phase

The CM should monitor cost management procedures through the completion of construction.

Schedule of Values
A schedule of values should be created shortly after contract award and must be reviewed and mutually agreed upon by the parties to avoid under- or over-payments during the project. The apportionment of indirect costs to the pay items must be carefully accomplished to ensure equitable reimbursement and to avoid inequities such as "front end loading."

The schedule of values should be detailed enough to allow accurate evaluation and calculation of amount to be billed. Once established, the schedule of values will reduce the occurrence of payment application disputes. There are two major methods used in reviewing progress payments:

- When the percentage of completion of scheduled activities method is used in determining the contractor progress payments, the CM should, in conjunction with the contractor(s), determine a schedule of values for each of the scheduled activities.
- When the percentage of completion by division of work is used in determining the contractor progress payments, the CM should, in conjunction with the contractor(s), determine a schedule of value for each bid package. This information should be used as the basis for all future progress payments to the contractor.

Change Order Control
As part of the overall financial control during the construction process, the CM establishes and implements a change order control system.

Once it is agreed that there has been a revision to the contracted scope of work there should be an adjustment to the contract price or time, or both. Determining a fair and equitable adjustment amount is a matter of obtaining and reviewing the supporting data as proof of costs. Organization of the data and a thorough understanding of the scope of the change order are integral in the review process.

The CM prepares an estimate of the cost of the change order listing the anticipated labor, material, equipment, subcontract work, contractor's overhead and profit, as well as any justified impact costs. Special attention should be given to reductions in the scope of work because these can easily be overlooked. The effect of the change on the schedule should be analyzed for time impact. This work should be completed in advance of receiving the change order pricing from the contractor so that an evaluation of the price can be made without delay.

Two types of pricing of change orders may be involved:

- **Forward pricing** - the pricing is done prior to the start of or during the work. The estimate of costs should itemize production rates, crew compositions, hours and equipment. Material costs should be listed and substantiated with quotes and price lists.
- **Post pricing** - the pricing is done at some point during or after the work is completed and represents actual costs based on records of man-hours consumed and material and equipment used. Comprehensive cost records are imperative. On force account work, the Work should be documented and verified daily by both the CM and the contractor.

In forward pricing the CM should also consider these special factors when evaluating production rates:

- Status and condition of the work
- Relative size and capability of the contractor(s)
- Size and complexity of the change
- Climatic conditions
- Mechanization that is possible
- Labor agreements
- Trade practices
- Learning curve
- Additional supervision required by the change

When evaluating material and equipment costs, the CM should also consider these special factors:

- Salvage of job material
- Odd lot sizes that add to cost
- Special delivery cost
- Potential higher price for proprietary items
- Escalation of costs since the original job was bid
- Storage costs that may be necessary
- Premiums for payment and performance bonds
- The necessity for additional insurance coverage
- Additional inspection and testing costs that may have to be added to the contractor's pricing to arrive at a total cost of the change

- Special equipment that may be required to perform the work

While impact costs, if any, may be difficult to quantify, the following issues should be addressed:
- Changes in sequence of work
- Changes in method and manner planned for doing the work
- Discontinuity of work
- Premium time incurred to overcome delays
- Congestion of work area
- Added mobilization and demobilization
- Effect on all contractors

Large impact costs, if any, can sometimes be determined by:
- Actual cost of identical work performed or what is sometimes referred to as a "measured mile" approach
- A reasonable estimate of the work cost if a change had not been encountered compared to the estimated cost of change order job conditions, or compared to the actual cost of work performed if post pricing was used
- Audit of the contractor's job cost records

Overhead and profit allowed on change order work should be established as fixed percentages by the original contract.

Trade-Off Studies
During the construction phase, the CM performs component studies on materials, systems, equipment, and accessories to ensure that economical and competitive components are selected consistent with the construction budget. Trade-off studies should be fully documented with the CM's recommendations and submitted to the owner and design professional.

Claims for Cost
The CM establishes a detailed audit record trail so that, in the event of subsequent audits, claims or investigation, a complete and comprehensive record of all project-related financial transactions is available in order of activity. (*See Chapter 4: Time Management | Construction Phase*)

Post Construction Phase

Final Cost Report
The CM summarizes total project costs in a final report, listing all change orders and identifying any unresolved issues which may have a cost impact. This report should be reviewed and provided to the owner.

Chapter 4: Time Management

Introduction

Construction Management involves the management of three basic project parameters: cost, time, and scope (including both the quantity and quality of the work). All Construction Managers (CM) recognize that these three parameters are closely linked and that a change in one can affect the others. In the parlance of the Construction Management profession, this linkage is sometimes known as "triple constraint" theory and is often represented by a triangle with pinned corners. Increase or decrease the length or magnitude of one side of the triangle and the lengths of the other sides are affected. So if the scope is increased, then the sides of the triangle representing cost and time may be increased, as well.

Theoretically, then, Construction Management involves managing these three parameters and maintaining the proper balance between competing objectives. Time management is an integral part of the CM's responsibilities on a project. This responsibility is met when the CM makes the most effective use of people, equipment, materials, and funds relative to time.

The CM achieves the most effective use of project resources through careful planning and expert execution. The primary time management tool used by CMs to meet these goals is the schedule. Consequently, the standards of Construction Management practice relative to time management are defined in this section in terms of the preparation, use, and analysis of schedules. How the CM achieves these goals depends on project type, size, and complexity, and the constraints of time, cost, and scope. In addition, the CM's responsibilities and, hence, the standard against which a CM's performance will be measured, must always consider the CM's role on the project, the applicable contract documents, and the other constraints under which the CM is working.

Generally, the CM's responsibilities related to time management can be summarized as follows:

- The CM ensures that the project team develops a project plan that considers time.
- The CM ensures that the project team develops a schedule to both plan and monitor time on the project.
- The CM guides the project team as to the appropriate form and content of the project schedule.
- The CM acts as the leader of the time management and scheduling effort.

This last responsibility itself has several basic pieces. Depending on the contractual relationships established among the parties on the project, the CM may be responsible for all or some portion of the following tasks:

- Developing the project schedule. This may include everything from collecting the necessary data related to work activities, durations, resources, and logic, to assembling these pieces into a coherent plan for time on the project.
- Updating the project schedule periodically to allow the project team to track, measure, and monitor its progress against its original plan.
- Revising the project schedule to reflect changes in the scope of the work or the plan for execution.
- Monitoring and analyzing the schedule to track project performance relative to time and alert other parties to deviations from the established plan.
- Should the project fall behind schedule, recommending mitigation actions to be taken by the project team to bring the project back within established goals or recommending revisions to project goals.
- Advising the project team regarding appropriate contract provisions relative to scheduling and time extensions.
- Reviewing, recommending acceptance of, and monitoring the schedules, schedule updates, and revised schedules prepared and submitted by other project participants.
- Preparing schedule analyses or reviewing, evaluating, negotiating, and making recommendations related to time extensions or acceleration based on analyses prepared and submitted by other project participants.

Notice that the words “accept,” “accepted,” and “acceptance” are used throughout this document. For consistency, these words are use in lieu of “approve,” “approved,” or “approval.” Regardless of the term used, acceptance typically means that the party providing acceptance takes on the responsibilities associated with that acceptance as defined in applicable contract documents. If the contract documents are silent, then acceptance will generally mean that the schedule as submitted is in compliance with the contract requirements and applicable industry standards. Acceptance, however, does not typically connote a guaranty that the work as scheduled can be competed as scheduled; except for work that is the responsibility of the party conferring acceptance. For example, the owner’s acceptance of the project schedule does not represent an endorsement of the contractor’s plan or confer on the owner an obligation to ensure that the contractor can complete the work as scheduled. That obligation remains the contractor’s. However, depending on the contract requirements, the owner’s acceptance of a schedule may place on the owner the obligation to complete its scope of work as scheduled.

Different aspects of the CM’s time management responsibilities are approached or handled in different ways depending on the stage of the project's development and execution. Consequently, the discussion that follows focuses on the standards of practice by project stage. The five project phases are pre-design, design, procurement, construction, and post construction.

Pre-Design Phase

The CM’s responsibilities related to time management during the pre-design phase can be summarized as follows:

Master Schedule

Typically, development of the master schedule begins with the CM and the owner agreeing on the overall goals of the project with respect to time. The CM will develop various alternative approaches for phasing, sequencing, management, and implementation of the design, procurement, construction, and post-construction phases, and discuss these alternatives with the owner. Then, based on the owner's decisions and direction regarding these alternatives, the CM will prepare the master schedule for the project and submit it to the owner for acceptance. This schedule communicates the overall time-related goals in a format that the owner can understand. The schedule format may range from bar graphs or charts for small projects to Critical Path Method (CPM) networks for larger or more complex projects. The accepted master schedule may become an integral part of the Project Management Plan *(See Chapter 2: Project Management | Pre-Design Phase.)*.

Typically, once the master schedule is accepted, it is the responsibility of the CM to monitor the progress of the activities on the master schedule and to recommend or take appropriate action when progress deviates from the established plan.

Milestone Schedule
A milestone schedule may be prepared by the CM after the owner accepts the master schedule. This milestone schedule highlights key events from the master schedule, with a particular emphasis on the design phase activities, and may include dates for design professional selection and the other significant steps in the completion of the design professional's scope of work. These dates might include the completion of cost/benefit studies; completion of 30%, 60%, and 90% drawings; completion of design and constructability reviews; the completion of bid packages; and other potential milestones. The milestone schedule may also include dates for the other phases such as the start and finish of the procurement phase or the start and finish of construction. The milestone schedule typically indicates the planned date, based on the owner's requirements, for each milestone activity is to be completed.

Contract Development
The CM may be asked to recommend for the owner's review and acceptance specific scheduling and time extension provisions and requirements for inclusion in the design professionals' contracts. This may include recommendations regarding the milestone schedule dates to be included in these contracts. The CM may also be called upon to make similar recommendations for other contracts, including the contractor's contract with the owner.

Float
The CM should recommend for the owner's review and acceptance specific provisions for the handling of float throughout the various stages of the project. The CM should typically recommend that float be a shared commodity available to all parties to the contract until it is consummated. Coordinating with the owner, the CM should recommend whether float should be determined relative to the scheduled completion dates or dates established in the contract. Related to this, the CM should coordinate with the owner and make recommendations as to how early-completion schedules submitted on the project should be addressed. Once accepted by the owner, the CM should make recommendations as to how best to implement the owner's decisions related to how float is to be determined, how early-completion schedules are to be administered, and float ownership. This may include making recommendations regarding appropriate contract language and explaining this language to proposers or bidders.

Design Phase

The CM's responsibilities related to time management during the design phase can be summarized as follows:

Maintaining the Master Schedule
During the design phase, activities on the master schedule are monitored by the CM. The master schedule is updated to reflect the detailed plan prepared for the design phase of the project. This detailed schedule is typically prepared by the design consultant or other entity responsible for preparing the project design. The master schedule is also updated to reflect the actual progress on master schedule activities on a regular basis, usually no more frequently than monthly, though more frequent updates may be appropriate on short-duration, large, or accelerated projects. As the scope of the project is developed during this phase, the CM makes recommendations for revisions to the master schedule. Such revisions may be the result of changes in the project scope, changes in regulatory or permitting requirements, site investigations, or design phase change orders executed by the owner. For example, revisions may be necessary when time extensions are granted to the design consultant. As provided by the project contract documents, master schedule revisions should be reviewed and accepted by all parties affected by the changes. In particular, all revisions to the master schedule should be submitted to the owner for review and acceptance.

Design Schedule
The design professional or other party responsible for preparation of the project design will typically work with the CM to prepare a realistic schedule for the planning and execution of the design phase requirements. This schedule should be compatible with the master schedule and the milestone schedule and the design professional's contract requirements. Once accepted by the owner, the CM incorporates this schedule information into the master schedule and the milestone schedule.

Monitoring the design phase
Typically, updates or revisions to the design phase schedule will be prepared by the design professional and submitted to the CM for review. The CM will use these updates and revisions to monitor the progress of the project and identify any deviations from the established project plan. Upon completion of its review, the CM will make appropriate recommendations to the owner for disposition of the schedule updates or revisions.

If the CM finds the submitted schedule acceptable, the CM will typically recommend acceptance by the owner. If the CM concludes that the schedule is deficient, typically the CM will work with the design professional to bring the submitted schedule into compliance with the applicable contract provisions and established industry standards. If the schedule submitted shows the project ahead or behind, the CM will make recommendations as to how to bring the schedule into compliance with the project master and milestone schedules or make recommendations regarding revisions to these schedules. This process may include the review of requests for time extensions or acceleration by the design professional. Once the owner accepts the proposed revisions, the CM will typically revise the master and milestone schedules as appropriate to reflect these revisions.

Pre-Bid Construction Schedule
The CM develops a pre-bid construction schedule and identifies major milestones for inclusion in the bidding documents before the contract documents are transmitted to the bidders. The pre-bid

schedule information is provided by the CM as a reasonable estimate of the proposed work sequence, contractual restraints and dependencies, and the contract or project duration based upon the completed design, the CM's past experience, the project status, and other information available at bid time. Appropriate information, requirements and constraints should be noted clearly in the bidding documents and should, once reviewed and accepted by the owner, become a part of the contract documents to be executed by each contractor.

Schedule Reports
The CM should prepare and distribute appropriate reports to the owner and other appropriate parties describing and depicting graphically actual progress on the project during the design phase relative to the project plan as depicted in the accepted master, milestone, and design phase schedules.

Procurement Phase

Contractor's Construction Schedule
The CM should participate with the owner and design professional to explain the project schedule requirements at the pre-bid conference. The CM should explain or clarify for the bidders the pre-bid construction schedule and the contractor's ultimate scheduling responsibilities. The objective is to obtain the contractor's participation in schedule development and maintenance, cooperation, accountability, and compatibility with the overall scheduling and reporting requirements of the contract documents.

It should be the CMs objective to have the successful bidder(s) become part of the project scheduling process. The CM provides a milestone schedule to the bidders and makes them aware of their scheduling responsibilities and obligation to participate in schedule development as required by the contract documents. The CM should explain the requirement for contractor(s) to prepare a construction schedule as provided in the contract documents, including applicable standards, requirements related to content and measurement of float, disposition of early-completion schedules, float ownership, granting of time extensions, and penalties or sanctions related to non-compliance with schedule requirements.

Addenda
The CM should review all addenda to determine the effect on scheduling and time of construction prior to issuance of the addenda. The CM should then recommend to the owner any appropriate revisions to the master schedule and pre-bid construction schedule and, after acceptance by the owner, make changes and distribute the revised schedules to the design professional and all bidders.

Schedule Reports
The CM should prepare and distribute appropriate reports to the owner and other appropriate parties describing and depicting graphically actual progress on the project relative to the project plan as depicted in the accepted master, milestone, and procurement phase schedules (if prepared).

Construction Phase

The CM's responsibilities related to time management during the construction phase can be summarized as follows:

The Initial or Preliminary Schedule

Typically, the CM is responsible to ensure that a schedule is in place for each phase of the project and for each stage of each phase. During the construction phase, development of a comprehensive, detailed project schedule may take several weeks at the beginning of the project. To ensure that some time management tool is in place during this period, the contractor is sometimes required to provide an initial or preliminary schedule for the purpose of establishing the contractor's plan to execute the first actions associated with the project and establish a tool by which the CM may monitor the progress of the project during the period when the baseline project schedule is being developed. The CM will typically be tasked with ensuring that the contractor fulfills its obligations under the contract as it relates to these schedules and recommending appropriate actions to the owner in the event the contractor fails to meet its obligations. It is important for the CM to fulfill its own obligations relative to enforcing the contract requirements regarding the provision of an initial or preliminary schedule as these schedules become the tool for planning the earliest stages of construction, monitoring the contractor's initial efforts, and addressing any deviations from the anticipated plan, including evaluation of delays and determining entitlement to time extensions.

The CM's responsibilities as they relate to the initial or preliminary schedule are similar to its responsibilities throughout the construction phase of the project:

- The CM is responsible to ensure that the construction contract requires the contractor to develop and submit an initial or preliminary schedule for acceptance prior to beginning construction. These requirements include identifying software or electronic submission requirements to ensure that the initial and preliminary schedule submissions are compatible with the master schedule software.
- The CM will then monitor the contractor's performance to ensure that the contractor makes a timely submission of the initial or preliminary schedule.
- If the contractor fails to submit the initial schedule as required by the contract, the CM will inform the owner and make recommendations as to how the contractor's failure should be addressed.
- Upon submission of the schedule, the CM will review the schedule to ensure compliance with the contract requirements and make recommendations to the owner regarding acceptance.
- If the schedule is not acceptable to the CM, the CM will make recommendations to the owner regarding how to address the contractor's submission.
- Once accepted, the CM will monitor the contractor's performance with regard to the initial schedule, notify the owner of any deviations, and make recommendations to the owner regarding how to address these deviations.
- If the baseline schedule has not been accepted within approximately two weeks of the expiration of the initial or preliminary schedule, the CM should make recommendations to the owner regarding how to address the impending deadline. These recommendations could involve the contractor's submittal of an extension to the initial or preliminary schedule. This submittal should go through an acceptance process similar to the original submission of the initial or preliminary schedule.

The Baseline Schedule

The CM plays a central role in the development, acceptance, implementation, and monitoring of the baseline schedule for the project. As with the initial or preliminary schedule, the CM typically assumes the responsibility to advise the owner as to how scheduling and time management on the project should be accomplished. This portion of the CM's responsibilities is typically accomplished in earlier phases, usually during design or procurement. During the construction portion of the project, the CM is then typically responsible to fulfill its obligations related to time management as established in earlier phases. With regard to the baseline schedule, these responsibilities typically include the following:

- Making appropriate recommendations regarding the contractor's time management and scheduling responsibilities in the contract.
- Monitoring the contractor's performance regarding the development of the baseline schedule, and making recommendations to the owner regarding actions to take when the contractor deviates from its scheduled performance.
- Reviewing the contractor's baseline schedule submissions to ensure compliance with the requirements of the contract and applicable industry standards, and making recommendations to the owner regarding the actions to take regarding the contractor's submission.
    - These actions might include acceptance, or a recommendation to reject the schedule, an accompanying description of schedule deficiencies, and, where appropriate, recommended corrections.
    - The CM must also ensure that the contractor adequately considers all the parties involved with the execution of the project so that the accepted baseline schedule becomes the plan for the project team, not just the contractor.
- The CM's responsibilities typically include monitoring of actual events in relation to the dates and durations on the accepted schedule. Under some contracts, these responsibilities might also include schedule updating. If, for example, the owner decides to act as its own general contractor, is self-performing a substantial amount of the work, or is fast-tracking the work with multiple contractors, or when construction is only a small piece of a much larger effort, the owner may be willing to trade the added responsibility (and risk exposure) that goes with owning the schedule for the greater control that comes with determining the sequence and pace of the project. Under these conditions, the CM could be tasked with developing, updating, and revising the project schedule as these responsibilities are delegated by the owner.

Schedule Updates

To allow effective time management, the project schedule must be used by the CM to plan and execute its work and to fulfill its obligations to monitor the performance of the other parties involved in the execution of the project. To remain valuable as a planning and monitoring tool, the schedule must be kept current. Typically, this means that the CM recommends to the owner and then helps the owner implement a process by which the project schedule is periodically updated.

For the purposes of this discussion, updating is limited to the incorporation of actual performance information related to the activities in the schedule; for example, the actual start and finish dates for schedule activities and minor revisions to schedule logic and durations. Minor revisions are defined for the purposes of this document as revisions that do not result in earlier or later scheduled completion dates for project milestones or do not appreciably affect the obligations of other parties to the project.

The CM's responsibilities related to schedule updates are similar to those for the baseline schedule. However, in addition, the CM will review the progress of the project against the accepted schedule to ensure that the contractor is accurately updating the schedule and also to advise the owner of deviations from the accepted plan depicted in the schedule update.

Schedule Revisions or Revised Schedules

Very few projects are completed exactly as planned. For this reason, there is often a need to make revisions to the accepted schedule in order to maintain a current and accurate time-management plan for the project team. These revisions reflect the decisions made by the project management team in response to project conditions. These decisions, when they are more than simple corrections of out-of-sequence logic or other small and insignificant adjustments, may necessitate more substantial revisions to the schedule. The process of incorporating these substantial changes is typically known as revising the schedule. When a revised schedule is necessary, the CM should treat the situation similarly to the submission of the baseline schedule given its potential to affect decisions made by the owner and other stakeholders involved with the project. The CMs' role in the process is crucial:

- If other parties do not recognize the need for revision first, it is the CM that must recognize the need for revisions to the project plan and provide the owner with recommendations as to how to address this need.
- Once the need to make revisions to the plan is recognized by the project team, the CM's responsibilities are similar to those related to the initial schedule, baseline schedule, and schedule updates.
    - The CM keeps the owner informed of progress on the development of the revised schedule and makes recommendations when this process falters.
    - The CM reviews any submissions made to ensure compliance with the contract and makes recommendations to the owner regarding acceptance or rejection of these submissions.
    - Upon acceptance, the CM then shifts its focus to the revised schedule for the purposes of monitoring the project team's performance.
- If the contractor is seeking a time extension, whether as a part of the schedule revision process or not, the CM's preference should be that time extensions be negotiated and agreed to before the associated delay actually occurs. This means that the CM must be alert to problems that might cause a delay before they occur. Most commonly, this will be possible when the owner is contemplating a change and the project team has time to consider the change before actually making a decision to proceed. Regardless of the timing of the delay, the CM's responsibilities are similar:
    - The CM ensures that the appropriate party is conducting the necessary analysis to determine the magnitude of the delay and the party responsible.
    - Once a submission is made, the CM reviews the submission to ensure that it correctly establishes the time extension due, if any.
    - Upon completion of its review, the CM makes recommendations to the owner regarding how to proceed: whether to accept the submission and execute an extension of time, acknowledge responsibility for the delay but consider acceleration to mitigate, or reject the submission with an appropriate basis.

Each of these types of schedules will be evaluated as discussed later in this section, and recommendations will be made regarding the rejection or acceptance of the submitted schedule. It is important that the CM maintain independence and objectivity. It is also important that the CM maintain its role as defined by the project's contracts and not assume the roles or responsibilities contracted to others. This ensures that the appropriate party fulfills it scheduling responsibilities and reduces the risk to the CM and the owner associated with usurping the planning and scheduling obligations of the contractors.

Maintaining the Master Schedule
During the construction phase, the CM also monitors activities on the master schedule. The master schedule is updated to reflect the detailed plan prepared for the construction phase of the project. The master schedule is also updated to reflect the actual progress on master schedule activities on a regular basis, usually no more frequently than monthly, though more frequent updates may be appropriate on short-duration, large, or accelerated projects. Based on the detailed construction phase schedules, the CM makes recommendations for revisions to the master schedule. As provided by the project contract documents, master schedule revisions should be reviewed and accepted by all parties affected by the changes. In particular, all revisions to the master schedule should be submitted to the owner for review and acceptance.

Schedule Reports
The CM should prepare and distribute appropriate reports to the owner and other appropriate parties describing and depicting graphically actual progress on the project relative to the project plan as depicted in the accepted master, milestone, and construction phase schedules.

Post-Construction Phase

Occupancy Plan
The CM may develop an occupancy plan that provides the owner with a smooth and orderly transition into the completed project and facilitates revenue income or beneficial use as quickly as possible. The occupancy plan should include participation of contractors, system start up, completion of punch lists, city/state/federal reviews and certification, and move in of the owner's staff or tenants. The CM should submit its occupancy plan to the owner for the owner's review and acceptance. Once accepted, the CM should incorporate the occupancy plan into the master and milestone schedules for the project. Thereafter, the CM should monitor the performance of work during the Post construction phase, update the occupancy plan as appropriate, provide recommendations with regard to any deviations from this plan, and provide appropriate reporting.

Chapter 5: Quality Management

Introduction

This section presents the key goals, philosophies and elements of providing services while enhancing quality in the planning/design/construction process, the Construction Management services and ultimately, in the constructed facilities.

Definitions

Project Procedures Manual (PPM)
A written, project-specific plan that outlines the project's scope, organization, and the specific approach to be undertaken to accomplish the various management tasks for the project. These quality management guidelines should be integrated into the various sections of the PPM to maintain a focus on project quality. On certain large projects, it may be appropriate for the CM to prepare a separate Quality Management Plan (QMP) which elaborates upon the quality guidance aspects of the PPM.

Quality
The degree to which the project and its components meet the owner's expectations, objectives, standards, and intended purpose, determined by measuring conformity of the project to the plans, specifications and applicable standards.

Quality Management (QM)
The process of planning, organizing, implementing, monitoring, and documenting a system of management practices that coordinate and direct relevant project resources and activities to achieve quality in an efficient, reliable, and consistent manner.

Quality Control
The continuous review, certification, inspection and testing of project components, including persons, systems, materials, documents, techniques and workmanship to determine whether or not such components conform to the plans, specifications, applicable standards, and project requirements.

Quality Assurance
The application of planned and systematic examinations or verifications which demonstrate that quality control procedures are being effectively implemented.

Regardless of the level of effort required by the CM's contract, quality management is an inherent element of the CM's basic service. Therefore, the CM should encourage the owner to develop and implement a comprehensive Quality Management Plan as one of the first project tasks undertaken, whether the CM begins providing services during the pre-design phase, after construction has begun, or at any time in between.

Pre-Design Phase

Goal
The goal during this phase of the work is to establish a program of quality management that will endure throughout the life of the project.

Clarifying Owner's Objectives
The CM should meet with the owner to clarify the expectations, goals and objectives of the quality management program. It is important that the owner understand the underlying concepts of a quality process, quality services, and a quality project. Costs and benefits should be explained.

Scope of Work
The CM may review to see that the scope of work for the design professional clearly outlines the various elements of the proposed services as accepted by the owner. The criteria by which the success of the completed project will be measured must be defined and clearly understood. This forms the basis for the Quality Management Plan. Consistent with CMAA guidelines, the CM should review the design professional's contract for conformity with expected quality standards and related project criteria including, but not limited to inspection/testing, sustainability, risk assessment and commissioning. Prior to starting any work activity, the design professional should identify all quality-related design criteria and assure that these criteria are acceptable to the owner.

Project Organization
The quality management organization should include key representatives of the design professional, CM and owner, preferably at the executive level, who will be responsible for the implementation of quality control and assurance initiatives.

Quality Management Plan (QMP)
The CM should develop a comprehensive Project Quality Management Plan, with direct input by the design professional and the owner.

The Quality Management Plan should identify the various steps in design development leading to approvals by the owner, users, government agencies, affected utility companies, and other agencies having jurisdiction over the project. The Plan should also provide for senior level design professional review of design criteria, calculations, drawings, and specifications.

The Quality Management Plan should be reviewed by all parties and modified as required and then agreed to in a formal sign-off procedure. A modification procedure should be developed for subsequent revisions to maintain a current and effective plan.

Design Phase

Goal
The goal of this phase is to assure the implementation of the QMP in order to achieve a set of

contract documents that support a successful procurement activity and ultimately the completion of the project in accordance with all of the project quality requirements.

Document Control

The CM takes action to see that a document control system is established during the design phase. This system provides for the orderly logging of design progress submissions for each individual contract, with a tabulation of approved plans to be advertised. The document control system is also applied to plans after bids are received, to conformed sets of plans illustrating all official addenda, and to change order plans during construction.

Review of Design Submittals

The CM should develop and implement a process so that all participating parties are given the opportunity to review design submittals as they are developed, and an opportunity to verify that quality objectives are being achieved.

Design Criteria Changes

Design criteria changes, when directed or required and mutually accepted, should be documented by the design professional in letter, email or memo form to the owner, with copies to the CM.

Quality Control

The design professional should proceed with design activities in conformance with the Quality Management Plan. This process involves methods to check concepts, calculations, and material selection procedures so that the level of quality expected by the owner or required by the contract is being achieved. Plans and specifications are to be reviewed for clarity, completeness, testing/documentation requirements and consistency.

Quality Assurance

A Quality Assurance Plan, as part of the Quality Management Plan, should be followed by the design professional, including the systematic reviews which demonstrate that quality control activities have, in fact, been undertaken in an acceptable manner. Reports of items requiring corrective action should be maintained in a separate log for follow-up review and action prior to completion of design. The CM provides oversight review of the design professional's QA efforts on behalf of the owner. Collaboration should be implemented with all project stakeholders to effectively and efficiently implement the Quality Assurance Plan.

Building Information Modeling (BIM)

The CM should assure that the owner has considered using Building Information Modeling for the project. This 3-D CAD process, to promote design coordination of various project elements, quantities, clash detection and craft activities, has a proven track record of significant efficiency, quality improvement, and reduction of rework for construction projects. When authorized and implemented, the CM shall assure that appropriate BIM information is implemented for the project.

Constructability Reviews

The CM develops a specific constructability review program for inclusion in the Quality Management Plan. The constructability reviews should include, at a minimum, a detailed review of the schedule, milestones, and constraints associated with the work, a field visit to confirm existing conditions have been considered in the design, and a detailed review of plans and specs to assure they are clear and coordinated. It is recommended that constructability reviews be conducted at the

30 percent, 60 percent, and 100 percent completion stages of contract documents. Constructability reviews should also consider availability of materials, availability and capabilities of local trades and other local market conditions. The review should also confirm that the documents are suitable for bidding purposes.

Sustainability
The CM should assure that the owner has considered sustainability goals and objectives for the project. The project's sustainability expectations and the CM team's sustainability qualifications must be set as early as possible to ensure alignment of expectations with roles and responsibilities among all the project stakeholders. When implemented and included in the Quality Management Plan, the CM shall assure that the owner has established clear criteria for the sustainability scope of work, phases of implementation, team responsibilities and expected outcomes and implications, be they fiscal or schedule or otherwise.

Value Engineering
The costs and benefits of a formal value engineering analysis should be discussed with the owner and if the owner agrees, provisions for a formal value engineering analysis should be included in the Quality Management Plan at various stages of the Work. A Certified Value Specialist (CVS) should be retained to lead these reviews.

Risk Management
The CM shall assure that the owner has been made aware of the benefits to develop a Risk Management Plan for the project. When included in the Quality Management Plan, the CM shall assure the Risk Management Plan is implemented, including measurement and reporting to the owner.

Establishment of Construction Duration
The construction duration should be established with activity durations based on documented experience, historical data or other recorded information, resulting in a pre-bid schedule being established in a CPM format.

Construction Testing Requirements
The design professional should detail specific tests expected to be performed by the contractor or supplier on the site and in fabrication plants. Any material or product certifications which are required and/or are acceptable in lieu of tests should be noted. The responsible party, testing requirements and the acceptance criteria should be clearly identified in the contract documents for all elements of construction.

Quality Management Specifications
The CM should develop quality management specifications in which the contractor's QA/QC responsibilities are identified, including organizational requirements for QA/QC. On larger projects it is as desirable to require the contractor to implement a written QM Plan. The Quality Management Plan should identify when quality management specifications are required as a part of the contract documents. The CM should confirm these specifications are included in the contract documents when required.

Implementation of QC/QA Requirements During Construction
The contract documents may include the specific requirements for a contractor's Quality

Management Plan. In the QM specifications, specific submission requirements are outlined dealing with contractor quality control activities and quality assurance efforts. The CM should assure the requirements are implemented. The contractor's performance of quality control and quality assurance activities can be a requirement for progress payments.

Public Relations/User Review
The CM should facilitate the user's understanding of the design documents. Depending on the nature of the owner's organization, it is often appropriate to involve the project's ultimate users in periodic reviews of the design as it progresses. On public projects the CM may assist in the development of a task force of public representatives to review and discuss various aspects of the project. On private projects, a task force of key personnel from the user group may be consulted through various presentations as the design develops.

Project Funding
The CM may verify that the necessary project funding has been authorized and that all fiscal requirements have been, and will continue to be, met, including the allocation of appropriate funding for activities which specifically impact on the quality of the project.

Project Review Meetings
Project review meetings can be conducted, no less than monthly, during the design phase of the project and continue through completion of work, with the key project participants in attendance. quality assurance and quality control of the design should be reviewed and discussed as a part of the project review meeting.

Reports
The QM Plan should designate the various design reports required of the design professional during the design phase, such as foundation assessments, geotechnical report, etc.

Procurement Phase

Goal
The goal of this phase is to conduct the procurement process in a manner that will comply with all internal and external quality requirements, secure contractors and suppliers capable of satisfying those quality requirements, and result in the successful and timely award of contracts for construction.

Procurement Planning
The CM establishes the goals for the procurement phase as a part of the QM Plan. The Master Schedule, as outlined in the Time Management section of the Standards, should be consulted. The CM should review the Master Schedule procurement cycle for advertisement, bid and award, together with any special approvals during the award cycle to assure the schedule reflects market conditions and is reasonable.

Advertisement and Solicitation of Bids
The CM should comply with prescribed standards for public agencies and private owners and propose any modifications to allow consistency with the Quality Management Plan for the project. The CM should participate in all pre-bid meetings, site visits, and addendum preparation.

Select Bidders List
Many owners identify and pre-qualify bidders they believe are qualified to pursue work in their market through special lists. The CM should assist the owner in managing any prequalification steps or establishing standards which are appropriate prior to any advertisements for bids.

Instructions to Bidders
The Instructions to Bidders section of a solicitation should be comprehensive and include clear, concise information which complements the advertisement or solicitation statement. The CM should review the instructions to assure this goal is reasonably achieved. Instructions should advise the various offerers of the procedures and requirements to submit an acceptable proposal for the owner's review.

Pre-Bid Conference
A pre-bid conference should be held for each contract being solicited by an owner. The CM should chair this conference or support the owner's project manager in this task. Key participants should be introduced at this time to the bidders present including the owner and his staff, the design professional and the CM. Pertinent schedule information should be reviewed by the CM, including Master Schedule information if part of a multi-project program. Site visits are suggested and may be mandatory. The CM should record minutes of the pre-bid conference and site visit. All direction that supplements or differs from the solicitation documents provided to bidders resulting from the pre-bid meeting must be issued by addendum.

Proposal Document Protocol and Bid Opening
Information regarding the forthcoming contracts, prior to and during bid, must be controlled in a manner that does not allow any bidder an unfair advantage over others. The CM, design consultant and owner work together in exercising caution and good judgment in maintaining the "level playing field" required for uniform and fair bidding. At bid opening the owner and CM representative, if applicable, should open all bids received and record the information, unless otherwise proscribed by statute.

Pre-Award Conference
The owner and CM should conduct a pre-award conference with the apparent successful bidder to review and discuss the terms, conditions, costs and scope of work. The conference could be a personal meeting with the parties, or via telephone, depending on the issues involved and should be structured to assure all parties have clear understanding of the contract and scope of work.

Contract Award
The owner or CM should formally notify the successful bidder by letter that they have been identified as most responsive bidder for the contract or have been otherwise selected to perform the work. This letter should be recognized as the "Notice of Intent to Award," by the owner. After receiving this notification the contractor is again advised by the CM of the requirements to provide necessary bonding, insurance, and other special requirements set forth in the instructions for bidders and contract documents.

Construction Phase

The following discussion focuses on the various quality initiatives that should be incorporated into the construction phase of any project. It should be reviewed in conjunction with the specific information set forth in this Standard of Practice and be integrated in the preparation of the detailed Quality Management Plan for each specific project.

Goal
The goal of this phase is to complete the construction in accordance with the quality requirements of the contract documents, with documentation to verify that such compliance was achieved.

Preconstruction Conference
The Quality Management Plan should require a preconstruction conference, attended by the contractor, owner, CM and design professional, to review and discuss the overall project. This conference is held after Notice of Intent to Award is made to the contractor but prior to the Notice to Proceed. At this time, the contractor should present to the owner's team the general approach including quality control to the project, while introducing the contractor's key personnel.

Construction Planning and Scheduling
To enhance quality regarding construction time, the contractor must submit a detailed schedule for the work. This schedule may be viewed as the plan by which the contractor guarantees that the work will be performed within the construction time set forth. Construction milestones should be addressed by the contractor in his schedule submission, as identified in the contract documents. This schedule should be reviewed and approved for use by the CM to verify its compliance with contract requirements.

Inspection and Testing
Consistent with the Quality Management Plan and the CM's contract, the CM verifies that testing and inspection of the contractor's work, on a daily basis when appropriate, is being accomplished to determine whether or not the work is being performed in accordance with the contract specifications. If the CM is providing such services, the Quality Management Plan provides for the quality control and assurance mechanisms to ensure the quality of the services.

Reports and Recordkeeping
The CM should maintain thorough documentation of daily inspection efforts for the project. In addition to inspection reports, records are maintained of all pertinent project data and correspondence on the project, progress photos and photos of existing conditions prior to the notice to proceed. Correspondence would include all submissions by the contractor, approvals by the owner, shop drawing submissions, logs, certifications, etc.

Changes in the Work
The general conditions or special provisions of the contract set forth the specific requirements to document and obtain approval by the owner of any changes in the work. The CM is routinely charged with the responsibility to review and assess any authorized extra work under the contract as to its effect on construction time, cost and quality.

Document Control and Distribution
The CM establishes procedures for document control and distribution of approved contract plans and specifications. The CM should issue all changed drawings, sketches, plans, etc. A log should be maintained of all current documents.

Non-Conforming and Deficient Work
The Quality Management Plan should state the specific requirements for quality control and quality assurance. The contractor(s) should systematically review quality control efforts by his forces. Periodically, items will be identified which are not in conformance with the contract specifications. A log must be maintained by the contractor(s), with copies to the CM, of all such items, until they are removed from the log as a result of an acceptable action by the contractor(s).

Progress Payments
The CM should propose an acceptable progress payment process to the owner, unless one exists within the owner's existing plan of operations. The progress payment format should be prepared to accurately represent all costs associated with the project, all current change orders and contingencies.

Final Inspection, Documentation and Punch List Work
Towards the end of the project, the contractor(s), by specification requirements, may request a final inspection of the work to determine if the work can be declared substantially complete. If in the opinion of the CM the work is sufficiently complete, a final inspection shall be conducted by the CM, attended by the contractor, designer and owner, and a punch list of outstanding items shall be developed by the CM. If all remaining punch list items are inconsequential to beneficial occupancy, the contract may be declared substantially complete. After acceptable completion of all outstanding items, the contract may be accepted as complete.

Commissioning
A formal commissioning plan should be prepared and implemented. The plan should identify the equipment and systems to be commissioned. Each item should be tested under various levels of performance to demonstrate capability to meet and sustain the system/equipment design. Reports should be issued documenting these activities. The CM should monitor to assure implementation of the commissioning plan.

Beneficial Occupancy
This term and provisions for its use should be defined in the contract specifications. Generally, it represents the time that a particular facility, structure, or area is taken over for use by the owner for its intended purpose. The quality of the facility, structure or area should be assessed by the CM to determine if it is reasonably acceptable for beneficial occupancy. This may occur before all work of the contract is complete.

Substantial Completion
This term should be defined in the contract specifications. Generally, it represents recognition by the owner that the project is ready for occupancy or use in accordance with its intended purpose. Certain minor punch list items which do not hamper the use of the facility to the owner may be completed within a reasonable or specified date after substantial completion. The specified level of quality should be achieved for accepted elements of the work at substantial completion.

Final Acceptance
Final acceptance of the work generally requires the owner to issue a "Certificate of Final Acceptance" to the contractor for the work and to file a Notice of Completion. This states that the contract is completed with no outstanding items remaining. This is also the milestone by which the contractor will notify his bonding and insurance companies that no further obligations remain on the contract.

Post Construction Phase

The achievement of quality during the post construction phase is largely a function of earlier planning completed, preparatory actions initiated in the previous phases of the project, and expedient project close-out.

The Quality Management Plan can require that the CM assist the owner in the review and implementation of operations and maintenance manuals associated with equipment installed and assist in pre-warranty expiration date checkouts.

QM Assessment with Owner

After the project is completed and all CM Services are nearly complete, the CM may review and discuss the overall quality management of the project with the owner. It is recommended that a detailed discussion be held with the owner and his key representatives to objectively assess the efforts which were conducted on the project and the benefits derived. This allows all parties to build upon the experiences encountered during the course of the project in a manner that would enhance quality in forthcoming work.

Final Report and Recommendations

The CM prepares a final report for the overall project with recommendations to the owner regarding activities during the course of work which may require re-evaluation for future work. These services should be provided for in the CM contract, developed with the owner at the start of work.

Chapter 6: Contract Administration

Introduction

This section addresses the administrative tasks of the CM during project execution and the administration and reporting requirements for all construction contracts.

Pre-Design Phase

Communication Procedures
The CM should develop procedures for recording and controlling the flow of submittals by the designer for approval by the owner. The CM should establish the systems and procedures for communications among the owner, designer(s) and CM over the course of the project.

Design Phase

Goal
The goal during this phase of the work is to assist in achieving a complete a set of documents defining a cost-effective project that will result in competitive bids in the current market within the owner's established budget, performance, and time requirements.

Design Phase Progress
The CM develops and implements a system for information flow to all project team members concerning design progress during this phase. The CM should apprise the team of any actual or potential constraints to the project goals and make written recommendations for corrective action.

During the entire design phase the CM maintains a process of review and consultation among team members on all relevant issues.

Design Review Meetings
In order to expedite the design reviews, the CM should provide for the flow of comments and owner approvals. A written record of comments and their disposition should be compiled, and the CM should act to see that minutes of all meetings are properly distributed.

Schedule Maintenance Report
Once the Master Schedule and Milestone Schedule have been prepared, the CM initiates a schedule maintenance report. This report is intended to monitor the project schedules and compare the actual progress, particularly of critical dates, against the scheduled progress. It is recommended that this report be issued on a monthly basis.

The schedule maintenance report is to be objective and include recommendations for correcting delays or incorporating changes that occur in the original or adjusted plan. This report should be timely, and prepared so as to portray the actual work conditions and project forecasts accurately.

Project Cost Report
The CM prepares a project cost report to compare the budget for the project to the actual costs incurred and the forecast to complete. The initial project costs are conceptual, but become more empirical as the project is defined and then constructed, until final actual costs are recorded. The comparisons should be recorded on the changes that occur in the project budget due to design development or scope changes that are initiated by team members. Minor variations to the original scope or Project Management Plan should be noted during project meetings. Major changes that affect time and/or cost are noted by issuing a change and/or a budget amendment, as may be required. The cost report should specify estimated cost compared to the project and construction budgets.

Procurement Phase

Goal
The goal in this phase is to assist in securing for each bid package a sufficient number of bidders, including subcontractors, who are qualified, competitive, interested in the work, and capable of doing the work within the project time and budget requirements.

Bidder Prequalification
Prior to any bidder prequalification that may be required, the CM may develop a contract scope breakdown for each contract on the project. The breakdown should consider availability of design information, schedule, and local contracting practices. In conjunction with the scope development, schedule information should be produced which includes key dates for receiving technical information, reviews and approvals, bidding, evaluation, and contract award.

In conjunction with establishing bidder lists, the project invitation, or request for bids, and other documents to be used for contracting should be developed by the CM and approved by the owner.

Development of Bidders List
The CM should assist the owner in developing the list of potential bidders and in prequalifying bidders.

Project bidding may be open to all interested bidders or to only prequalified and approved bidders, depending upon the owner's requirements. In an open bid environment, the CM should evaluate the bids for competitiveness, responsiveness and ability of the bidder to do the work. The CM should also confirm that the bidders are responsible and are financially strong.

For closed bidding, the CM should develop the criteria for bidder selection in consultation with the owner and the designer.

It is recommended that this activity be initiated during the design phase, as the type and availability of contractors are factors in consideration of some design elements and bid packaging.

Bidders Interest Campaign
The CM should conduct a telephone and/or a written campaign to generate maximum interest among qualified bidders without bias or prejudice towards any firms. Information received from the bidders should be recorded formally and presented with other data used in determining the bidders list.

Notices and Advertisements
When the owner desires to have open bidding in lieu of a selected bidders list, notices and advertisements are required. The CM should assist the owner in the preparation and placement of such notices. Usual placements are in trade journals and newspapers in the desired trade areas. Sufficient time must be allowed to ensure response from interested bidders.

The notices should be clear as to scope of work and schedule, as well as the steps necessary for obtaining bidding documents. Care must be exercised to follow specific notice requirements for public bidding.

Delivery of Bid Documents
The CM should administer the distribution of bid documents, in coordination with the designer. The CM should verify that all interested and/or qualified bidders receive the appropriate bid documents and maintain records of all transmittals.

Information to Bidders
The CM should develop and coordinate procedures to provide answers to bidders' questions and to issue addenda in a timely manner within the prescribed bidding period. The team members must be cognizant of the content and approve each addendum issued.

Addenda
The CM should review addenda and coordinate their issuance with the designer and owner in the same manner as exercised with the bidding documents. The bidders should be made aware of any issue in advance, and addenda must be received and acknowledged by bidders in time for adequate review and response.

Pre-Bid Conferences
The CM may be responsible for conducting the pre-bid conferences. These conferences are intended to be a forum for explanation of project requirements concerning schedule, access to the site, time constraints, owner's administrative requirements, and technical information pertaining to the project. The CM, owner and designer should be prepared to accept questions from bidders and respond in writing prior to bid closing. Minutes of these meetings should be recorded and officially issued to all bidders.

A site tour is conducted by the CM as part of the pre-bid conference to afford all bidders first-hand knowledge of site conditions and any constraints.

Bid Openings and Evaluation
Bid openings may be structured as private or public, depending upon project requirements. The unopened sealed bids should be held in tight security. The CM may assist the owner in recording bid receipt times in a formal procedure. At the established time, the bids should be opened and recorded on a bid comparison form similar to the bid form. The CM may assist in evaluating the bids for

completeness, responsiveness, and pricing and should coordinate this evaluation with any technical review that may be required by the designer. All bidder exceptions and clarifications should be resolved by the CM in a manner suitable to the owner. Early bids should not be opened prior to the designated time, and late bids should be formally returned unopened.

Any recommendations made by the CM for contract award should be in writing, giving the reasons for the decision and including copies of the bids and bid comparisons for the owner's use.

Post Bid Interview
The CM may conduct the post bid interview to discuss the proposed contract with the bidder to whom award is anticipated, to be certain there is clear understanding of project scope, and to discuss any bid alternatives the bidder may have submitted. The CM should confirm the absence of any bid errors and inform the bidder of the permit requirements, as well as the required insurance documents and labor affidavits, quality issues and any special requirements of the contract documents. Items discussed should be documented.

Construction Contracts
After owner approval of the successful bidder(s), the CM, if requested by the owner, should assist in the execution of the construction contract(s).

Schedule Maintenance Report
The CM's schedule maintenance report should compare the actual bid dates against the proposed bid dates from the Project Management Plan. Should the actual bid dates indicate schedule impact, the reasons and effects should be explained. On some projects, the schedule maintenance report is combined with the construction schedule report.

Project Cost Report
The project cost report should be updated by the CM to indicate actual bid prices compared to budget figures for each contract. An analysis of the impact of bid amounts should also be included. The team members now have actual cost information to compare against the Project Management Plan budget.

Cash Flow Reports
As with the project cost report, the cash flow report reflects a greater accuracy in predicting expenditures, since it is based on actual bids rather than budget figures. This report should be produced monthly by the CM unless the owner desires a longer time span.

Construction Phase

Goal
The goal in this phase to expedite and improve the efficiency of the construction process through professional planning and execution of project activities, all focused upon fulfilling the owner's scope, cost, quality and time requirements.

Permits, Insurance, Labor Affidavits, and Bonds
The CM monitors the progress of contractor(s) in securing and maintaining proof of insurance, necessary building permits, insurance, labor affidavits, and bonds.

Pre-Construction Orientation Conference
The CM should call a meeting of the project team and interested parties to discuss the requirements of the contract, the contractor's approach, and to review the administrative and other reporting procedures required prior to issuance of a Notice to Proceed. The CM should prepare an agenda and conduct this meeting prior to the contractor(s) moving onto the project site. Minutes of the meeting should be taken and distributed to all parties.

Notice to Proceed
The CM should issue Notice to Proceed to the contractor once it is confirmed there are no outstanding issues that could delay the commencement of work.

Assignment of Owner-Purchased Equipment and Materials
The CM may assist the owner in the transfer and acceptance by the contractor(s) of any owner-purchased materials and equipment. This equipment should be assigned, or title legally transferred, to the contractor responsible for installation.

On Site Communication Procedures
The project team must function effectively and expeditiously during the construction phase. The CM should prepare communication procedures to be used on site, such as:

- Project directory
- Communication flow chart
- Contractor correspondence files
- Chain of responsibility and authority
- Submittal flow chart and logs
- Field orders
- Coordination meetings
- Quality assurance/quality control
- Shop drawings
- Substitutes
- Directives and reports
- Cost and schedule performance data

Project Site Meetings
To manage the construction activities effectively, the CM should organize, conduct, and record regularly scheduled meetings involving the CM, contractor's supervisory personnel, the designer and the owner, as required. Purposes of these meetings should be to:

- Discuss medium and long range plans for contractor(s).
- Discuss and resolve any scheduling/coordination problems of or between contractors.
- Obtain answers and clarification to any questions the contractor(s) may have of the designer and/or set direction for obtaining that information on a timely basis.
- Review and approve monthly payment requests.
- Coordinate long lead item procurement.
- Resolve any other issues that may be brought to the group.

Dissemination of the minutes of these meetings should be timely in order to realize full value of the discussion and resolutions achieved. Minutes of individual contractor meetings should be distributed to the project team members.

Contract Documentation Procedures
The CM should distribute to all involved parties the information that is important to their project responsibilities. The CM should establish recording systems for receipt, handling, and distribution of the following:

- Contract documents
- Contractor requests for information
- Owner's directives
- Designer's directives
- Submittal receipt and approvals
- Changed conditions
- Claims
- Meeting minutes
- Project periodic reports
- Daily field reports
- Payment requests
- Photographs

Field Reporting
The CM's on-site staff should provide daily written reports of project activities including, as a minimum requirement, the following:

- Weather conditions.
- Contractors working and number of workers representing each contractor and subcontractor.
- Project visitors.
- Significant materials and equipment received.
- General description of each contractor's activities and brief discussion of any specific problems, their resolution or direction set for resolution.
- Project delays or potential delays.
- Contractor's on-site equipment and utilization.

Quality Review
The CM should establish and administer the procedures by which the quality of the project is assured. Quality review under Construction Management becomes a common pursuit of all team members on the project. The CM should work with the owner and design professional to develop a Quality Management Plan (QMP) for each project as described in Section 5 of this manual. The on-site function of the CM does not, in any way, mitigate the contractual obligation of the contractor to provide quality performance. The contractor is solely responsible for the quality of work.

It is recommended that the contractor be required to provide, as a QC program, a written description of how to meet the quality requirements. Each program should include the mandatory inspections and testing in the specifications, as well as any other inspections, tests or procedures that are necessary to meet the requirements of the contact documents. In some contracts the QC programs are very detailed and involved; in other contracts they consist of a statement committing the contractor(s) to the procedures described in the specifications. In administering the contractor's QC program, the CM's role is one of fairly and impartially implementing the owner's requirements as stipulated in the contract documents.

The CM should coordinate field-testing and inspection which is not a part of the contractor's work scope. This interface must be carefully considered and defined at the time of bid packaging and further described in the project QMP.

Nonconforming Work

Should the CM discover that the contractor(s) work fails to conform to the contract documents, the CM should:

- Notify the contractor in writing of non-conforming work and seek corrective action;
- Inform the owner and designer.
- With the designer's input, determine if correction of the work in question can best be achieved by removal or rework, or by owner acceptance, subject to credit.
- Recommend that payments not be made for nonconforming work.
- Follow-up until a satisfactory solution is reached.

Prompt detection of nonconforming work is no more important than prompt disposition of the finding. The longer a resolution is delayed, the more expensive is its effect on the project. The normal resolutions of "replace," "rework," or "accept-as-is" should be quickly analyzed and priced and the approved disposition communicated to the contractor with the payment terms to be applied to it.

Safety

The development and application of a safety program for each contract is the responsibility of the contractor(s) who has the direct control of the work forces and control of methods and means of construction. The CM may be responsible for review and verification that the contractor has a program and that the programs are coordinated. (*See Chapter 7: Safety Management*.) The CM should not be responsible for contractor implementation or compliance with contractor safety programs.

Change Order Report

All change orders should be reported in an overall change order report to reflect transactions and current status. This report may be issued monthly and the net effect on the original or current construction budget and Master Schedule noted. Both the owner-approved change orders and the known potential changes may be recorded so that the team members are totally cognizant of the cost status of the project.

Expeditious handling of change orders helps to prevent claims. Resolution of changes in the work should be handled on a timely basis and coordinated with the designer as required. This routine will encourage cooperation by contractors and awareness by the owner.

Force Account

The CM should, at the owner's request, monitor and maintain cost records of expended labor, material and equipment for purposes of establishing cost for claims and/or change orders for which a pre-agreed price could not be reached.

Complete and accurate records should be kept of "time and material" or "cost-plus" work for invoice verification, as well as establishment of cost.

The contractor(s) should be required to submit a daily time sheet to the CM for approval as well as documentation for all material and equipment purchases and renewals required to complete the task. These CM approved documents should support and accompany the contractor's invoice requesting payment for a task or partial progress billing.

Cash Flow Projection Report
The CM should establish a cash flow reporting system. The system should provide for timely reaction to, and owner notification of, any major change in expenditures. The system should be responsive to changes in the schedule and to changes in scope of work. Reports should be issued not less than monthly.

Progress Payments
The CM should establish a system whereby the contractor is paid in a timely manner for acceptable work. The system should be consistent with the owner's objectives and the contract requirements.

The system should identify to the contractor(s) the forms and supporting documents required, including proper contract cost breakdowns for pay purposes in order to facilitate rapid reconciliation of contractor's applications for payment.

Construction Phase Reports
The CM should continue issuing the reports initiated during the procurement phase. These reports are:

- Schedule maintenance reports.
- Project cost summary reports.
- Cash flow projection reports.
- Construction schedule reports.
- Progress payment reports.

It is essential that communication be consistent. The above reports should be updated monthly and the CM should review pertinent information with the other project team members.

Project Summary by Exceptions
This is a narrative prepared for the owner's review, pointing out impacts to the Project Management Plan and exceptions to that plan. The CM should monitor all facets of the project and communicate with the project team members concerning problems that occur during this phase to facilitate prompt action.

Special Record Keeping
The project management information system should specify a program of written documentation and accountability. When problems arise or are anticipated, the CM should increase the amount of detail and intensify efforts at documenting particular areas of concern.

In addition to the written daily reports, the CM should establish a program of photographic documentation that records job progress, documents conflicts or probable claims, and provides photographs for public relations. The extent of photography depends on the complexity of the project. Photographs should show existing site conditions such as mud, snow, ice, etc., and key elements of the work going in place. In the event of change orders or probable claims, it is essential to establish a photographic record as soon as the problem is recognized or suspected.

All photographs should be captioned and time dated.

Claims Processing
The CM receives all notices of claims by the contractor(s) against the owner for additional costs or time. The CM evaluates the claim contents, obtains factual information, reviews the impact, if any, of the alleged cause based on the current construction schedule, and make recommendations for the owner's consideration with respect to the contractor's claim. The CM may coordinate claims analysis and resolution efforts with other consultants and counsel engaged by the owner. At the owner's request, the CM may negotiate the claim of the contractor(s) on behalf of the owner pursuant to the owner's instructions. The CM may make final recommendations to the owner concerning settlement or other appropriate action. Careful documentation by the CM offers the owner protection against unjust or frivolous claims.

Each situation should be analyzed in light of pertinent contract clauses.

Record Drawings
Most owners require record drawings at the completion of the project. The CM should establish procedures for assembling and handling record drawings which are appropriate to the particular project. When the contractor(s) are required to provide a set of marked-up drawings, the CM will typically review these documents prior to the approval of any final payment application. At the end of the project, the CM should forward the contractor's marked-up drawings to the designer, who prepares a finished set of record documents for the owner.

When the CM has the responsibility for the preparation and completion of the record documents, the method to be used should be determined early and set out in the Construction Management Plan.

These drawings should show revisions in sizing and location of materials and equipment that vary substantially from the size and location shown on the plans and which are not documented by change orders.

Post-Construction Phase

Maintenance Manuals and Operating Procedures
During the course of the project, the contractor is required to submit maintenance manuals and procedures for operating equipment and systems installed in its work. Prior to final completion, the CM should coordinate the compilation, organization, and indexing of these materials and bind them into document sets.

Spare Parts and Warranties
The CM should coordinate all requirements for spare parts and warranties.

Final Permits
Regulatory agencies require permits to permanently utilize or operate a facility. Some agencies are more stringent than others and may require documentation, testing and statements concerning completeness of the project. Most require a final inspection. The CM should assure compliance with these requirements and assist in securing all permits.

Move-In/Start-up Activities
At the owner's request, the CM should assist in scheduling and coordinating for move-in or start-up and assist with training of the owner's personnel.

Final Payment
When the contractor has notified the CM and the CM has confirmed that all punch list items are complete, the CM should make recommendation, in writing to the owner, in connection with final payment to the contractor(s).

Contract Closeout
The CM should coordinate and expedite the completion of contractor submittal requirements prior to contract closeout, including the following:
- Certificate of substantial completion.
- Completion of punch list work.
- Final lien waivers.
- Guarantees/warranties.
- Final payment application.

The CM should work with the owner in final project cost accounting, providing project cost records and general project documentation as required and established at the outset of the project.

Contractor Call-Backs/Warranty Work
The CM may remain on-site after substantial completion for a period specified in the owner/CM agreement at the time of contract signing or as modified by subsequent agreement to assist the owner in resolving warranty issues.

It is not usually cost effective for the consultant CM to remain on-site until all warranty work is completed. Therefore, the CM should provide the owner with a list outlining responsibilities of each contract, or name and address of the company and name and telephone number of the contact person.

Close Out Reports
All significant reports that have been issued during the design and construction phases should be summarized in a final project history report. Cost accounting should be prepared with the final resolution of all expenditures. These reports should officially note the dates of substantial completion and commencement of warranties.

Chapter 7: Safety Management

Foreword

CMAA has long advocated a collaborative approach to safety management for construction projects and programs. In such a collaborative environment, *some* responsibility for safety is widely shared. All project participants, for example, have a duty to call attention to observed unsafe conditions as a key step in preventing injuries to themselves or others.

In addition to this basic ethical requirement, other responsibilities for job site safety derive from statutes, regulations, case law and contracts. Construction Management contracts should assign safety responsibilities consistent with the current status of the law, but do not always achieve this end. Because the legal obligations for safety must consider contractual obligations, regulatory compliance, and even criminal statutes, there is no simple answer to the question "what is the Construction Manager's (CM) responsibility for project safety?"

The CM should be aware of these sources and types of responsibility. Based on this understanding, the CM should counsel the owner in creating contracts and processes so that:

- Responsibility for specific risks is assigned to the party most able to control and mitigate those risks, and
- A "safety culture" on the project makes it clear that all participants are expected to report known hazards to the appropriate individual or entity responsible for the involved work, as well as perform their own activities in full compliance with applicable laws and regulations, and
- Appropriate liability protection is provided to those parties responsible for monitoring construction activities on behalf of the owner.

Among other functions, the CM should be alert to possible inconsistencies or contradictions in the contracts between the owner and various other entities, and understand that laws and regulations may impose obligations in addition to or even in contravention of the contract terms.

The 'baseline' responsibilities of the CM related to safety are those spelled out by the CM contract and statute/law. The 'baseline' responsibilities differ sharply between CM-Agent and CM-at-Risk deriving largely from who is in control of the construction site. Typically the CM-at-Risk is in control of the site; CM-Agents are not. A typical CM-Agent agreement will generally require the CM to monitor the contractor's activities as they relate to the contract documents and in some cases, the contractor's submitted safety plan. Beyond the 'baseline' responsibilities, both CM-Agents and CMs-at-Risk may contract with the owner to provide additional safety related services such as the Safety

Management Services described herein. These may also include: project- or program-wide education to enhance awareness of safe practices and the ability of participants to recognize potential hazards; periodic monitoring and reporting related to safety conditions; other services as mutually agreed, but only if subparagraphs (a) and (c), above are strictly incorporated.

Introduction

This section focuses on the subject of providing safety management services to the owner if so required by the owner. Generally, the CM's obligation to provide services related to safety varies substantially from project to project and must be clearly specified in the contract between the owner and the CM. The CM should also review the contractor's agreement with the owner to ensure that there is no contract language specifying CM safety obligations or responsibility that is not clearly defined in the CM agreement.

The approach to safety management contained in this section is an example of a proactive approach; however it is important for the CM and owner to note that the approach described herein is an approach that is much more aggressive than that specified by the A-Series CMAA Standard Forms of Agreement. This proactive approach can be an appropriate method of providing comprehensive safety services to owners who are willing to provide the CM with the appropriate compensation, insurance coverage, and contract indemnification clauses. Prior to providing any safety management services, whether proactive or not, the CM should thoroughly review all legal implications of doing so and understand the risks associated with this service. It should also be noted that on some projects, indemnification clauses and insurance coverage for safety issues should be considered by the CM even if the services described in this section are not provided. As a minimum the CM must follow the safety policy and practices of his own organization

NOTE: The owner and the CM should also be aware of other safety management options which may be available. Depending on the owner's resources these options include:

In the instance when an owner has a well-established Safety Program/Organization, the owner can provide the Safety Coordinator to perform the noted project safety functions, and interface accordingly with the CM

If neither the owner nor the CM has an established Safety Program/Organization, with the resources to conduct the functions of the Safety Coordinator, a Safety Consultant may provide the functions of the Safety Coordinator and interface appropriately with the owner and the CM

Owner Controlled Insurance Programs (OCIP) usually includes more stringent safety controls. OCIP's are generally found on projects that have $100 million dollars or more of construction value.

The CM must have a safety program in place for its employees in accordance with the local laws and regulations. This program should include as a minimum, education and training for the CM staff commensurate with company policy and the hazards expected to be encountered during the construction. The CM (company) is ultimately responsible for the safety of its employees.

Pre-Design Phase

Owner Commitment

The CM should discuss and thoroughly understand the owner's level of commitment for an overall safety program for construction work on the jobsite. The owner has the overall responsibility for taking action should there be an issue regarding the nature of a hazard or safety responsibilities between the CM and contractor. If there is not a strong commitment to safety on the behalf of the owner, the CM may **not** want to take a contractual safety role on the project. The CM and owner should discuss the advantages and disadvantages for doing so as well as the current Occupational Safety and Health Administration (OSHA) requirements, expectations and established goals for the project. If a decision is made to have the CM implement and organize a safety program, the CM's contract with the owner must clearly define the scope of such services and include compensation to cover the CM's cost for appropriate liability protection. The prudent CM negotiates a separate fee for providing Safety Management Services. The added cost for acquiring additional insurance coverage should be included. The following information is provided based upon the assumption that the owner has requested and contracted with the CM to provide an overall Jobsite safety program

Initial Scope of Services for CM Providing an Overall Jobsite Safety Program
The CM should review the contractor's contract documents prior to procurement to ensure that there is adequate language to facilitate managing safety on the project. Project safety should be considered a process that is elevated above other issues and resolved in a timely manner. The CM needs to make it clear to the owner that anyone on the CM staff observing a safety hazard will bring the issue to the contractor for corrective action. Should the CM encounter an imminent danger situation, the CM must be empowered to suspend work on that activity immediately on behalf of the owner who will be ultimately responsible for the suspension. The CM's safety services scope can vary by contract from periodic observation and monitoring to more detailed monitoring, documenting, and reporting the contractor's safety progress.

Project Organization
An early member of the project team should be the CM's safety coordinator. The safety coordinator begins to develop input from a safety perspective, for such items as the Construction Management Plan, project procedures manuals, pre-construction drawings, constructability reviews, and the management information system.

Staffing Considerations
In order to coordinate and monitor contractor safety efforts effectively, a separate safety staff is created within the Construction Management team. The safety staff is comprised of safety professionals with project specific experience and knowledge of:

- Federal, state, county and local safety regulations
- Building Officials and Code Administrators (BOCA) and National Fire Protection Association (NFPA) codes\
- American National Standards Institute (ANSI) standards
- Occupational Safety and Health Administration (OSHA)
- Environmental Protection Agency (EPA); Distributed Energy Resource (DER) and other environmental regulations
- Hazard communications requirements
- Construction operations, specifications and drawings
- Labor relations

Some projects may require the expertise of a Certified Safety Professional (CSP), Construction Health and Safety Technician (CHST), and/or Certified Industrial Hygienist (CIH) due to special conditions which may exist on the jobsite, e.g., asbestos or hazardous waste removal. It is important to convey to the owner the need to staff the project with experienced safety professionals. The staff must be of adequate size to cover the project efficiently and fulfill the agreed to contract scope.

Design Phase

The CM safety coordinator meets with the design team to achieve an understanding of the scope for the project. At this time the safety coordinator can be provided the opportunity to review drawings and discuss specific elements of the project to determine potential safety hazards, which may exist once the project is begun. "Design for construction safety" is a term that is used to consider safety during the design of a project. For example, window elevations, parapet wall heights, and construction sequencing can all help to prevent construction accidents.

The CM safety coordinator may then provide input for the construction contract documents concerning specific safety devices, equipment, and training that may be needed to mitigate the potential hazards. For example, certain roof designs may require special fall arresting devices and/or safety nets. It is to the benefit of all concerned if specialized equipment is required by the contract documents and not left to the discretion of the successful bidder. It should be made clear in the contract however, that it is the primary responsibility of the contractor performing the construction activity to perform its own review of the drawings to determine potential hazards. Any guidelines contained in the contract shall be considered a minimal requirement. The contractors are then required to devise systems or purchase necessary protective equipment at no additional cost to the owner. In addition, the contractor may be required to provide protective equipment to the owner's inspection team.

Indemnification clauses and insurance requirements should be reviewed by legal for incorporation into the contractor's contract documents. The intent is to protect the owner and CM.

Contract Requirements and Drafting Guidelines

The CM safety coordinator determines the items to be included in the construction contract documents concerning safety from the review conducted during the design phase. The contract documents should be structured to ensure the prime contractors and their subcontractors are responsible for safety. Each prime contractor should be required to submit, as per the contract documents, the following information for review by the CM:

- Written safety program
- Resume of safety representative
- Hazard communication program
- Specialized programs for specific job hazards
- Environmental waste disposal plan
- Drug and alcohol program (where required)
- Safety training programs
- Union safety regulations (where applicable)
- Site specific safety plan
- Task specific safety and health plans for high risk activities.

The contract documents should clearly state the contractor is solely responsible for the safety and welfare of his employees and for the protection of property and the general public. The contractor shall comply with all federal, state, local, and county safety regulations, applicable to his work site.

The prime contractor shall, through and with his safety representative, ensure that all of his subcontractors of any tier fully comply with the prime contractor's jobsite safety program. The safety representative shall be a full time employee of the contractor whose sole responsibility shall be for supervising compliance with applicable safety requirements on the work site and for developing and implementing safety training classes for all job personnel. The safety representative shall have stop work authority.
Subcontractors that have more than 25 employees on the site should be required to have a full time safety representative. The owner shall have the authority to request removal of the contractor's safety representative if that representative is judged to be improperly or inadequately performing his duties; however, that authority should not in any way affect the contractor's sole responsibility for performing the work safely, nor shall it impose any obligation upon the owner, the owner's CM, or any other party than the contractor, to ensure the contractor performs his work safely.

Written Safety Program
An essential element of the contractor's safety effort is the jobsite safety program. The contractor's safety program should contain all the necessary elements for the contractor to administer his program in accordance with his contract.

At a minimum, the contractor's written safety program should address the following:

- Compliance with laws, rules, and regulations, including any updates:
  - OSHA
  - Federal, state and local
  - Owner, CM, insurance carriers
  - 100% safety orientation of all jobsite personnel and visitors. (Verifiable tracking system – can be through visual sticker identification on hard hats)
- Duties and responsibilities of contractor's management personnel for safety
  - Project manager
  - General superintendent
  - Foreman
  - Safety manager/representative
  - Safety committee or team(s)
- Infractions of safety rules
  - Life threatening(imminent anger) situation corrected immediately
  - Serious hazards – would need to be defined in the contract
  - Reported to contractor's designated safety representative
  - Timely correction
  - Prime contractors to enforce safety requirements on their subcontractors
  - Non-complying employees to be removed from the project by the contractor or at the request of the owner/CM
- Housekeeping
  - Continuous cleaning required
  - Final clean-up required
  - Owner will perform if required and charge contractors

    - Designated staging plan
- Means of Implementing Program - Proactive
    - CM representative attends weekly toolbox meetings with agenda recorded
    - Incorporate safety in weekly project meetings; ask questions to help the
- contractor plan safety into the work
    - Safety committee or safety walk around inspections with the contractor
    - Emergency procedures and phone numbers
    - Project bulletin board with required policies
    - Employees on each shift should have first aid/CPR training and maintain a current first aid/CPR card issued by an agency such as the American Red Cross
    - Completion of a job hazard analysis for each critical non-routine or high hazard construction activity and communication of this analysis to workers through pre-installation meetings for each new activity
    - Accessible safety program manual
    - Effective communication with a means of elevating safety issues to upper management for resolution
    - Tracking and record keeping procedures
- Accident Investigation
    - Investigate, document and report all accidents and near-misses
    - Develop steps to prevent a recurrence
    - Completion of all reporting paperwork
    - Proper notification and distribution

The contract documents should state the contractor's compliance with requirements for safety and/or CM's or owner's review of the contractor's safety program shall not relieve or decrease the liability of the contractor for safety.

No provision of the contract documents should act to make the owner, the CM or any other party than the contractor responsible for safety. The contractor should indemnify, defend and hold harmless the owner, CM, or other authorized representatives of the owner, from and against any and all actions, damages, fines, suits and losses arising from the contractor's failure to meet all safety requirements and provide a safe work site.

Safety as a Prequalification Criterion

The CM can assist the owner in considering contractors' safety records as a criterion for prequalification to bid on projects for that owner. This criterion should include contractor lost time frequency average, lost time severity average, OSHA 200 and 300 form information and the experience modification rate (interstate and/or state EMR) as determined by the state Worker's Compensation Board. This information can be helpful to screen bidders that may carry with them poor safety programs and may cause the owner increased Worker's Compensation cost. This is particularly important when the owner is providing a Wrap-Up Insurance Program (OCIP). The contractor must also provide an up-to-date list of all OSHA/state citations issued to them within the past three (3) years to include the disposition of each citation. The CM can find citation information on the OSHA website, www.osha.gov, under Establishment Search.

Procurement Phase

Pre-Bid Conference
The CM's safety representative and/or client safety representative can be provided the opportunity to address potential bidders at the Pre-Bid Conference. Safety requirements pertaining to the contract are highlighted at this time.

Construction Phase

Emergency Response Coordination
The CM safety representative should contact local authorities prior to bid to determine the availability of ambulance service, emergency response, police, and fire units.

Once the construction contract is awarded, the contractor's safety manager shall establish emergency response procedures, means and methods.

Safety Submittals
A review of the contractor's safety related submittals is conducted to determine if the requirements of the contract specifications have been met. The CM's review is not intended to be all encompassing nor to anticipate each jobsite condition the contractor may encounter. The contract provisions should indicate that no work can begin until the safety program is approved. For some projects/programs, it may be appropriate to allow a two stage safety program submittal: one covering the initial 90 days for mobilization, and the second covering the remainder of the contract. The contractor's submitted program is the central element for safety compliance by the contractor and his subcontractors. The contractors plan should include documentation of competent persons assigned to the project.

It is also important for the CM to develop his own safety program for Construction Management employees on the jobsite. Construction Management employees could be exposed to many of the same hazards, as contractor personnel. Therefore, it is good practice to provide and document training for the CM's personnel. The CM should at a minimum comply with the prime contractor's jobsite safety program.

Compliance Agencies
It is recommended that both the owner and CM develop lines of communication with agencies responsible for enforcing compliance of regulations applicable to construction of the project. The CM can encourage contractors that have been awarded work on the project to meet with these officials as well. A review of the project scope and contractual relationships between the owner, CM, and prime contractors is suggested prior to the start of construction activity.

Pre-Construction Conference
The CM's safety representative addresses all prime contractors at the pre-construction conference. At this time, information should be reviewed with the contractors concerning submittal requirements, emergency response programs and procedures, safety meeting times and schedules, training requirements, site safety surveys, accident investigations and reporting procedures. The contractor should be reminded to transmit all safety related materials to all subcontractors of any tier. The contractor's contract should have language to require the contractor to provide adequate

documentation for safety. The contractor should conduct additional meetings with subcontractors to review the information provided during the initial preconstruction meeting.

Contractor Safety Enforcement and Compliance
Each contractor shall appoint as stated in the contract, a safety representative to assist the contractor's management personnel in the implementation of the contractor's jobsite safety program. The safety representative and contractor's management personnel inspect on a daily basis their construction activity for compliance with established compliance criteria and document.

The CM monitors the contractor's daily construction activities and notifies the contractor in writing (with copies to the owner) of any deficiencies or imminent hazards or situations observed. The CM then follows up with the contractor to determine if corrective measures have been taken. The CM's actions in this regard are not intended to relieve the contractors of their responsibilities for safety on the jobsite.

Should the contractor fail to correct an unsafe condition, the CM immediately notifies the owner of the contractor's failure to correct the unsafe condition. The owner then notifies the contractor through the CM that the unsafe condition must be corrected or the work in question will be stopped until the condition is corrected to the satisfaction of the owner. Extensions of time or additional compensation are not granted the contractor as a result of any stop order so issued. Keep in mind that while an unsafe condition continues as a result of this sequence of communications, someone may be at risk

Safety Coordination Meetings
Prior to the performance of all critical, high hazard, or non-routine (as defined by the contract or contractor's submitted safety plan) construction activities, a job hazard analysis (JHA) shall be performed by the contractor. This job hazard analysis shall outline plans and procedures to be followed by the contractor in order to perform the work in a safe manner. A safety coordination meeting takes place between the CM, the contractor, and other affected contractors to discuss the job hazard analysis. At this time, the contractor thoroughly reviews the work in question and ensures safety guidelines are communicated to all concerned parties. The contractor is required to conduct training and hold meetings with the contractor employees using the JHA prior to conducting the work.

Safety Committee
The CM participates as a member of the jobsite safety committee. Other members of the committee can be comprised of the owner's safety manager, contractor's management, safety and labor representatives. The committee meets at least once a month to review safety issues and contractor progress on the jobsite. The agenda for the meetings should include:

- The results and recommendations of weekly committee walk-around inspections, or other safety inspections of the project
- A review of the contractor's safety/training activities
- A review and update of jobsite emergency procedures and access routes
- Coordination of hazard communication information for compliance with the federal hazard communication standard
- A review of accidents on-site and steps which were implemented to prevent a recurrence
- A look at anticipated construction activity to determine if safety coordination issues between contractors should take place

- A review of contractor accident rates in conjunction with National Standards

Safety Audits
The CM conducts periodic safety audits, if specified in the CM contract, in order to monitor contractor progress and compliance with the following:

- Orientation training
- Hazard communication training
- Accident investigations
- Jobsite inspection
- Emergency procedures
- Disciplinary action
- Safety meetings
- Overall administration of their safety program

It is recommended that the contractor participate in the CM audit at the time of the audit and be given the opportunity to take immediate corrective action if appropriate. A report of the audit is forwarded to the owner for his review and appropriate action. The purpose of the audit is to document observed areas where the contractor or his subcontractors are out of compliance with the contractor's jobsite and/or project safety program. The audit is not an all-inclusive listing of safety conditions on the project. In addition, the suggestions included in the safety audit are intended only to notify the contractor of observed instances in which it is not in compliance with its own safety program. The contractor is, by means of the safety audit, reminded of this obligation to comply with the safety program, including the regulations, laws, ordinances referred therein

Monthly Reports
The CM provides monthly reports to the owner containing the status of the program and of accident frequency and severity. Comparisons to national averages should be included

CM Safety Training
Construction Management employees should be initially trained and periodically refreshed in the identification and avoidance of hazards encountered on the construction site as per their jobsite safety program.

Chapter 8: Program Management

Introduction

This section discusses Program Management which, in the context of the construction industry, is the application of Construction Management to large, complex or multiple capital improvement projects. A Program Manager (PM) is generally assigned the responsibility of managing all of the resources and relationships necessary to achieve an owner's desired outcome. Depending on the owner's organization and needs, Program Management services may be provided by in-house personnel or contracted to a qualified consultant.

There are many similarities between project management and Program Management. Both utilize integrated systems and procedures such as budgeting, estimating, scheduling, procurement and inspection to manage the design and construction process. The principal differences between project management and Program Management are in the size, complexity and scope of the projects; the level of management and decision making; and the concurrency and magnitude of activity. (*See Chapter 2: Project Management.*)

Generally, a PM is employed to manage and coordinate a large capital program; potentially with multiple facilities in different locations. The PM may be asked to manage or contract for seemingly unrelated activities, which may range far from traditional design and construction activities. These activities may include assisting the owner in securing financing for the project, leading public relations and legislative initiatives, operating and maintaining the completed facility, and facilitating or purchasing a variety of products or services. The owner's needs and resources determine the scope of the PM's services. Owners with significant in-house expertise may not elect to contract for the full scope of a PM's services, but rather selectively choose services to supplement their own resources and expertise. Successful Program Management requires owner involvement and the integration of outsourced services into the owner's organization. Therefore, understanding interpersonal and organization integration is an important issue.

Program Management services are provided by a variety of professional consultants, such as Construction Managers, design-builders, designers, developers and others. The Construction Management profession developed and flourished as a result of the ever-increasing complexity of the construction process and the need to provide leadership in resolving the differences and coordinating the activities among owners, designers, contractors and other stakeholders. Construction Managers, by their training and experience, possess the knowledge, skills and abilities needed for effective Program Management. In many cases, Program Management may be considered an expansion of traditional Construction Management services, which is the context of this section.

Owners lacking the internal resources or expertise to perform Program Management may contract for these in an "agency" or "at risk" arrangement. In an "agency" arrangement, the PM is paid a fee to perform the services required by the owner, which may include managing the contracts between the owner and other professionals such as architects, engineers, Construction Managers and builders who are also contracted directly to the owner. In the agency arrangement, the PM acts as an advocate for the owner; however, the PM is not directly responsible for the performance of the other consultants and contractors. As such, the PM is not liable for problems caused by other team members and does not have a duty to the other team members unless stated in the PM's contract with the owner.

In an "at risk" arrangement, the PM is directly responsible to deliver the project according to the requirements of the contract. The PM may perform the necessary services directly or hire sub consultants and subcontractors to assist. Ultimately, the PM is responsible to the owner for the quality, cost and schedule of all of the deliverables in the contract. Conflicting interests may exist between the owner and the PM as a result of this arrangement. The most delicate issue occurs when an owner converts a PM agency contract, in which the PM acts in the owner's interests, to an "at risk" contract, in which the PM acts in its own interests. Although the intent can be clear, it is difficult for both parties to adjust their relationship. When using the "at risk" delivery method, the owner may want to consider hiring another consultant to provide agency PM to represent their interest.

Whether following the agency model or "at risk" model, it is imperative that the owner and the PM structure their contract to avoid or limit conflicts of interest and to avoid creating an adversarial relationship. Even so, the "at risk" arrangement is better suited to CM rather than the full portfolio of tasks typically performed under a PM contract. The primary detraction in using "at risk" PM is the difficulty in defining PM scope at the outset with sufficient accuracy, because Program Management activities are more often qualitative than quantitative and more often controlled by third parties. When working under a Guaranteed Maximum Price (GMP) and a fixed completion date arrangement, this situation can easily create unmanageable risk. This can lead to misunderstandings, disputes, and multiple changes that are more difficult to resolve than CM services in terms of cost and schedule. For example, how would an "at risk" PM schedule and budget "legislative funding support services" to secure project funding, while committing to a fixed completion date? In contrast, construction contracting activities are generally better suited to well defined cost and schedule control measures, so that CM "at risk" is preferable to PM "at risk" from the important aspects of scope definition and reasonable risk allocation.

Program Development Phase

Ideally, Program Management starts very early in the thought process that leads to a major capital improvement program. Typically, an owner must address an existing capital improvement need. The need may be an impending regulatory requirement, or perhaps a severe capacity restraint, which overpowers the organization's capabilities to manage the program or various phases of the program. By considering at the outset the organizational capabilities needed, many owners conclude that their ability to execute a major program is limited by lack of staff and, in some cases, the proper expertise that is necessary to define and manage the program on a sustained basis. Therefore, the owner will acquire the necessary expertise by contracting with an independent entity, a firm or firms that can provide the necessary staff and expertise to support the program.

There is clear value in combining in-house staff with outsourced resources. On one hand, the owner must have a trusted "smart, experienced and responsible" manager to consolidate and control the owner's many program needs and to select, contract and manage the outsourced services. There can be in-house staff for continuous improvement, proprietary processes, core specialties, and for services that aren't readily available on the market. On the other hand, the owner can benefit by outsourcing commodity services and products, resource leveling, and using "on call" arrangements for highly specialized talent that isn't needed on a continuing basis and for high-paid talent that would upset internal pay scales. Finally, most owners can search out the best firms in the industry and learn from them as they work together. This approach gleans the best from both organizations, using outsourced support that will vary from part to full-time as the needs of the program dictate.

To enhance the opportunity for success, the PM's role should start early in the program definition phase. This includes an active role in defining objectives and concepts, and may extend to the acceptance and operation of the completed projects on behalf of the owner. Program Management ideally includes the early participation of the PM in developing and making the initial strategic, technical and business decisions that define and become the basis for the capital improvement program. The PM has the greatest opportunity for improving the chances for success during the program definition phase. As the program is being developed, a comprehensive Program Management Plan (PMP) is developed that then becomes the program's governance document.

In this early definition stage, the PM fosters an environment in which technical, legal and business professionals can collaborate to develop the PMP. If this collaboration is successful, the owner's original concepts can evolve into a viable program that meets quality, scope, schedule and cost expectations. Working as an integral part of the owner's implementation team, the PM guides the PMP process and presents the compiled document to the owner.

The Program Management Team

In this early stage, the Program Management core team is generally small. The team may be made up of planners, schedulers, conceptual estimators, financial experts, lawyers and other front-end experts as needed. These professionals may be available within the owner's organization, the selected PM firm or within the various specialty firms that make up the Program Management team and may be introduced on a consulting basis to meet specific program needs. Supplementing the core team with part-time professionals helps to keep the core team small and efficient. A staff of administrators, technical professionals and managers normally support the program also. This staff is responsible for supporting the initial Program Management team for such tasks as information systems, logistics support, and production of the PMP.

The role and authority vested in the Program Management team by the owner should be agreed upon at the onset of the work. The owner may add additional roles and responsibilities to the PM's portfolio as the needs arise. An organization chart and task descriptions should be drafted and agreed upon together with the owner, along with a decision matrix showing how specific recommendations will be formulated and who will make final decisions. The majority of the time, Program Management works best as an integral part or extension of the owner's staff.

An essential component of the Program Management team that should be established during this early phase is the Project Controls team. The success of a program is measured as much on proper budget, schedule and document control as much as it is measured by the technical success of the constructed facilities. Key personnel on this team include cost control engineers, schedulers, estimators, programmers and administrators who assist the PM in developing the overall scope, cost and schedule of the program. The project controls system is the backbone of the program. Early establishment of good project controls will enable managers to identify, assess and manage program trends effectively. This builds confidence in the PM team and will win support from the owner throughout the term of the program.

Program Management Plan (PMP)
One of the mainstays of Program Management is the written plan, or Program Management Plan (PMP); which is approved by the owner and defines the vision, implementation strategy, schedule and budget criteria, and the policies, procedures and standards for the program. It is a living document that must be updated periodically. The PMP is the master reference document for the Program Management team and provides guidance to the consultants engaged throughout the life of the program, from inception through planning, design and construction. The PMP provides a level of continuity and standardization across the program to facilitate time and cost effective communications and decision making. It serves as an organization's formal process for reviewing, evaluating, prioritizing, documenting, approving, implementing and maintaining all of its projects within the program.

Program Management Office (PMO)
As a result of best practices initiatives, certain agencies and owner organizations establish a Program Management Office (PMO) to oversee and implement all projects within the PMP (e.g., new construction, modernized facilities, information technology, and non-technical projects) The PMO concept is a management process that is seamlessly integrated and planned collaboratively. Within the PMO process, governance responsibilities and task ownership must be clear. A best practice PMO is one that has a strong charter which defines program success, typically in terms of quality work, safe work, work in scope, work on schedule, and work on budget. A strong charter coupled with a solid, well-structured PMP results in both successful scope and cost controls.

The PMO organization or team must be a well-coordinated, fully-integrated and high-performing group. This group should have the role and responsibility to oversee program delivery within five key functional areas:

- Understand the owner's needs and translate them into a capital program
    - Define and plan
    - Provide risk management and quality assurance
- Set project delivery strategy, define the project functions and select project teams to deliver them
    - Set up the program's infrastructure, processes and management office
    - Coordinate and establish standards for implementation
    - Support program processes and procedures (as outlined in the PMP)
    - Implement strategies
- Control program execution through budgets and schedules, procedures, documentation and communication
    - Provide project management and support
    - Coordinate the overall team
    - Establish and enforce technical standards
    - Provide project planning, budgeting, scheduling and document control

- Provide status reporting
- Effectively close out the program
- Collect and institutionalize best practices and lessons learned
    - Identify and incorporate continuous best practices

Best practice organizations also invest in project management skills training for staff in order to achieve consistency in project delivery and to reduce project failures. Best practice organizations also have an executive group that has the overall management responsibility of monitoring performance measurement systems.

Metrics are used to track program performance (scope, budget, and schedule) in real time. PMO organizations implement a review process using these key performance measures. Best practice organizations link and align their performance measurement systems (scorecards) with long-range goals and strategic objectives. These organizations also value and measure individual input in the form of satisfaction surveys to key stakeholders (e.g. user groups, consultants, and contractors). Best practice organizations are continually improving their Program Management methodologies.

Management Information Systems (MIS)
Large capital improvement programs often present the team with an opportunity to supplement, improve or replace the owner's management information systems. The owner's systems may not be adequate or appropriate to accommodate the additional volume of data and documentation that results from the major program. The management information system should be based on the specific criteria formulated by the PM to control and report on the progress of the program. Computer systems, both hardware and software, must be chosen early in the process and established as a standard throughout the program. This will allow continuity of information and reporting as the program expands.

One of the challenges of long duration programs is that they introduce a software upgrade risk. With programs that can carry through 10 or more years, software upgrades are inevitable and must be managed. Conversion to new software systems and even upgrades of the original software can be problematic. It is important to consider the stability of the software providers, including their record of support, when selecting software systems. As software vendors promote their "new and improved" upgrades, conventional wisdom for PM's is to avoid the cutting edge. There is too much at risk with major programs to serve as the beta group for software that lacks an industry track record.

Reporting of progress, schedule, costs, scope changes and quality compliance must be achieved in a standard electronic format available to every entity engaged in the program. In addition, the flow of documentation must be established and an early decision must be made to capture, archive, and distribute documents in an electronic or manual mode. Electronic document control for large capital improvement programs can be cost effective and provides many side benefits that are essential to large capital programs. The PM must determine the right level of data sharing and integration of systems that is practical.

Scope Definition
Concurrent with the establishment of the management information support systems is the requirement to establish detailed procedures that control the administration, accounting and

management of the program. The primary focus at the earliest stage is to validate the need for the program and determine its fiscal viability. It is essential that the PM provide reasonable cost estimates based on realistic schedules, the full scope of work and the agreed level of quality. At this stage the PM must anticipate potential delays and factor appropriate contingencies into the program. The PM must identify the scope of as many related requirements as can reasonably be identified. These may include environmental studies, sustainability, wetland preservation, archaeological investigations, historical preservation and entitlement considerations; among other activities leading to the final permits. Each will have an impact on the cost and schedule of the program. Once the program has been quantified and agreed upon together with the owner, the next step is to develop the program in terms of schedule, cost, quality and scope.

One of the most difficult areas to reduce to writing is the level of quality. It must be understood that the level of quality impacts all areas, but most importantly the final cost of the improvements. Quality may also have a dramatic impact on the length of time required to design and construct the program. The PM, with the support of the planners and designers, must establish the quality standards that will be met by each consultant and contractor. This may result in a set of simple program quality guidelines or a detailed manual of quality standards.

A final scope of work is drafted for approval by the owner. It is based on detailed working sessions with the owner as well as other stakeholders. A realistic budget and schedule are then established for final approval including cost escalations, market conditions, risk assessment and appropriate design and contingencies. Formal approval is usually reserved for a board of directors or similar entity with the appropriate fiscal responsibility.

The owner may request a study of various strategies to improve program cost or schedule including various delivery methods. In addition, the PM may examine a strategy for dividing the program into manageable segments or projects. This process may go through numerous cycles before the ideal solution is found. The execution strategy, once approved by the owner, is fully documented by the PM and included in the PMP along with the resulting budget, overall scope of work, quality standards, program schedule, and the major milestones that are critical to the successful implementation of the program.

Design Phase

The PM's role is to manage a program of multiple projects or a large project with multiple elements. During the design phase, the PM is focused on the overall program design aspects and how they interrelate, rather than on the individual design of various projects. However, it is the smaller individual projects comprising the program that must all come together to deliver a complete and functional finished product. The PM is responsible for directing the production of designs to meet the objectives within the context of the program constraints. The PM is also responsible for integrating all of the program elements and the individual projects. All of the elements of Program Management – including cost management and time management – are required during the design phase. The PM's role is to manage the scope, schedule and budget of the overall program. Impacts such as design delays, cost overruns, and environmental issues, on a single design can have implications for the entire program.

Design Organization Structure

The PM must establish the organizational structure so that the required resources are available to complete designs for individual projects within the required schedule, budget and quality standards. This structure also needs to facilitate integration of the program elements and communication within the Program Management team. Structuring the design organization, which will probably include several design teams, may include consideration of client/owner policies such as inclusion of disadvantaged, local and/or small businesses. The structure needs to be sufficiently flexible to provide a balanced pool of resources during periods of uneven workload.

The PM also assists the owner in selection of the design team. In addition to establishing a scope of services for each of the projects, the PM should standardize the process by assisting the owner in developing a "standard" contract form for scope of services or by utilizing industry standards contracts, such as the CMAA series.

Design Criteria

The PM oversees the development of the design criteria, a crucial factor in successful implementation of a large program. Good design criteria are needed to promote design consistency and maximize design efficiency. Such efforts will assist in controlling construction costs, expediting procurement, and improving ease of maintenance by assuring consistency among projects in the program.

The design criteria should address a number of issues. These include space and functionality, codes and standards, operation and maintenance requirements, safety and security, and local market conditions such as availability of materials.

Communication during this phase is critical. The PM involves all relevant parties in the development of the design criteria. The owner, the user, and the regulatory agencies contribute to the development of the criteria. Design standards should be communicated to all appropriate project team members, so that they understand the expected level of quality. Programs of projects have been shown to benefit from standardization of designs for systems and project elements wherever possible, as this can reduce design, construction, and operations and maintenance costs, and also reduce construction time. The more standardized the process, the more efficient the design process will be from one team to the next. PMs have an opportunity that project managers don't have. They can examine their individual projects to find similarities. When there is a similarity, they can rotate the similarity from the project workflow to the program. Then there is an opportunity for repetition instead of reinvention on every new project. Most important, they can improve across multiple projects. The results can produce enormous benefits in time, cost and quality.

"Rotation" describes the process of turning a custom, project-oriented activity into a continuous, program-oriented standard. Standard processes, standard products and standard human participation save time and money. But standards shouldn't be static; they should be a platform for continuous improvement. People do better work as they gain experience. They improve their processes, their work products and the buildings, and the people themselves get better. The amount of rotation, repetition and refinement that can be achieved in a program is a function of the number of projects, the similarity of the projects and the authority of the PM to enforce standards and push improvement. The 3 Rs require analyzing projects in a program to identify the similarities, choosing the similarities that are the most repetitious and offer the greatest possibilities for standardization and continuous improvement, and focusing on ways to improve these standards at the program level.

The PM should provide typical or similar documents to the team members for use as examples to reinforce the expectations of the final design deliverable. At this stage, the PM is concerned with delivering a design that meets the owner's criteria and applying a realistic construction methodology consistently across the overall design program. This typically will include identifying the code requirements and refining quality standards of the finished product. Additionally, the PM will need to identify and address regulatory requirements. These may include the environmental, wetlands, local permitting, and other necessary regulatory requirements that can impede the successful delivery of the program if not addressed early in the process.

Design Development

Design development in large programs involves projects which might be designed simultaneously, in overlapping sequence, or in series. The PM must focus on the overall design program so that the various designers adhere to schedule and deliver coordinated work products. The PM must monitor design contract costs as well as construction budget estimates for consistency with overall program budgets. The PM must establish a comprehensive design review process; and advise the owner of any deviation from approved program standards of performance. The PM must promote designs with an eye toward constructability, initial capital costs, and life-cycle costing including operation and maintenance.

The PM should seek to improve the individual designs, drawing on lessons learned from early projects through construction requests for information, bids, and shared experience within the program. The PM should also seek opportunities for cost and time savings through value engineering and applicable peer reviews.

Building Information Modeling brings the previously separate functions of planning, design, construction, commissioning and maintenance/management together as an integrated whole. With the increased emphasis on life-cycle cost of construction, the PM may work with the owner to establish criteria for all phases of the program to optimize the flow of information among all the participants in the program.

The PM facilitates constructability reviews for project designs. The PM also reviews construction estimates prepared by the designers and prepares independent check estimates so that the project is within budget.

Construction Contract Packaging

The PM will often assist the owner with shaping the overall design program into executable contract packages that meet the owner's scheduling and operational needs. In this effort, the PM will focus on the integration of the overall design program and how the various design packages will be scoped, designed, phased, and scheduled to comply with the owner's goals. This can be particularly challenging when construction of a large program must fit within the owner's current envelope of on-going operations.

The PM should be instrumental in the construction contract development, utilizing either industry standard contracts, such as the CMAA series, or assisting the owner in developing a customized construction contract that meets the program needs. Depending on those needs, the PM may also provide recommendations and assistance with alternative construction delivery methods.

Quality Management
A critical component of the design review process is consistency. The designer needs to understand clearly the standards and expectations against which the design will be evaluated, and this needs to be consistent from beginning to end. The same review team should be involved at each stage of the design process whenever practical. This provides for consistency and efficiency, resulting in better value to the owner and better quality for the project.

The PM reviews designs to verify consistency with design criteria, regulatory requirements and constructability considerations. The PM also monitors the design team's compliance with the program's quality management plan and document control plan. Steps to enhance design quality may include peer reviews of designs and periodic audits of the design manager's records.

Cost Management
The PM's responsibilities for cost management during design include management of design costs, the estimated costs of facilities under design, and the overall program costs. Management of program costs during design involves a disciplined application of the program's procedures and processes for allocation of project and program contingencies. The PM should maintain up-to-date local market construction cost information and pricing indices to ensure the accuracy of construction cost estimates and budgets. The PM controls costs during design by balancing design resources and by promoting design efficiencies such as standardization of systems in general use within multiple projects.

The PM also manages program costs through construction contract packaging. The PM can add value by monitoring market conditions, conducting contractor outreach workshops, and adjusting contract packaging and the timing of bid advertisements to attract more competition. Large programs can often affect local construction markets and seasonal conditions may need to be accounted for in some regions.

At times program costs may be affected by the need for interim facilities ("swing space") for entities displaced by project construction. The PM can minimize these costs by requiring designers to allow for construction phasing. Cost management by the PM may also include management of cash flow within the program budget, depending on revenue from bond sales, tax levies or other financing mechanisms.

Cost management is fundamentally different in Program Management than in a single project. The classic view of cost control is that one makes estimates, establishes a budget, estimates design as it progresses, works diligently to prevent scope creep and hits the budget at the end of the job. In addition to a greater opportunity for owners to change their requirements, variability and uncertainty of pricing are potentially more of a problem in a program as opposed to a project.

Since no one can control those price events, the PM needs to have adjustment mechanisms. Budgeting and estimating are predictions of future costs and are rational processes, but bidding can be irrational and unpredictable. The project budgets are based on estimates of construction cost. These budgets will likely anticipate inflation and each project budget will likely include a contingency to cover the unknown and provide some ability to react to surprises. PMs are savvy enough to know that unpredictability is predictable. Eventually, on every program there will be a budget bust, the potential for grievous embarrassment and a big problem to solve.

If the program is viewed as a series of independent projects, each with its own contingency, then it is highly likely that the program will exceed the original budget. Here is what will happen:

As the program unfolds and time passes, there will be cost swings, above and below a core inflation rate, driven by temporary market conditions. So, in a program with many projects, there's a tendency for price valleys to get filled with scope increases, and the peaks are climbed with embarrassing supplemental appropriations. The inevitable price fluctuations cause inevitable program overruns. The remedy is to view the program budget as a whole and to manage valleys by shunting the values they create into program contingency.

Time Management

The PM must formulate the program schedule that addresses contract phasing with appropriate regard for controlling activities among multiple contracts. This process will create a critical path that will move among various contracts through the life of the program. A useful strategy is to generate interface plans that describe and detail the areas of overlap as well as the coordination issues among contractors. Interface plans become particularly valuable when the program includes phased access release areas that one contractor gains from another while both are actively under way. A line on a plan that delineates one contractor's work area from another's is invaluable in providing clarity. By carefully depicting the space and time of interface points, the PM can mitigate a major source of dispute and delay. Once the program schedule is set, the PM should track progress against it and encourage the team to look further and further ahead to identify variances in the making. By identifying schedule departures in advance, the Program Management team has time to develop work-around plans and implement mitigation measures before the issues impact progress.

Information Management

Communication at all levels within the program team is critical. The PM needs to communicate constantly on issues related to design, costs, schedule, and other program concerns. The PM is responsible for establishing an environment that facilitates and encourages designers, sub-consultants and affected parties to communicate regularly and effectively. Communication and information management tools include use of check lists to track progress of the project teams; meeting minutes, action items lists, and records of telephone calls; and a system for disseminating the information to the project team to keep everyone informed and on task.

Web-based project management systems are becoming the standard tool for managing information for large programs. Web-based systems allow large and geographically dispersed teams to be in constant communication, and for such communication to be documented. System characteristics vary, but generally include document control, communication tools, a calendar, and review and approval functions.

Procurement

Procurement Scope

The procurement function can extend from inception through final acceptance by the owner/operator. It can include multiple phases and functions, such as up-front professional services to develop a business plan or implementation plan, A/E design services to develop a concept and provide detailed design documents, CM services to provide constructability reviews and to manage the construction phase, CM at risk/or general contractor that will build the facility, and start up and commissioning specialist services that can work with the owner/operator to accept and operate the facility. Typically procurement includes advertising, the request for proposals or bids, pre-proposal/pre-bid meetings, addenda, receipt of proposals/bids, bid review, and contract award.

The PM's procurement responsibility can start, however, before there is a definition of scope and/or services to be procured. PMs can advise owners as to funding, permitting, contract packaging, phasing, interdependencies, design standards, and the management organization as well as contract strategy and contract methodology. For example, the Program Manager would review the advantages and risks of procuring owner furnished equipment and long lead items.

Procurement Strategy
As part of the PMP, a procurement strategy would be articulated and based on identified projects, scope of work documentation, order of magnitude budgets and program phasing. The owner may have established procurement procedures or they might be developed and implemented through the program organization. The PM must evaluate the relationships and interfaces among the projects (such as physical, operational, and type of work) over time to gain a thorough understanding. Based on this understanding the PM would recommend a strategy for how to package (number of contracts) and deliver (e.g. design build, traditional design bid build, and fast track). Deciding what contract packages and type of delivery are most time and cost effective to the owner is one step that many PMs miss or spend too little time on. It is an important step because the number of contracts and the delivery method not only affect owner risk, but they also drive the extent of planning, design and construction contract soft costs - the management costs necessary to implement the program.

PM Role in Procurement
The owner can use its organization, a PM or a combination of resources to provide procurement services.

As services are defined based on scope, the PM can recommend what scope and services need further clarification through planning, what can move to conceptual and detailed design and what and how construction will be managed. The PM can also assist the owner by developing scope and procurement documentation for proposal or bidding purposes including estimates, design standards and schedules.

As projects move through their various phases, the PM should revisit with the owner the earlier decisions relative to packaging, delivery strategy and the procurement plan. Of course, the PM is responsible for expediting or facilitating the process to meet the program goals. The owner can charge the PM, for example, with the additional responsibility in the procurement phase of integrating and distributing all qualification or solicitation documentation, to include Requests for Qualifications or Requests for Proposals, contract drawings, project specifications and addenda. The timely issuance of addenda is important. Addenda issued too close to the bid due date may result in poor bid results or cause a postponement of the bid date. Once the bids are received, the PM must assist the owner in expediting the award process. This includes working with the designer or contractor in its submission of the bond and insurance information and working with the owner to expedite review, contract award and issuance of notice to proceed. Any issue that impacts a given project has the potential to impact the ultimate outcome of the program of which it is a part.

As projects are further defined in the design phase, the PM directly or through the Construction Manager must review again those things that typically impact a project. Some examples include delays, cost growth, poor quality, market conditions, the dynamics of change, technology and regulatory impacts. A second or third look will likely precipitate further due diligence and adjustments to previous assumptions.

The PM must advise the owner as to the sequence of the projects that make up the program. Availability of funding, interdependencies among projects, contract packaging, and phasing are all factors which enter into overall decision making and scheduling.

Procurement strategies also have budget implications. Some procurement strategies that should be discussed and agreed upon when formulating the preliminary project budget include the following:

- Pre-Design and/or Pre-Construction Support Services
- Design-bid-build, CM-at-risk or design-build project delivery methods
- Owner furnished equipment or materials and long lead items
- Contract Pricing Strategies
    - Firm fixed price or lump sum contracts
    - Cost reimbursement contracts
    - Unit price contracts
- Property Acquisition Strategy
- Utility Relocation Strategy

Any or all of these are issues to consider when developing potential procurement strategies, depending on the nature of the program as well as the legal and financial requirements. All of these issues will have budget implications that the PM must take into account when arriving at the initial construction and program budgets.

Market Analysis/Bid Opportunity Communications

In addition, the PM can provide detailed market analysis of the potential construction bidding climate. This can be accomplished by determining the availability of labor, equipment and material resources on a global basis. The PM can also tailor this information to meet specific owner requirements such as minority business enterprise (MBE) participation. In some cases the PM may conduct industry outreach to attract proposers/bidders. This could involve publicizing the magnitude of large programs by developing tailored presentations to the design and construction industry and the media in an effort to highlight the program and market the potential commercial opportunities. These preliminary orientation forums are excellent tools for informing the industry and helping to encourage greater competition.

Schedule and Document Management

In the procurement phase, the PM also recommends program schedule and other time-related specifications that are appropriate for the specific project and the overall program, consistent with the size and complexity of the work. This can provide a level of understanding and build confidence with the owner and contractors. From a program perspective it is important that the PM identify the interfacing milestones and provide the appropriate coordination language to address schedule overlap and to mitigate schedule impacts as a result of delays to project interfaces. The necessity for clear, concise, unambiguous scheduling specifications cannot be overemphasized.

In addition, the PM can typically schedule the necessary pre-proposal/bid meetings with designers/contractors, coordinate project site investigations, if applicable, and review the project's master schedule, pre-bid schedule and scheduling requirements with potential bidders. During this process, it is important for the PM to engage a dialogue with potential bidders, seeking their commitment, input and response to the time management and scheduling requirements consistent with the owner's procurement regulations.

In certain public agency organizations, communications with potential proposers/bidders may not be allowed because of the potential for or perception of a conflict of interest. Commitment to making the program schedule work is the responsibility of all the project players but it is the PM that develops and orchestrates the process. Key to this success is the ability of the PM to develop an agreement or understanding among team members on the relevant time elements of their projects and scheduling requirements and how they support the program schedule. The PM integrates project elements into the program so that it meets identified future needs, while proactively making adjustments to meet the owner's ultimate goals.

Construction Phase

The PMs objective during construction is to expedite and enhance the efficiency of the construction process through planning, organizing, providing structure, communicating openly and facilitating the process while focusing on fulfilling the owner's scope, cost, quality and time requirements for the entire program. This is best achieved by adopting a commitment to create an environment in which contractors can be productive. The operative characteristics are clarity, flexibility, speed, and efficient program processes. To that end, the PM typically performs the following functions.

Provision of On-Site Facilities
When requested as part of PM services, the PM can plan the logistical support required to effectively manage the construction. This can occur early in the planning process. Based on the scope and contract packaging assumptions, the PM can develop plans for centralized and/or common office and site facilities for use by all entities engaged in the program. The PM can prepare an order of magnitude assessment of resources based on the scope. By quantifying the total resources on the program schedule the PM can analyze and determine the peak demand for facilities as well as the pace of staff mobilization. This provides the opportunity to optimize the phased expansion and contraction of the program facilities to match demand.

Coordination and Communication
The PM provides coordination and leadership to the planners, designers, Construction Managers, contractors and other entities involved in meeting the program requirements. One of the PM's challenges is to understand the roles and responsibilities within the owner's organization and program team and to determine what information needs to be communicated to whom and when. If all communications with the consultants and contractors are either through or with the prior knowledge any one person or organization, then there is either a delay in decision making or the program becomes overly reliant on the judgment and communications of one entity. However, if there isn't a certain amount of structure to formal communications, then there is loss of quality, at best, and chaos, at worst, with no one in charge and no one accountable. The real challenge for the PM is to foster a work environment of open communication with the right procedure and documentation at the right level. The PM must establish this balance with procedures and reporting requirements so that communications flow with continuity and organization across the program. Most experienced professionals recognize the need for the right communications and know what communications are required and when the PM must personally send them. On this point, it is valuable to staff the project with professionals who have the judgment to recognize when to route

communications through the PM and when to move ahead without PM review for the sake of efficiency.

The PM continually monitors the program by measuring progress of each project, identifying the key interfacing milestones among projects and their impact on the program, and by facilitating actions of all the stakeholders to accommodate individual project needs while avoiding impacts to the program as a whole. The goal is to maximize the efficiency of the program from planning through construction.

Program Progress Meetings
The PM conducts periodic program progress meetings and provides periodic performance reports to the owner. These meetings are conducted with representatives of the various projects. The PM will follow established owner protocols or recommend new protocols and procedures as appropriate. Where owner protocols do not exist, the PM establishes the reporting criteria, format and performance metrics such as a critical path schedule, manpower, cash flow curves, work placement rates and cost compared to budget reports. The PM may monitor program performance by chairing or facilitating these project review meetings, which may cover safety, quality, schedule, cost, and operational issues. These meetings and the information presented provide the basis for decision making and coordination among the various stakeholders. Typically program meetings are scheduled once a month; with smaller individual meetings held more frequently or as needed.

Time Management
The PM establishes procedures for planning and monitoring compliance with the program time line as developed by the program schedule, which is also commonly referred to as the master program schedule and the integrated program schedule. The PM establishes the overall phasing of the program and contract packaging. After defining the logic, sequencing and interfacing milestones, the PM develops the program schedule, overall durations for the projects, and the critical path of the program. The PM then incorporates these time elements into the various contract documents, including program float based on the risk assessment of potential time impacts. During the construction phase, the PM will incorporate the contractors' CPM schedule updates into the program schedule. Project activities may be adjusted in order to maintain the most efficient and effective program schedule considering an optimum balance of time, cost, safety and quality goals. The individual contractor baseline schedules form the basis for evaluating and resolving time-related contract claims. The program schedule is the best tool for making program level decisions when there are schedule conflicts between or among projects.

Budget and Cost Monitoring
The PM develops the program budget based on the initial scope definition, phasing and packaging. The PM records, projects and monitors program costs throughout the program from planning to construction. As project contracts are awarded, the project line item estimates are replaced with the actual committed amounts, plus allowances for unknowns or contingencies.

As scopes are defined and as costs become more definitive, the program budget is updated to reflect the latest cost to budget comparisons. Once actual cost growth trends can be measured, then the PM can utilize this data to recommend decisions in managing the overall program budget. The objective is to manage the incurred costs, estimated costs, and costs to complete in order to stay within the program budget.

Funding/Cash Flow
The PM forecasts cash flows, not only based on the initial budget assessments, but continually throughout the life of the program as costs are defined and forecasted. Using time and cost management techniques, the PM will keep the owner informed of cash needs for the development of the program financial plan, for bond issues and for normal contract payments. The PM through the CM monitors the payment procedure for processing payments to the contractors and conformance to contract requirements.

Requests for Information
It is common in the industry for contractors to pose questions using a formal document called a Request for Information ("RFI"). This is a standard project management tool. What distinguishes this process for programs is that the PM must establish more formal control and provide group access to the information to facilitate open communication and speed to resolution. The PM typically uses an electronic RFI process in which the contractor, PM and designer can all view each RFI via a program server or a secure internet website. Each RFI is numbered and the time to resolution is recorded in an RFI log. Most programs strive for a one week response time for RFI's.

Other variations to the traditional project management RFI process that tend to be distinctive of programs are the request for change ("RFC") and the request for explanation ("RFE"). Often, contractors will pose change requests using the RFI tool. Because change requests take longer to review and resolve, it is important for the PM to consider establishing an RFC process, similar to the RFI process, with a longer review period for RFC's. A less commonly used tool is the RFE. The RFE is the opposite of an RFI. A RFE is initiated by the owner or PM and is posed to the contractor. For example, the owner or PM may issue a RFE if the contractor were failing to prosecute critical path work items. Because the RFE has seen limited use in the industry to date, there is not a generally accepted duration for contractors to respond to RFE's. A suggested approach is to allow the contractor the same time to respond to a RFE as the designer has to respond to a RFI.

Change Orders
The PM works with the owner to establish the change order procedure and reports and monitors the change order process for all contracts. Refer to Section 3.0, Cost Management, for a detailed discussion on this subject. Whether the change is to a design contract or construction contract the authorization, notice and direction to the designer/contractor must be documented and the process managed in a time and cost effective manner. The PM must render sound advice to the owner so that decisions relative to change can be handled effectively.

Claims Management
The PM, and/or Construction Manager, as applicable and per the owner's protocol, establishes methods and procedures to minimize the potential impact of claims through prompt, equitable, and consistent resolution strategies for notices of intent to claim. The objective is to address contract changes with minimal disruption to the on-going program construction effort. The PM monitors the claims management process. Resolving claims on one project may have a direct impact on other projects and the PM must make recommendations that will minimize the overall impact on the program. This sometimes means that individual contractors suffer greater impacts as part of a program than they would otherwise experience for the same event in a stand-alone contract. The program procedures and construction contract documents should address the management of claims

including merit evaluations, entitlement evaluation, negotiations and settlement procedures, handling of disputes, and appeal procedures.

Quality Management

The PM and the owner establish the quality standards for the program, and, in conjunction with the CM, the procedures for meeting contract requirements. Quality procedures typically delineate responsibilities for quality control ("QC") and for quality assurance ("QA"). QC is defined as the operational techniques and activities that are used to fulfill requirements for quality. QA is defined as all those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality. The PM monitors and provides oversight during the design process and works with the CM to assure quality during the construction process. Whether the owner chooses to perform quality control directly or whether they choose to only provide QA of the designer's or contractor's quality programs, the PM usually implements and establishes a method of measurement to achieve the quality requirements of the program.

The PM must assure that all projects are adequately managed so as to achieve the same quality standards set for the program. QC and QA responsibilities must be clearly defined in the design and construction documents. The PM, working in conjunction with the CM, monitors the performance of the Construction Management team's inspection and testing for QC and QA so that all projects are consistently inspected to the quality standards established for the program.

Owner-Purchased Materials and Equipment

The PM investigates the potential benefits of the owner directly purchasing materials and equipment for the program and makes recommendations to the owner. Upon concurrence by the owner, the PM works with the designer to develop appropriate contract documents for procurement. The PM monitors the procurement of owner furnished materials and equipment to assure that the needs of projects are met in terms of schedule and construction coordination.

Record Drawings

Record drawings are contract documents that incorporate important final changes and variations that are not shown in the plans, based upon what was actually built. Changes are continually recorded on record drawings during the project life, so that a final set of record drawings is available at project completion. The PM monitors the process of furnishing record drawings to the owner. Working with the owner, a system is established for receiving, storing and referencing record drawings. The actual day-to-day updates to record drawings may be the Construction Manager's responsibility, but the PM must establish the standard requirements and establish continuity across the program.

Document Control

The PM, working with the owner, establishes procedures for document control, record keeping and file retention. The PM also defines document control procedures for continuity and consistency among all projects. The PM may also establish and implement the management system necessary to receive, record, track, distribute and file all documentation. The ability to manage the flow of documentation effectively is absolutely critical to program communications and decision making. The procedures for identifying and duplicating, and the method of handling and storing records are established early in the program. During the construction phase, the PM works with the CM to assure the adequacy of the document control process.

Management Reporting
The PM monitors the reporting system that was established early in the program. The system would facilitate creation and production of Construction Management reports. The value of the reports hinges in large part on the freshness of the data. Ideally, the reports would reflect the status of the program in real time. An acceptable approach would be to create a reporting system that captures the progress of every contract every week. This is feasible, even for multi-billion dollar programs. The Construction Management section of the program report summarizes status and issues of scope, cost, quality, safety and schedule for all of the projects within the program. The PM monitors the type, format, frequency, and distribution of the report for the owner.

Post Construction Phase

Program Completion
Completing a program requires procedures to close out all program contractual and administrative activities. After substantial completion of a program segment or individual project, the PM monitors the close-out of each project and verifies completion through the individual Construction Manager for that project. Close out items would include completion of all construction contract punch lists and issuance of substantial completion; settlement of all changes and claims; submittal to the owner of required documents such as warranties, operation and maintenance manuals, and record drawings; acceptable disposition of spare parts; confirmation that permit, right-of-way requirements and training are complete; confirmation that grant or funding provisions are satisfied; receipt of signed releases from the contractors; issuance of final payment; and demobilization of contractor facilities.

Program Projects Interface
The PM coordinates the completion and turnover of individual projects and monitors the remaining interfaces with the other projects still under construction within the program. These interfaces with the active projects are often critical. Where facilities are needed before other projects are complete and temporary infrastructure is needed, the PM must identify the temporary infrastructure scope and cost, and incorporate the work into the program to allow full activation of the facilities being turned over. Phasing of projects is another Program Management function that promotes the efficient use of completed projects and or parts of projects to maximize the owner's return on investment.

Maintenance Management
Operations and maintenance ("O&M") management support is a natural extension of the activation process and is based on advance planning that should take place at the start of the planning process and include adequate staffing and resources. It may also include training of staff. The PM can assist the owner in the process of maintenance management of a new program. The PM can assess the maintenance needs of the projects, and design a maintenance management system to address these needs. The issues of maintenance effort, schedule, materials required, and spare parts inventory may be included in the PMs responsibilities. Typically, the PM is responsible so that the O&M manuals, as-built drawings, and spare parts lists are in accordance with the owner's current O&M management system. The PM may utilize Geographic Information Systems, Global Positioning Systems and Building Information Management Systems to provide effective O&M support.

Activation
Program activation, or startup, is the process of transitioning from construction to permanent operation of a facility and the owner or owner's staff become prepared to accept and operate a new

facility or facilities. In this phase, the PM assists the owner in managing the activation function by providing support to define staff planning, service contract requirements, facility requirements that are not provided through the construction contract, operational planning, and operational assessments. The goal is to obtain maximum utilization of the activated facility at the least cost in parallel with the design and construction process, and integrate the facility into the production and operations plans and schedules. On major programs, the activation process may be a sequential process of bringing on-line various facilities or components of a given facility and testing those facilities or components under real conditions before acceptance for permanent operations. The PM may support the owner by developing staff plans based on the transition of ownership and a schedule to mobilize the owner's advance staff. The PM may also support the owner in developing and administering procedures for warranty administration to assure that defective work is remedied in a timely manner. Activation should have high visibility throughout program development and execution. The progress and issues should be reported periodically directly to the owner. Issues requiring management decisions and additional resources are best presented in a formal reporting system.

Facility Management

In large and complex programs, the operation, maintenance and funding commitments are often key to meeting the program objectives. For example, Build, Operate, and Transfer (BOT) programs often have a significant operational period with specific maintenance and repair obligations and expansion milestones based on agreed demand. The PM may be retained through the operational period to oversee and monitor program objectives. Since the PM has intimate knowledge of the program and has established a long-term relationship with the owner, the PM is normally well suited to this facility management role.

Administrative Close-Out

The PM's responsibilities for administrative close-out relate to demobilizing the program team and completing activities with other stakeholders, arranging the disposition of program records, closing of funding and financing agreements, and performing an evaluation of program success and lessons learned. The PM should follow the procedures and actions specified in each contract's terms and conditions to settle and close the project's design and construction contract agreements. The PM will need to work with the owner's finance staff to close out the funding to the program or projects. The PM should also review the PMP so that all elements of the program are complete.

Program Evaluation

Before the program is over and key program staff has dispersed, it is desirable for the PM to hold a "lessons learned" session. The lessons learned should focus on identifying program strengths and weaknesses with recommendations on how to improve future performance of projects. The program evaluation typically covers the entire architectural, engineering, procurement and construction performance, as well as the post construction phase. It should include evaluation of the Program Management staff performance. Additionally, the program evaluation could include a post occupancy evaluation by formally evaluating certain features and/or the operations of the completed facilities to determine whether modifications should be made to the design for future projects.

Chapter 9: Sustainability

Introduction

This section discusses the expanding subject of sustainability as it pertains to the role of the CM. It outlines in general terms key goals, philosophies and elements of sustainability. The general philosophy is to be incorporated with other key elements of the construction management plan including cost time and quality management as well as within the Project Management Plan.

Definitions

USGBC
The U.S. Green Building Council is a non-profit organization devoted to shifting the building industry towards sustainability by providing information and standards on how buildings are designed, built and operated. The USGBC is best known for the development of the Leadership in Energy and Environmental Design (LEED®) rating system and Greenbuild, a green building conference.

LEED
The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ encourages and accelerates global adoption of sustainable green building and development practices through the creation and implementation of universally understood and accepted tools and performance criteria.

GBI Green Globes
Green Globes is a green management tool that includes an assessment protocol, a rating system and guide for integrating environmentally friendly design into both new and existing commercial buildings.

Sustainable
The condition of being able to meet the needs of present generations without compromising resources for future generations.

Building Commissioning (Cx)
The startup phase of a new or remodeled building. This phase includes testing and fine-tuning of the HVAC and other systems to assure proper functioning and adherence to design criteria. Commissioning also includes preparation of the system operation manuals and instruction of the building maintenance personnel.

Life Cycle
The consecutive, interlinked stages of a product, beginning with raw materials acquisition and manufacture and continuing with its fabrication, manufacture, construction, and use, and concluding with any of a variety of recovery, recycling, or waste management options.

Pre-Design Phase

Establishing Project Sustainability Goals
The CM should work with the owner to establish the sustainability goals and objectives on the project. Setting the project's sustainability expectations is an important first step to ensure alignment of the expectations with the roles and responsibilities of the project stakeholders. The CM should include the sustainability objectives, team responsibilities and sustainability procedures in the Project Sustainability Plan. The CM must have the necessary experience and qualifications to support the owner in this effort.

Project sustainability goals must be developed prior to start of design, including the decision whether the project will be registered with the USGBC.

Contract Development
As the CM works with the owner's legal counsel in developing the contract for the design team, appropriate language should be recommended related to the sustainability goals to be achieved by the design.

Project Procedures Manual
The Project Procedures Manual developed by the CM should address the procedures related to sustainability, for all phases of the project. The Project Procedures Manual should define the procedures necessary to assure that the sustainability criteria are achieved during each phase of the work as well as the roles and responsibilities of project participants.

Project Commissioning Plan
If the independent commissioning agent is employed by the construction management team, it is the CM team's responsibility to develop the Project Commissioning Plan. If the independent commissioning agent is employed by others, the CM should ensure the Commissioning Plan is initially created prior to the start of design. In either case, the Commissioning Plan must be in concert with the Project Sustainability Plan and the sustainability requirements of the owner. The CM should review the plan to ensure it is readily applicable and enforceable. It should be reviewed for consistency with the master project schedule and overall project goals and objectives. The project goals and objectives and the commissioning plan should be reflective one of the other.

Pre-Design Project Conference
The CM should include the project sustainability champion, the sustainable design professionals and the commissioning agent as a part of the pre-design conference. The Project Sustainability Plan should be reviewed including the sustainable goals and objectives to be met during the project. Roles and responsibilities regarding project sustainability should be clearly defined and reviewed.

Design Phase

The owner and the CM should agree on the detailed scope and number of sustainability reviews required. The CM should also coordinate life cycle analysis, alternative studies, and energy usage analysis. The CM should establish and regularly review sustainability goals, LEED and/or GREEN GLOBE standard targeted for achievement on the project.

Procurement Phase

Projects requiring certification with the USGBC or GBI should include appropriate requirements within the bid documents. If the owner and designer choose NOT to have the project formally registered with the USGBC or GBI but intend for it to be a LEED or GREEN GLOBES equivalent project, appropriate requirements must also be defined within the bid documents. It is the designer's responsibility to include the specific sustainable requirements to be achieved by the contractor. These requirements should be specifically called for in the contract drawings, specifications and/or BIM. The bid documents should also include minimum sustainability related qualifications of bidders.

Meetings
Sustainability should be discussed at the pre-bid meeting. It should specifically be noted whether the project is to be a GREEN GLOBE or LEED certified project and if it is, what is required by the contractor to ensure the specified level of certification is attained and qualifying experience of the bidders. The CM should assist the owner with review of the bids received, including a review of qualifications of bidder relative to GREEN GLOBES, LEED and/or sustainability experience and qualification requirements in the bid documents.

Construction Phase

Pre-construction Conference
If a project is registered with the USGC as LEED certified or greater, or with GBI for a specific number of GREEN GLOBES, it is recommended to have a separate pre-construction conference with the contractor to ensure a clear understanding of the sustainability documentation requirements as the project progresses. If a project is not registered, it is still recommended that responsible environmentally sustainable construction practices be reviewed with the contractor. At this time, the contractor should present to the owner's team the general approach to the project, identifying what sustainable construction practices will be employed.

Construction Planning and Scheduling
The schedule submitted by the contractor should include a series of activities related to sustainability. If the project is registered with the USGBC as LEED certified or better, or GBI GREEN GLOBES, more project activities and or longer durations to allow for monitoring and documentation should be expected.

Inspection and Testing Consistent with the Project Commissioning Plan (PCP)
The CM should verify through inspection of the contractor's work, preferably on a daily basis, to determine whether or not the work is being performed in accordance with environmental codes and regulations, the PCP, the contract documentation and, where applicable LEED or GREEN

GLOBE credit criteria. If the CM is providing such services, these services should be defined in detail.

Reports and Recordkeeping
The CM should maintain thorough documentation of all environmental measures employed on the project. This includes but is not limited to: waste recycling, waste reduction, emissions mitigations, noise and vibrations mitigations, dust reduction efforts, etc. When a project is to be LEED or GREEN GLOBE certified and it has been defined contractually that the CM is to organize the required documentation s/he shall request the required documentation from the GC at the earliest point in the project. If an independent commissioning agent is to be employed by the CM all related documentation should be compiled by the CM throughout the life of the project most notably during the construction phase. If an independent commissioning agent is employed by the owner, the CM should ensure the Cx agent is furnishing the appropriate paperwork in a timely fashion.

Sustainability RFI's or USGBC Credit Interpretation Requests
When a project is specifically determined to be sustainable (striving to achieve specific sustainable goals), requests for additional information or in the case of USGBC registered LEED 'to be certified projects' may require credit interpretations. A system/procedure must be in place in order to vet these requests. The traditional RFI approach may be appropriate depending upon the complexity of the sustainable applications. This should be discussed and agreed to at the pre-construction conference.

Post-Construction Phase

GBI or LEED Application Process During the Post-Construction Phase
The CM's responsibility is to assure the contractors have provided all documentation necessary for certification and/or required by the contract and that the Contractor and CM assigned responsibilities have been met. The GREEN GLOBE or LEED application will be submitted by the party designated as the agent for the project. This could be the CM, GC, designer or the project's s sustainability champion.

LEED/GREEN GLOBE Review Process
Upon receipt of the preliminary GREEN GLOBE/LEED Review document noting the credit achievement anticipated, pending, and denied, the designated responsible professional will call a meeting with the designer, contractor and owner to review the comments with the team to establish an action plan to resolve all open issues.

Training Sessions
If specific sustainability elements were installed as a part of the project, appropriate training should be specified in the contract documents. Prior to closeout this training should be completed. The CM should confirm that the training is available to the appropriate facilities management personnel as well as the owner. The training should include an introduction reiterating the sustainable goals and objectives of the project.

Final Owner Sign-off
Final owner sign-off should only be recommended once all the requirements as defined in the Project Sustainability Plan, and included in the construction documents are completed and verified.

Chapter 10: Risk Management

Introduction

Risk (n.) A Source of danger; the possibility of suffering harm or loss.

In the context of design and construction, risk management is the process to methodically address risk and work to lessen the impact of the occurrence of risk events on a project or program in all phases of development. Opposite of risk are opportunities which if acted upon have the potential to reduce overall projects/program (referred to hereafter as "project") cost and schedule and or improve quality.

Risk management is inherent in any business enterprise including that of the owner and Construction Manager (CM). Although the A-Series CMAA Standard Forms of Agreement only imply a nominal risk management role for the CM, administration of contracts, which contain insurance requirements, waivers, bonds, liquidated damages, claims and indemnity provisions are subjects of risk management.

The owner's reliance on the CM for risk management services varies greatly. The intent of this document is to provide the CM with a guide to a standard implementation of risk management on a project.

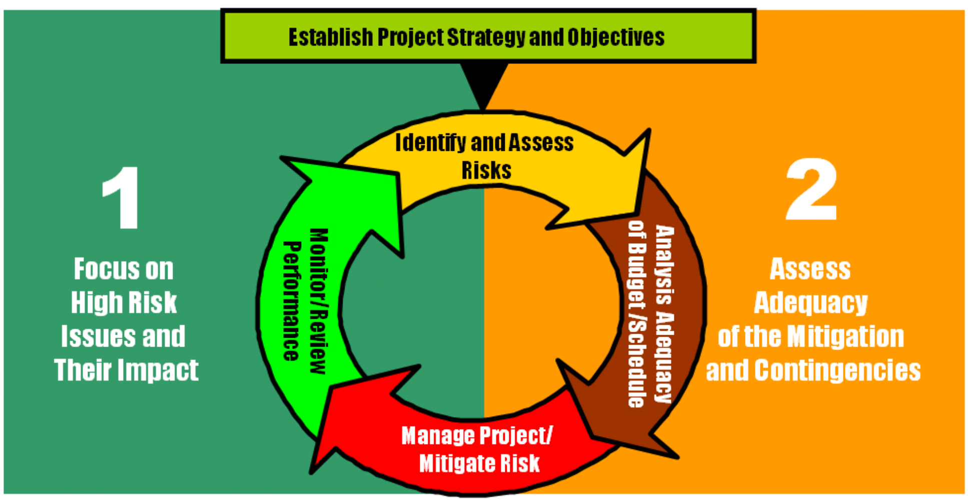
The objective of risk management for construction projects and programs is to provide a process for the early identification of risks and opportunities in order to allow them to be tracked and managed throughout the project. Risks may be transferred from an owner to a third party, mitigated with various forms of project insurance and minimized or eliminated through design and engineering. Risk is known to be inherent to major capital construction projects. Although some risk events are unpredictable, other risks can exist in response to the actions and decisions that are made when planning the implementation of a project. For purposes of this discussion, we will focus on planning for the mitigation of risk consequences, which are defined as potential losses, damages, or any other undesirable events – including the loss of opportunities.

In addition to reviewing project scope, cost and schedule to identify risks and opportunities to be managed throughout the project, the CM also has the task of reviewing project contracts for potential risks and liabilities, and reviewing legal requirements in the contracts to determine the potential impact of contract clauses and developing a plan to address these potential impacts.

Risk management

Risk management and planning begins in the early phases of project development. Recognizing the need to apply risk management processes during the pre-design and design phases is often critical to effective project development on large and complex projects. All construction project plans are based on estimates that contain uncertainty. Often the larger or more complex the project, the more severe the risk consequences can be. One issue with planning capital construction projects is the magnitude of uncertainties that exist. Where there is uncertainty, there is also risk of unfavorable consequences. The best method for dealing with these uncertainties and the associated risk consequences is to develop and implement a risk management process as part of the Construction Management process. A structured risk management methodology should be one of the key management processes integrated with the project management applications receiving the same level of attention as budget control and scheduling, decision-making, and claims avoidance. Controlling risks should not be an arbitrary function that is separate or apart from other project management applications. Risk management is expected to be a continuous process on projects and be integrated into the project management processes.

Figure 1: Continuous risk strategy and management



An iterative and continuous process for managing risk as it changes and shifts.

Figure 1 illustrates the overall objectives of a strategic risk management process. The first step in risk management strategy is acknowledging that the potential for risk consequences cannot be completely eliminated, but can be mitigated. Major capital construction projects are commonly faced with all types of risk events, such as adverse weather, differing site conditions, required or desired scope changes, unavailability of specific types of resources, unanticipated environmental factors, or community pressures. The adverse effects associated with these events are normally manifested in the form of increased cost, re-sequencing of construction activities, and delays that have the potential to interfere with successful project delivery.

CMAA has defined five major phases of project and or program development: 1) Pre-Design, 2) Design, 3) Procurement 4) Construction and 5) Post Construction.

Risk management meetings should be held during each of these phases to help the project team identify and focus on the risks that can be managed within a particular phase. The risks are also typically categorized as emanating from within the control of the project team or external to the project with minimal control from the project team. The risk management process should start at the very beginning of the project with development of a *Design and Construction Risk Management Plan,* which details the processes planned for assessing, mitigating and managing the potential risks. The plan should contain a statement of purpose for risk management process and the overall project performance objectives to be achieved.

The *Design and Construction Risk Management Plan* should also summarize key definitions of risk terminology, establish program and process policies, and identify each stage of the process. More specifically, the plan should document the risk identification and mitigation methods to be used. This plan in itself should help guide the project team's overall understanding of risk management processes and help create personal connection and commitment for using the risk management methodology.

The risk management plan generally includes the following major steps:

1. Risk Identification
2. Risk Analysis
3. Risk management

Each of these implementation steps should be followed by the CM during each project phase. The following are some specifics to each phase that the CM should consider in the review and the minimal suggested involvement for input during the risk meetings:

1. **Pre-Design**: Review of the design concepts and studies, potential external challenges or deterrents to the project, funding, schedule, community impact, etc. The review should include the CM, owner, designers and other project stakeholders.
2. **Design**: Review of the construction plans and specifications, proposed schedule, estimated costs, utility relocations and coordination, environmental mitigation, land purchases or issues, permitting, constraints, access, etc. Prior to advertising for bids, review of construction contract language with special emphasis on the appropriate allocation or mitigation of identified items of risk and the potential impact to scope, cost and schedule. The review should include the CM, owner, designers, as well as construction representatives if possible.
3. **Procurement**: Review questions from bidders for possible unidentified issues or risks, adequacy of number of bidders, and necessary addenda.
4. **Construction**: Review previously identified risks throughout construction to assure they are appropriately managed, review unforeseen conditions or other risks not previously identified, and potential construction change issues affecting scope, cost and schedule. Should include CM, owner, designer, contractor and other representatives with input to critical construction issues.
5. **Post Construction**: Review of warranties, maintenance and operations plan, and any outstanding construction items and potential claims. Should include CM, owner, operations and maintenance personnel, and contractor representative (if necessary).

The following describes services the CM should typically provide a client for these major risk management implementation steps. The CMAA Procedures /Guidelines for risk management provide more detail on the recommended methods for carrying out these steps.

Risk identification

Risk identification is the process of evaluating the project to be constructed and recognize the possible risks that could impact the project, typically related to scope, cost and schedule. Many risk managers, consultants, owners and insurance companies have lists, survey and audit forms, and other means of collection and documenting the risks on typical projects. Some important items in the identification of risk include:

- Realistic project assumptions – View the project assumptions realistically. Do not allow the project assumptions to be interpreted too idealistically, and promote the thinking that all will go according to plan.
- Gather expert judgments – Collect a spectrum of expert judgments, which supports unbiased assessments and analysis.
- Clearly understand risk elements and their impacts – Clearly understand the elements of risks and their potential impacts in the early phases of project planning and development.
- View project realistically, not idealistically - For an effective risk management strategy, the expected results of the project, in terms of cost and schedule, must be objective and realistic.

The CM should be the facilitator in organizing teams to assist in identifying risk as early as possible on a program, with the first meetings being held late in the pre-design phase. Continued discussion on identifying, analyzing and managing risks should be held at each of the project phases.

Figure 2: Overall strategy of the risk management program

Employing risk management processes to help attain success and meet expectations.

Figure 2 illustrates the importance of the strategic risk process and risk identification to ultimately minimize the impact of risks and maximize any opportunities that are identified.

Risk analysis

The identification and logging of the risks and opportunities is only the beginning of the risk management process. Once the risks and opportunities for the project are identified, they can then be analyzed to provide the project team and stakeholders with a structured assessment of the potential for the risk to impact the project. This allows the team to focus on those risks that are considered to have the most likely chance of occurrence with the greatest potential project impact. An example of the qualitative portion of this evaluation is the following:

Figure 3: Risk Evaluation Scoring Criteria

RISK EVENT STATUS

SEVERITY					
CRITICAL	SERIOUS	MAJOR	MAJOR	CRITICAL	CRITICAL
MAJOR	MODERATE	SERIOUS	MAJOR	MAJOR	CRITICAL
SERIOUS	MODERATE	MODERATE	SERIOUS	SERIOUS	MAJOR
MODERATE	MODERATE	MODERATE	MODERATE	SERIOUS	SERIOUS
MINOR	MINOR	MINOR	MODERATE	MODERATE	SERIOUS
	MINOR	UNLIKELY	POSSIBLE	LIKELY	ALMOST CERTAIN

LIKELIHOOD

Figure 3 is developed based on input from the project team who are most familiar with the risk potential, and risks are evaluated (or scored) based on the likelihood that the risk will actually occur and the severity of the impact on the project should it occur. Note that in this qualitative review; no figures are estimated, but the matrix of likelihood and severity results in the project team being able to categorize risk from "Critical" to "Minor," providing a guide to help identify where to devote time to project risks. As the CM moves the team into the quantitative stage, figures are estimated for severity and percentages are estimated for likelihood to better define potential risk impacts.

The CM must be instrumental in ensuring that the after all of the risks are identified they are analyzed to determine their potential impact on the project. The risks are also analyzed to determine who on the project team can be assigned to follow-up on action items related to each risk, that then become part of the risk management plan.

Important points of the risk analysis include:

- Assess and analyze risks impacts – Complete the evaluation and analysis of particular risks to the point of determining the impacts they will have on the project goals and objectives.
- Complete mitigation and contingency plans – Fully develop mitigation and contingency plans sufficient for the degree of impact associated with the risks identified.
- Synthesize the risks – Synthesize all construction risks and determining the total cumulative effects.

Risk management

Once the risks and opportunities have been identified and assessed, the knowledge and information gathered is utilized to properly manage them. The CM should ensure that a structured process is followed through all project phases to ensure that risks and opportunities are managed to avoid unnecessary risk impacts and realize the potential opportunities. The following are four essential components of the risk management process.

Communication & Reporting
Utilizing the project risk database that includes all of the risks and opportunities identified, the CM holds project team meetings to communicate the risks/opportunities and collect feedback, updates and other related information. Reports are sent to internal project personnel based on those who should be aware and are in the best position to act to mitigate the risks and or achieve the opportunity.

Tracking
With each update from the project risk meetings, the risks/opportunities are tracked and adjusted, based on input from the project team. Additions to the list are added as they become known. Risks/opportunities maybe retired if the project team considers there is no longer a potential for the risk/opportunity to impact the project. The tracking must be updated and communicated consistently to maintain a focus on the priorities of the project team.

Mitigation
Possibly the most important part of the risk management process is mitigation. As the risks are first identified, a member of the project team is given the primary responsibility for the risk. This entity or individual would have the most opportunity to work towards mitigating the risk and minimizing any impact to the project. The assignee is responsible for providing a risk mitigation plan. This plan is a set of action items with responsibilities and required dates, with the intent that these actions enacted by those responsible will provide the best possibility of mitigating the risk to reduce the impact to the project.

Resolution
As the mitigation plan is put in place, action items are completed, and decisions are made related to the project, the project risks come to a resolution. The risk can be avoided or eliminated, mitigated, transferred or deferred, or become a reality (with an impact to the project). As the risks come to resolution, the risk data is updated to include the results, along with notes related to the resolution and any "lessons learned" related to the risk.

Figure 4. Relationship Among Project Risk Management Stages

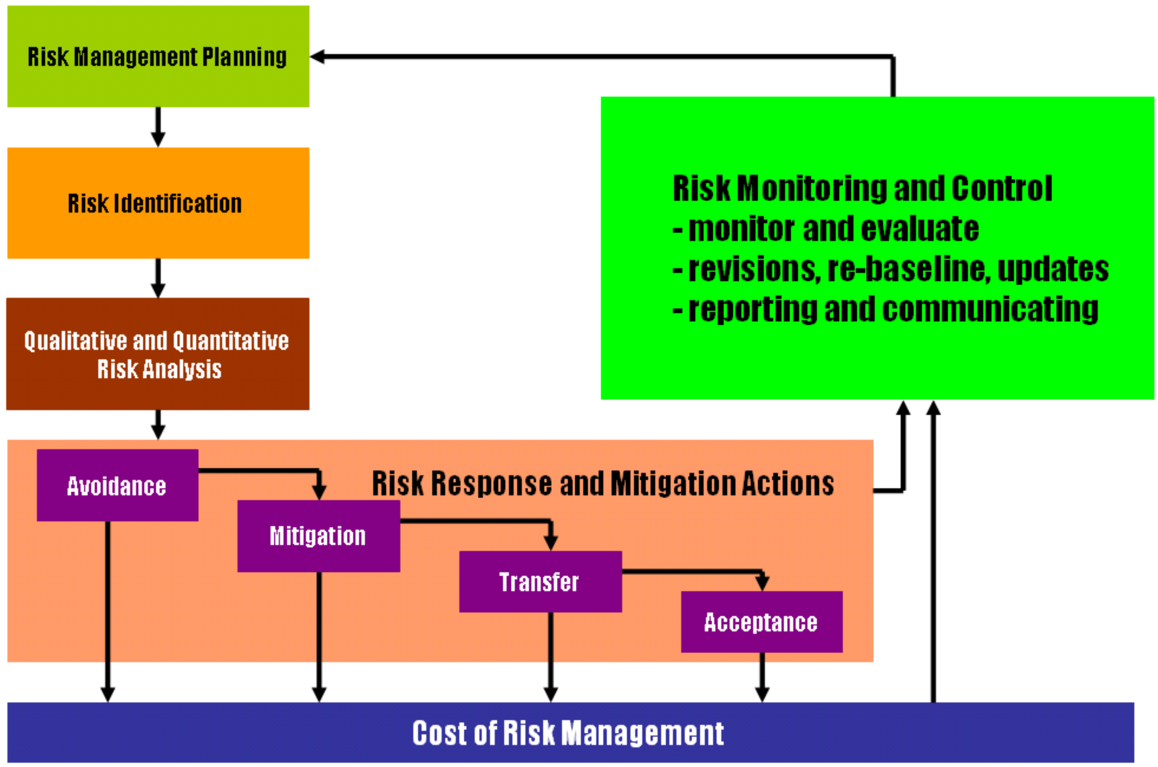


Figure 4 documents the risk management process described previously. It documents the flow from the risk management planning, to risk identification, to risk analysis, culminating in a resolution where the risk is avoided, mitigated, transferred or accepted, ultimately with the impact on the project being assessed. Thoroughly documenting this risk management process in the risk log allows for the continued interface of the risk with the other project control tools including budget and schedule management, for reporting and communicating and for keeping the log for future similar projects and sharing "lessons learned."

Continuous Evaluation of the Risk Effects

Any project can expect to continue to face numerous potential impacts compounded upon the already identified risks. As the capital project transitions into the implementation phase of procurement and construction, the risks can change; therefore, risk management cannot be looked upon as an independent function, but rather it should be planned from the beginning as an integrated part of the owner's Construction Management process. There can be many risks outside of the control of the project team that have the potential to cause impacts if not continually monitored. The project owner should have an ongoing integrated process for risk management based on sound fundamental principles. As conditions change, the CM on behalf of the owner should have a process in place for implementing new mitigation strategies and options as project conditions change.

A continuous integrated risk management process will help reduce the potential for unidentified negative impacts, will improve the CM's continuous efforts of obtaining consensus, continue coalition building, and maintain a steady focus on the project's constraints and objectives.

Conclusion

A careful review by the owner and the CM of their respective risk management capabilities will allow for understanding of their optimum roles which must be articulated clearly in the CM contract scope. As is the case with safety, the CM should be familiar with all of the legal implications and responsibilities of providing risk management services. If neither party possesses the required skill set, an outside risk management consultant with construction expertise should be retained by the project team.

It is not reasonable to think that risk can be eliminated from construction projects. However, risk events can be acknowledged much more explicitly and managed a great deal better with more accountability than is typically the case. The challenge is to recognize risk, decide what to do about it and manage it. To enhance project delivery and performance, an integrated risk management process should be one of the tools used with the construction management applications. The benefits of the risk management process are expected to include:

- Provide a disciplined framework for systematically guiding the process of identifying and managing risk that may not otherwise be considered;
- Helps avoid/reduce large losses and lessens the frequency of smaller losses;
- Helps identify opportunities that become realities and enhance the project delivery
- Improve decision making through clarifying responsibilities and authorities; and
- Support a better understanding for managing risks leading to increased project confidence and improved allocation of resources.

Chapter 11: Building Information Modeling (BIM)

Introduction

BIM is a process by which digital representations of the physical and functional characteristics of a facility are captured, , analyzed, documented, and assessed virtually, then revised iteratively through the design and construction process. The model continues to evolve in the construction phase to analyze and communicate the building process in a virtual environment, including sequence of work, means and methods, logistics and documentation of as-built conditions. The process then continues throughout the lifetime of the facility with the model serving as a shared knowledge resource for information about a facility that forms a reliable basis for decisions during its lifecycle from inception through design to construction, occupancy and operations.

A building information model may be best described by its key features such as 3D parametric modeling, engineering analysis, clash detection, 4D schedules, quantity take-off, and general information assignment (including specification or product data linkage).

The design and construction industry is currently addressing the impact of BIM on the traditional project delivery processes. Given the ongoing BIM evolutionary process, the role of a Construction Manager can vary significantly based on the extent of adoption of the BIM process by the owner and the project delivery team, the Construction Manager's contractual obligations, and owner expectations. It is also likely that the Construction Manager's role will continue to evolve and change as the BIM process matures. This standard of practice is written so as to maximize the role of the Construction Manager in the BIM process, consistent with the CM's traditional role on a project, and to afford the CM the opportunity to lead the overall process as it continues to evolve.

The Construction Management profession is in a position to deliver many of BIM's benefits through implementation of the virtual construction techniques without significant modifications to the current business models. The CM is the central information hub for the project and as such is in the best position to manage the high value BIM process.

The SOP below provides a brief summary of the CM's role and responsibilities in implementing BIM on a project by phase. The CM must also accept the following general responsibilities related to the BIM process:

The CM has the responsibility to stay current and remain educated on the BIM process.
The CM has the responsibility to educate the owner and the project team on the benefits, features, limitations and the implementation process for BIM.

By educating its own personnel and the rest of the project team, the CM has the opportunity to continue its leadership role in the project delivery process with appropriate application of BIM.

Definitions

3D parametric modeling
3D modeling is a superior design environment when compared to traditional 2D CAD. 3D modeling applications have the ability to capture design intent parametrically, which facilitates model creation and editing and therefore reduces the likelihood of coordination errors. Although preparation of the 3D model may be a significant part of most BIM efforts, a model alone does not constitute BIM. The 3D model, however, is a great tool for visualization of the design to benefit the project team and the project.

Engineering Analysis
At the core of BIM lies a digital database in which objects, spaces, and facility characteristics are defined and stored. These characteristics make it possible to use BIM as a virtual representation of a physical facility, and hence, capable of supporting qualitative and quantitative analyses. These BIM-enabled analyses, whether for structural, energy consumption, daylight analysis or a number of other performance simulations, can significantly enhance the efficiency and efficacy of the design, planning and building processes.

Clash detection
Since the 3D model represents virtual true space, a BIM process known as "clash detection" can be utilized to check for interferences by searching for intersecting volumes. It is often the case to use a third party application not only to clash a single model but combine and clash multiple models from disparate sources in a common environment.

4D Schedules
A 4D BIM scheduling application can dynamically link the project CPM schedule activities to 3D objects in the BIM model. This allows for a graphically rich and animated representation of the planned construction sequence set against time. 4D schedules are a powerful tool for phasing, coordinating and communicating planned work to a variety of audiences including project stakeholders and those directly responsible for executing the work. These schedules also support simulated what-if scenarios.

5D Cost Management Capabilities
Every element in the BIM model can be attributed to what it will actually represent in terms of resources and respective costs. This capability will allow a parametric and dynamic quantity take-off for bills of materials, which will result in a more accurate estimate and therefore less time spent by the estimators on the quantity take-off and more time spent on performing cost estimate analysis.

BIM Integrator
The BIM integrator is a role needed when BIM is implemented with certain delivery methods, in particular, the traditional Design-Bid-Build. The BIM integrator role can be assigned to the architect/engineer, builder, CM or another independent party. The main responsibilities for the BIM integrator role are:

- Ensure a smooth transition of the model from the design to the construction phase.

- Maintain a central model at all times and incorporate the latest available information from multiple project participants.
- Bring new project team members, (subs, vendors, etc) up to speed on the BIM project objectives and current model status.
- Ensure a complete and thorough transition of the model from the construction phase to the owner.
- Verify, in all the project phases, that the model meets the owner's BIM requirements and the project BIM specifications.
- Assure interoperability between models on those projects where a multiple model approach is unavoidable.

Pre-Design Phase

Establishing BIM Goals & Objectives
The CM shall work with the owner to establish the goals & objectives of using BIM on the project. Project BIM expectations and the team BIM qualifications shall be set as early as possible to ensure alignment of the expectations with the BIM roles and responsibilities among the project stakeholders.

The goal during this phase is for the owner to establish a clear understanding of the BIM scope of work, phases of implementation, team responsibilities and expected outcome. The CM shall educate the owner on the BIM process and promote its appropriate use. There also needs to be a clear understanding of any implications that might affect the project as well as the shortcomings of the BIM technology as it is related to the project.

The CM shall include the BIM objectives and team responsibilities in the Construction Management Plan.

Selection of the Design Team
If it is established in the Construction Management Plan that BIM will be used in the execution of the project, the CM shall include the BIM experience of the design team in BIM and their implementation approach among the selection criteria in the Request For Qualifications (RFQ). The CM shall market the project to the design community and seek design teams with BIM experience to propose on the project. During the RFQ review and interview process, BIM capabilities of the design teams should be given appropriate weight, depending on the importance of BIM for that project in the selection criteria. BIM scope of work shall be defined and made clear to the designer and all the members that will be joining the team thereafter.

Contract Development
As the CM works with the owner's legal counsel in developing the contract for the design team, appropriate language shall be recommended related to the use of BIM by the design team and the availability of the model created by the design team to other project team members, including the CM and the construction team. The contract also needs to address the structure or format of the BIM, including the level of detail and allowable use of 2D detailing. Contract shall also address the use of BIM by structural, civil, MEP and other subconsultants.

Project Procedures Manual
The Project Procedures Manual developed by the CM shall address the procedures related to BIM for all phases of the project. The Project Procedures Manual shall establish modeling criteria for BIM so that the model can be used for all the project BIM objectives. This may also be a stand-alone document rather than part of the Project Procedures Manual. If it is a separate document, the Project Procedures Manual shall integrate the requirements of this document.

BIM standards for the project shall be developed and included in the design contract and further expanded in the BIM procedures. BIM distribution and access protocols shall be clearly defined in the procedures. BIM procedures that impose requirements on contractors must be coordinated with bid and contract documents.

Model Development by the CM
It will be in the best interests of the project if the design team adopts the BIM approach to development of design documents and the construction team uses BIM in their construction approach. However, if this is not the case, the CM shall consider developing the model itself and providing its services using this tool. Depending on the project, the CM may be able to develop a model to create budget and detailed estimate, 4D scheduling, constructability reviews and specific site logistics and coordination issues. Adoption of this approach will depend on the type and size of the project, the cost and level of detail of the model and the resulting benefit of the model. If the development of a detailed model for the complete project by the CM is not a good investment, the CM shall explore modeling portions of the project to achieve specific, relevant functions that can enhance the success of the project with a positive return on investment.

BIM and project delivery systems
The CM shall recognize that the application of BIM varies significantly based on the delivery system chosen. Use of Design-Build approach maximizes the chance of collaboration between the designer and builder using the model. Use of CM-at-Risk with the possibility of major subcontractor providing design assistance during the design phase also enhances the use of BIM as a collaborative tool. The traditional Design-Bid-Build process may limit the interaction between the designer and builder with the model until construction starts; in this case the BIM integrator role is a key to the success of the BIM implementation. The delivery system will also influence the adoption of BIM on a project. The Construction Management Plan and Project Procedures Manual will also be significantly different as related to BIM implementation, based on the delivery system.

Design Phase

Compliance with BIM standards
As defined in the pre-design phase and the designer or design-build entity contract, the CM shall conduct a 'BIM kick-off' meeting to further clarify and agree on BIM standards and implementation procedures on the project. Periodic design review meetings must address and monitor compliance with established BIM standards. Design milestone submittals (such as schematic, design development, construction documents) must be reviewed for compliance with established BIM standards.

Design Document Review
The CM and the designer or the design-build team shall utilize the BIM model to perform multiple design reviews. The model can be used to assist in compliance with design criteria and to perform

and facilitate multiple group review meetings. Using the BIM model for design review will help the team visualize the spaces and functions, optimize the design and facilitate the decision making process. The CM shall take full advantage of the visualization benefits of the BIM so that the Owner, user groups and other stake-holders can see their project virtually and minimize the potential for changes after the building is constructed.

The model should be used to perform clash detection and facilitate coordination between all design disciplines. During design reviews, "virtual hardhat reviews" could be done; this is a virtual walk through the model to examine and review jobsite logistics and the facilities being constructed or renovated. 'Clash detection' exercises shall also be performed by the designer, CM or a third party to identify physical conflicts, spatial constraints and to facilitate better coordination among various disciplines.

Document Control
Document control protocols should be established in the pre-design phase. Document control is a very important part in a BIM designed project, due to the likely existence of multiple database structures. The CM (or the BIM integrator, if different than the CM) shall be responsible for document control and should ensure that everyone on the team follows the document distribution and other document control protocols. These protocols must also define procedures for accessing and manipulating BIM model(s). If any revisions to the document control protocols are identified, the CM is to ensure that the BIM procedures document is updated.

Contracts/Agreements
See Procurement section.

Public Relations, Community Outreach and Buy-In
Using the BIM model and creating phasing and 4D simulation, the CM shall assist the Owner in public relations activities, particularly to communicate the project with the community and with parties that will be impacted by the project.

Cost Control
Depending upon the BIM objectives established for the project, the CM should attempt to maximize the use of model based budgeting and estimating. On projects that require the development of design fully utilizing BIM processes, the CM shall collaborate with the design team to define model development criteria to enable development of model based estimating. To benefit most from the model, the cost structures could be developed earlier than in a conventional project. The model based budget and estimate can be used for options analysis and value engineering, including exercises to modify the design to match the budget, as needed.

Procurement Phase

Influence of Delivery Method
The bidding process and the use of BIM will change significantly based on the delivery method. The CM shall be knowledgeable about the application of BIM in the procurement phase for the various delivery methods.

Bidding and Contracting Process

Bid Documents
Building Information Models developed by the design team should be formally included as part of the procurement documents. This approach provides the responders with the maximum information available to facilitate their full understanding of the project. If the owner and designer choose not to include the modeling documentation formally as part of the procurement documents the CM should encourage their use as reference documents, with proper delineation of order of precedence of the information provided.

Contracts/Agreements
Ideally, the CM should encourage the owner to have the BIM requirements written into the contract documents. Typically, this would have been established in the Construction Management Plan. When the Construction Management Plan incorporates full BIM implementation, the CM shall verify that the model and all its parts or sub-models and databases are required to be updated and revised to reflect as-built conditions. The contract should require that as-built documented models and databases be linked together and submitted at the end of the project. Training on how to access information from updated model must be included as part of the contract.

Pre-Bid or Pre-Proposal Meeting
The CM shall use the model to communicate the project to the prospective bidders or proposers at the pre-bid or pre-proposal meeting and to facilitate generation of comments and questions by contractors prior to submission of bids or proposals. CM shall also highlight and explain the BIM requirements of the project.

Marketing of the Project
The CM shall market the project in general and generate interest from the entities that are well versed in the BIM process in order that qualified entities with extensive BIM experience and knowledge participate in the procurement phase.

Selection of Contractor(s), Design-Bid-Build, CM at Risk or Design-Build
In the case of a Design-Bid-Build process, the CM can use the pre-qualification process and incorporate BIM experience as one of the factors. After bids are received and evaluated, a pre-award conference with the apparent low bidder shall be held. The CM shall verify the capability of the contractor to comply with the BIM requirements of the project articulated in the contract documents.

In the case of a Design-Build or CM-at-Risk delivery process, the selection process likely will include review of written proposals and interview(s). The CM shall play a central role in reviewing the proposals for compliance with BIM requirements. In the interviews, the CM needs to ensure that the approach and capabilities of the entities related to BIM are clearly articulated and are considered as one of the factors in the selection.

Construction Phase

Transitioning the Model to Construction
The CM (or the BIM integrator, if different than the CM) shall work closely with the construction phase team to transition the model to the construction phase, using the document control protocol (see Design phase).

During construction, the CM shall facilitate proactive participation of stakeholders including owner/operator, designer, contractor, subcontractors, suppliers, equipment manufacturers and system integrators as well as select third parties such as building official(s), local utility companies, insurers, sureties and other stakeholders. The CM should ensure that the responsibility for updating each model and all requirements from the above listed team members must be clearly defined in the scope of work and the contract language.

On-Site Facilities
Construction administration has been considered the final stage of design, when issues are addressed and solutions are devised for field-encountered problems as well as revisions in the scope of work. The CM should encourage the full use of the BIM to address problems and facilitate solutions. To facilitate this capability on projects of appropriate size and complexity, it is recommended to have an available on-site model and a designated BIM integrator who will monitor and update the model as the project moves forward. Availability of a 'virtual plan room' will also significantly enhance the use of BIM for construction.

Coordination
The contractor, CM-at-Risk or design-builder is responsible for project coordination throughout construction. Regardless of project delivery method, the builder should be contractually obligated to use the model to ensure project coordination. This would include revising the model based on existing conditions, incorporating information from subcontractors' shop drawing submittals, and clash detection. The role of the CM is to ensure and encourage the full use of the BIM tool in coordination and issue resolution.

Time Management
Use of the 4D model is a great tool in time management. The CM needs to encourage its use by the builder. It will also be prudent for the CM to develop a project specific 4D model based on the project BIM. The construction schedule can be tied to the model to allow visualization of deviations from planned sequences and durations. This practice should be incorporated in the periodic progress review process. In order to accomplish this, the CM needs to establish the protocol through the contract documents or procedures manual.

Budget & Cost Monitoring
The builder has the opportunity to use the BIM for the cost management of the project. The opportunities for the CM to use BIM for cost management during construction are limited. Some of the opportunities for using the model in cost management are discussed under change orders.

RFIs, Submittals & Shop Drawings
The CM should encourage the use of the model to produce shop drawings. Such requirements must be defined in the contract documents and implemented. The review of the shop drawings can be done by the design team by reviewing the model submitted by the builder. The extent of such extensive BIM implementation needs to be defined as early as the Construction Management Plan, articulated in the designer's and builder's (or design-builder's) contract documents and project procedures. Further the CM needs to verify that there is buy-in to the full implementation by the stake-holders to maximize the chances of success. Use of the model for RFI review can be very effective by helping the design team visualize the conditions related to the RFI.

Change Orders
When reviewing and pricing the change orders, the BIM can provide the CM with a great tool to visualize the change by viewing the model. The responsibility for documenting the change orders on the model must be clearly articulated and generally should be placed with the builder. The CM shall verify such incorporation, similar to their role in verifying the posting of the changes to the as-built documents.

Owner-Purchased Materials and Equipment
If during construction additional components, materials and/or equipment supplied by the owner are installed, the model shall be updated by the builder or BIM integrator to include the owner-purchased designation. Quantities and schedule of values for the materials can be extracted from the BIM model for an accurate count and to save time.

Record Model
The CM must monitor that model updates are done throughout the construction phase and, if required by the owner, the model evolves into an as-built model for record purposes. It is also possible that the builder may start its own model, rather than build upon the model produced by the designer. Irrespective of the approach, the CM shall ensure that contract language is clear on the entity responsible for updating the model as an as-built document and on the desired level of detail. Further, the CM needs to monitor compliance to verify that the owner receives a proper as-built model at the end of construction, in accordance with the contract requirements.

Post Construction Phase

Transitioning the Model to the Owner and Facility Management
The CM shall ensure that the model is transitioned to the owner at a minimum as an as-built model developed though the design and construction process. Such model can provide benefits to the owner related to facility management, such as space planning related to occupant assignment, furniture and equipment inventory etc.

On the other hand, a model that can be transitioned to the facility management is of most value to the owner. Such model is highly dependent on the owners' facility management systems and their current operations and maintenance processes and procedures. The CM needs to work closely with the owner's facility management team and the project team to define what the facility management team wants and needs from the model and in what format will the information be useful for future use.

During the post construction phase the CM shall continue to work collaboratively with the stakeholders including owner/operator, designer, contractor, subcontractors, suppliers, equipment manufacturers and system integrators. Responsibility for mastering the as-built, and/or facility management (BIM) model resides in the office of the facility's operations. This includes managing and updating the model. The CM shall also manage the proper training for the owners and the facility operators.

Maintenance Manuals and Operating Procedures
The software technologies are being developed to link O&M documentation to the product data that would be linked to the as-built models. As operations personnel need to reference training videos for refreshers, or operating procedural documentation it will be accessible via a BIM link.

The CM needs to stay abreast of these developments and facilitate their incorporation into the project as and when appropriate.

Spare Parts and Warranties
Schedules of spare parts submitted and the related warranties can be input into the as-built model, accessible to the operations personnel. The CM needs to include such requirements in the contract of the builder and verify that it is done or arrange for a third party vendor to incorporate such information into the model. Once this model is transferred to the facility operations personnel, it is their responsibility to keep the inventory of the spare parts schedules updated. These personnel would then be triggered to order new parts accordingly. The responsibility of the CM is to verify that training of the facility operations personnel is included in the contract document and conducted before turning over the facility and the model to them.

Final Permits
The CM should also endeavor to verify that copies of final permits are linked to the as-built model for reference by the operations personnel.

Asset/Facilities Management
Regular inspection, maintenance, and repair logs can be linked to the model to provide an accurate up-to-date history of the facility including equipment and materials.

The CM's responsibility is to stay abreast of the available technology and facilitate implementation appropriate for the facility and the capabilities of the facility operations personnel.

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Petitioners' Attachment No. JCK-2R

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, DC 20314-1000

ER 1110-2-1302

CECW-EC

Regulation
No. 1110-2-1302

30 June 2016

Engineering and Design
CIVIL WORKS COST ENGINEERING

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DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
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CECW-EC

Regulation
No. 1110-2-1302

30 June 2016

Engineering and Design
CIVIL WORKS COST ENGINEERING

1. Purpose. This engineer regulation (ER) provides policy, guidance, and procedures for cost engineering responsibilities for all Civil Works projects assigned to the U.S. Army Corps of Engineers (USACE).

2. Applicability. This regulation is applicable to all Headquarters USACE (HQUSACE) elements, divisions and major subordinate commands (MSCs), districts, laboratories, and field operating activities involved in the Civil Works program. It is applicable to cost products prepared by USACE representatives or others, Federal or non-Federal, in support of all authorization, appropriations, decision, and implementation reports and documents for all Civil Works projects that invest Federal dollars.

3. Distribution Statement. Approved for public release; distribution is unlimited.

4. References. References are in Appendix A.

5. Definitions. Various acronyms and terms are commonly used in this regulation to describe phases, types, and parts of cost products. For commonality, and to ensure understanding, definitions used in this regulation are described in the Glossary.

6. Policy. All cost engineering products required to support USACE managed Civil Works projects must be prepared in accordance with this regulation and all referenced regulations, policy and guidance, including engineering manuals, pamphlets and USACE memoranda. Cost engineering products are defined as those cost-related products performed and provided by the cost engineering office, including quantities, estimates, schedules, risk analyses, total project costs and cost-related reports.

a. By 33 U.S.C. 622, the Secretary of the Army, acting through the Chief of Engineers, will contract for improvements to the rivers and harbors in the manner most economical and advantageous to the United States. Contracts will be used for this work if private industry has the capability and the work can be done at reasonable prices and in a timely manner. All construction cost estimates are to be prepared in accordance

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This engineer regulation supersedes ER 1110-2-1302, dated 15 September 2008 with 33 U.S.C. 624, in as much detail as though the Government were competing for the award. Therefore, all costs that a prudent and experienced contractor would expect to incur shall be included in the cost estimate. Civil Works projects originate when a state or city (local sponsor) requests assistance from USACE for an improvement to a national river or harbor. These projects are investigated and developed under the requirements of ER 1105-2-100 and ER 1110-2-1150. Congressional authorization and appropriations are required to start design or construction of most Civil Works projects.

b. Civil Works projects are planned and approved in accordance with ER 1105-2-100, Planning Guidance Notebook, and are designed in accordance with ER 1110-2-1150, Engineering and Design for Civil Works Projects. Civil Works projects specific to Dam Safety should also adhere to ER 1110-2-1156, Safety of Dams – Policy and Procedures, as well as these regulations. Cost development within these regulations must continue to adhere to this regulation (ER 1110-2-1302).

c. Budget Estimates and Independent Government Estimates. Cost estimates are categorized into two types: budget estimates or Independent Government estimates (IGEs). The budget estimate supports funding requests as well as comparisons made to current available funding. Updated costs during project execution and comparisons to the available funding are also referred to as current working estimates (CWE). IGE's are estimates that are prepared to support a contract award. The IGE consists of a title page, signature page, and price schedule, submitted to the Contracting Officer under protective sealed For Official Use Only (FOUO) envelope. The Government estimate back-up data is the detailed cost data, which includes production and crew development methodology, labor, equipment, and crew backup files, subcontractor quotes and all other data identified as detail sheets. The backup data is FOUO and is not to be released. Supporting documents that are publicly available as parts of the solicitation (such as plans, specifications, and project descriptions) are not part of the Government estimate.

(1) In accordance with Federal Acquisition Regulation (FAR) 36.203, Independent Government Estimates must be prepared in as much detail as though the Government were competing for award. All IGEs must be developed as complete and as accurately as possible based upon the latest available information. The cost estimate will represent the "fair and reasonable" cost to the Government.

d. All estimates should include within the cost estimate all allowable costs, which a prudent and experienced contractor would expect to incur. Design (if applicable) and construction efforts needed for project completion must be included in the cost estimate. These costs might address such items as performance specifications, deliveries, site preparation, access, cleanup, and other such items not included in the plans and specifications but would be part of the costs a prudent contractor would expect to incur.

e. Cost estimates must be defensible documents that include description of project scope, major assumptions, sufficient rationale, and basis of costs presented within the estimate. Cost estimates are to be developed in as much detail as practical for the work involved for the specific design phase. At a minimum, the detail included in the cost estimate will make it a standalone and defendable document. Estimate data that includes unit prices, lump sums, and allowances must contain a basis for cost.

f. Detailed preparation requirements and the format of the cost engineering products must follow policy and guidance.

g. Cost engineering products developed by architect-engineer (A-E) contractors or by other offices (i.e., Area Offices, Resident Offices, etc.) must conform to all cost ERs, EMs, and other applicable regulations (shown at Appendix A).

h. Quality control reviews must occur on all cost engineering products (e.g., quantities, estimates, schedules, risk analyses, total project costs, cost-related reports and appendixes, etc.), whether prepared by the cost engineering office, by other authorized offices (i.e., Area offices, Resident Offices, A-E Firms, etc.), or by contract, as prescribed by the specific review procedures in this regulation and those referenced. Reviews will be performed by qualified government personnel in the cost engineering office, which have not participated in the development of the cost product. Cost engineering products must be reviewed to confirm that each estimate meets the project scope and associated USACE regulations and that the assumptions and logic used are valid in estimating the cost of all features.

i. Cost engineering products used to support decision documents for the MSC, HQUSACE and/or Congressional authorization/appropriation must undergo an agency technical review (ATR). HQUSACE mandates that the Review Management Organization (RMO), including National Planning Centers of Expertise (PCX), coordinate with the Civil Works Cost Engineering and Agency Technical Review Mandatory Center of Expertise (Cost MCX) currently located at the Walla Walla District.

7. Function of the Project Delivery Team.

a. USACE is committed to effective management of the scope, quality, cost, and schedule of each project by using project delivery teams (PDTs). ER 5-1-11 presents the requirements for establishing a PDT for all projects. A project manager (PM) leads each PDT, which is comprised of everyone necessary for successful development and execution of all phases of the project. The PDT may consist of individuals from more than one USACE district and may include specialists, consultants/contractors, stakeholders, or representatives from other Federal and state agencies. Team members are chosen for their skills and abilities to successfully execute a quality project.

b. A member of the cost engineering office must be an integral PDT participant, supporting the PM in developing, monitoring, and management of cost engineering products from the study phase through project completion.

c. The coordinated efforts of all PDT members must provide sufficient project information for development of all cost engineering products at the established project development level required within ER 1110-2-1150.

8. Responsibilities.

a. Project Manager (PM)/Planner. The assigned PM/planner provides support to the cost engineering element with sufficient funding and time to produce quality products in accordance with Federal law, Federal Acquisition Regulations, and USACE regulations, guidance, and policies. In support of cost engineering product development, the project team lead is responsible for the following:

(1) Ensure cost engineering representation is included as a full and active PDT member in the development and update of cost engineering products at all project phases and milestones from inception to completion.

(2) Provide PDT leadership and facilitation with responsibility for assuring that the project stays focused on the public interest and on the customer's needs with resulting clarity in project scoping that supports cost engineering product development.

(3) Ensure the PDT provides the cost engineer with all necessary data and information within their respective areas of responsibility to support development of quality cost products.

(4) Support cost engineering principles and applications relative to project scope development and management, quantity development, estimates, schedules, risk analyses, value engineering, cost updates, and cost management.

(5) Coordinate with and rely on cost engineering approved data when reporting costs, schedules and risks internally and externally.

(6) Develop a Risk Management Plan (RMP) which identifies planned measures for risk identification, and risk reduction actions utilizing the construction estimates, schedules and risk analyses to effectively manage the risk throughout implementation of the project; the RMP is a living document that is updated in coordination with the PDT and cost engineer as the project progresses through all phases of project execution.

(7) Coordinate the project schedule and risk analysis within the PDT structure to develop the risk management plan and establish and justify chosen project contingencies with corresponding confidence levels as applicable.

(8) Assure each project has received a formal Cost ATR on the project cost products, cost changes when required.

(9) Coordinate and consult with the Cost MCX technical experts and engage their services as early as possible in the planning, design, and agency technical review (ATR) processes. Communicate with the Cost MCX on high visibility projects or as required.

(10) Provide district project review board technical support on project costs as required.

(11) Ensure the Total Project Cost Summary (TPCS), Justification (J)-Sheet and all reports correctly reflect the costs developed within the cost engineering office, respective work breakdown structure and features and cost-sharing agreements. Ensure the TPCS also includes the cost data from the PDT and other appropriate offices, including any sunk or spent costs to ensure a complete TPCS. PDT involvement must include spent and forecast real estate, PED and construction management costs.

(12) Review, approve, sign, and date all TPCS documents.

(13) Ensure timely coordination and collaboration with programmer, economist, and project cost engineer at critical milestones.

(14) Assure the cost PDT member communicates with the PM, on the requirements concerning update of cost engineering products.

(15) Ensure cost engineering receives annual funding to support cost management practices and controls, program updates for review and concurrence. For mega-projects (see para. 26 g.), ensure the allocation of appropriate resources for project controls and earned-value management practices as required.

b. Project Delivery Team. The Project Delivery Team (PDT) carries critical responsibilities in supporting the cost engineering functions and cost engineering product development. The PDT must:

(1) Develop scope and technical information for delivery of a complete usable project. Develop sufficient design documents to support the cost engineering products at the various project development phases. Coordinate with the cost engineer to determine the appropriate level of project details. The PDT and design personnel must work with the cost engineer to determine the design level required for function, safety and risk reduction.

(2) Must establish a project acquisition plan at Feasibility phase to reduce acquisition risks and improve estimate assumptions and quality.

(3) Participate in risk meetings throughout the project life to develop and maintain the project risk register. Also, the PDT members must help identify the cost and schedule threshold levels associated with the identified risks.

(4) Support the cost engineer in development of the total project cost by providing the associated scope and estimated costs of non-construction elements within the CW-WBS. This includes the 01-Lands and Damages, 02-Relocations, 22-Feasibility, 30-Planning, Engineering and Design, 31-Construction Management and spent cost accounts.

(5) Responsible for defining confidence/risk levels associated with their office products. See information under “Risk Identification for Determining Uncertainties and Contingencies” for details regarding PDT participation in risk development and management.

c. Chief, Cost Engineering. The Chief of the Cost Engineering Office is responsible for the development of all cost engineering products including cost estimate, construction schedule and risk analysis for the construction CW-WBS features as a member of the PDT and in accordance with HQUSACE regulations, guidance, and policies. Responsibilities include:

(1) Responsible for adhering to the latest cost engineering regulations, manuals, and guidance. The chief manages the overall workload, which is subject to funding, ensuring a capable workforce by hiring adequate resources, and providing necessary training and software tools. Software includes the mandatory Microcomputer Aided Cost Estimating System (MCACES), Cost Engineering Dredge Estimating Program, quantity take-off, scheduling programs, and risk analysis (Crystal Ball).

(2) Responsible for assuring a cost engineering PDT member is actively engaged in the planning and execution of projects.

(3) Responsible for the quality of cost engineering products during all phases of development. Quality responsibilities include those cost engineering products prepared by self or others, whether in-district, other districts, architect-engineer (A-E) community, or other organizations where Federal design and construction dollars are USACE managed.

(4) When cost engineering products are to be prepared by others (AE's, local sponsor, etc.), ensure that cost products developed comply with USACE cost engineering regulations, policies and guidance, including the support of ATRs.

(5) Responsible for ensuring that cost engineering products prepared by A-E firms or others are reviewed and validated within the district cost engineering office. This will be evidenced by the chief of the cost engineering elements signature on the cost estimate before release or submission.

(6) Ensure resource needs for all appropriate estimating activities, including site visits prior to and during construction, are properly communicated to the PM to facilitate the provision of adequate funding and scheduling for cost engineering requirements within the Project Management Plan (PMP).

(7) Ensure cost engineering products are updated, reviewed, approved and signed by the cost engineering chief in accordance with applicable sections of this and other applicable regulations.

(8) Document and review bid data and results, protests, and mistakes in bids. Analyze, evaluate, and make recommendations on proposed district actions for bid protests and mistakes in bid.

(9) Support HQUSACE Cost Engineering initiatives that include but are not limited to cost engineering database development, usage, historical recording of cost estimate data, bid data results, and construction feature unit pricing.

(10) Support USACE, contracting, and PDT processes including bid schedule development, bid and proposal evaluations, source selection boards, project review boards, value engineering, quality management, quality reviews, ATRs, and independent external peer reviews.

(11) Foster and develop qualified cost engineers to support ATR cost product reviews.

(12) Support the PM and PDT members in the total cost management processes.

d. Cost Engineer. The cost engineer is responsible for development of the cost engineering products as defined within this regulation. Responsibilities include:

(1) Support and coordinate with project management, program management, and economists at key milestones of study and cost reporting. The cost engineer must support the PM in the development of the PMP scope as pertains to cost engineering products associated with project execution. The cost engineer will provide the labor estimate for cost engineering services.

(2) Work with all PDT members and local interests to sufficiently define and confidently include project scopes and construction, designs, drawings, quantities, pertinent environmental and permitting restrictions, project schedules and risks in preparing sound budget estimates.

(3) Responsible for the development of all cost engineering products as a member of the PDT and in accordance with HQUSACE regulations, policies and guidance. Non-construction costs (real estate, 30 PED, Construction Management, etc.) will be developed by the responsible PDT members but the cost engineer will support the project manager as the PDT member for gathering the data and ensuring adequate documentation for costs identified in the TPCS.

(4) Quantity development (take-offs) for lump sum project features, CW-WBS estimates, construction schedules, risk analyses, life cycle cost analyses, TPC, cost product narratives and reports, a documented record of quality control checks and documentation supporting the contract negotiation process.

(5) Confirming quantities provided by the PDT and developing sub-quantities for items requiring additional documentation.

(6) Performing quantity, cost, schedule and risk updates as required to support design changes, acquisition strategy changes, budget estimate requests and IGEs.

(7) Identification to the project manager a budget allowance for Management Control activities within the TPC to assure cost, schedule, and risk are living documents and are used as a tool throughout the project life.

(8) Provide cost engineering support in the development of Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) costs in support of construction estimates and economic calculations.

(9) Provide cost estimating support to the value engineer in conducting value engineering studies.

e. Cost engineering services by Non-USACE or Engineering Firms. Preparation of budget estimates, Independent Government Estimates and associated cost engineering products are inherently the responsibility of the Government when Federal funds are to be requested, received or spent. When others develop cost engineering products for USACE projects, the tasking and product development are the responsibility of the USACE Cost Engineering Office. These services must be provided by personnel experienced in cost engineering, scheduling, and cost risk analysis. Cost products developed Non-USACE will be provided to the Cost Engineering office for review and subsequent approval. The Cost Engineering office will assume ownership of the products for proper use of the cost information.

f. Civil Works Cost Engineering Mandatory Center of Expertise. The MCX has certain USACE responsibilities to support the civil works mission. Responsibilities include:

(1) Assisting HQUSACE with policy development, policy/guidance review and enforcement, for Cost and Schedule Risk Analysis (CSRA), agency technical reviews, and Cost Engineering Dredge Estimating Program (CEDEP).

(2) Maintaining technical expertise related to current cost engineering regulations and guidance.

(3) Provide technical support to HQUSACE on development, upgrade, maintenance, and implementation of MCACES and related supporting databases.

(4) Provide technical assistance and resources to HQUSACE, division command, or MSC and/or district command on cost engineering issues and product development including quality control and technical reviews.

(5) Serve as the proponent for the CSRA development and policy.

(6) Serving as a quality assurance, and quality review agent as required by current USACE policies on cost related products. Ensure that the Cost ATR reviewers are qualified and technically competent with the necessary technical experience to perform the Cost ATR and maintain a database of qualified personnel.

(7) Receiving, interpreting, disseminating, and implementing cost engineering guidance, direction, and correspondence from higher authority in a timely manner.

(8) Participating in HQUSACE Cost Engineering Steering Committee and lead subcommittee efforts.

(9) Developing and providing cost engineering instructors at the national level to help develop and mentor the cost engineering community.

(10) Serve as Technical Center of Expertise for the Construction Equipment / Civil Works Cost Index Database. This includes all research, development and communication.

g. Division or MSC Cost Engineer.

(1) Serve as division or MSC point of contact in communicating with HQUSACE cost engineering offices.

(2) Receive, disseminate, and implement cost engineering guidance, direction, and correspondence from higher authority in a timely manner.

(3) Establish and maintain a cost engineering quality assurance program overseeing the district's quality control to ensure the accuracy and completeness of project cost engineering products prepared either in-house or by A-E firms.

(4) Conduct periodic field reviews of district commands' execution of cost quality management and recommend necessary corrective actions when warranted.

(5) Support and encourage technical development and training of USACE cost engineers in performing ATRs of cost engineering products.

(6) Review proposed project reports requiring approval above the authority delegated to district commanders. Where policy/guidance dictates, assure districts have obtained the required ATR certifications.

(7) Participate in HQUSACE Cost Engineering Steering Committee and lead subcommittee efforts.

(8) Conduct and lead annual regional cost engineering meetings that include cost engineering supervisors and senior engineers. Meetings should address current regulations, cost related programs, issues, findings, recommendations, resolutions, and progress.

(9) Provide technical assistance to districts and MSC elements on cost engineering issues. Consolidate and disseminate MSC-wide historical cost data.

(10) Provide technical support to HQUSACE on development, upgrade, maintenance, and implementation of MCACES and related supporting databases.

(11) Support the Department of Defense (DoD) Tri-Service Cost Engineering Certification Board by encouraging cost estimators within the division or MSC area of responsibility to obtain certification and assist the board with proctoring tests for candidates. At a minimum, certification as a Certified Cost Consultant or Certified Cost Engineer must be obtained and maintained.

9. Cost Engineering Products and Updates. Cost engineering products include quantities, estimates, schedules and escalation, risk analyses and contingencies, and

cost reports. These products are critical management tools used for establishing and monitoring costs, schedule, and risks over the project life cycle.

a. Cost engineering involvement in the project's cost estimate development and updates are continuous. The level of estimating intensity varies with progression through the different phases of project development and implementation. The five typical project phases are:

(1) Federal Interest Determination (Alternative Studies).

(2) Feasibility phase.

(3) Preconstruction, engineering, and design (PED) phase.

(4) Construction phase.

(5) O&M, Repair, Replacement, and Rehabilitation phase.

In some cases, such as Continuing Authorities Program (CAP) projects, phases are combined into Feasibility and Implementation.

b. Update of the cost products are a key component to project management controls. Cost engineering products must be updated to reflect project scoping changes, clarifying technical information, acquisition strategy identification or changes, construction element changes and current commodity cost (labor, equipment, materials, etc.). Update of construction schedule and cost and schedule risk update.

(1) Regular updates (annually or sooner) must be performed to ensure the total project cost estimate is based on current information. The cost PDT member is required to evaluate changes on the project for the above items to determine appropriate methods for updating the cost products. Full updates (requiring updated cost pricing based on the above factors must occur within a two-year timeframe measured from the previous estimate preparation date. Escalation of cost (if deemed appropriate by the cost development responsible personnel) may occur within the two-year period.

(2) Total project cost estimates presented for budget or funding requests must have an estimate preparation date within two years of the date of submission.

(3) Total project cost estimates presented in Chief of Engineer's reports must have an estimate preparation date within two years of the report date

(4) For active authorized total project costs, the cost products must be updated annually as identified above and include spent costs within TPCS. For projects that are currently not active and are attempting to seek funds to become active, the product submittal must follow the requirements from above. HQUSACE reserves the right to require estimate product updates regardless of timelines. Refer specific update requirements including review requirements to the Cost MCX.

c. The Civil Works Construction Cost Index System (CWCCIS), EM 1110-2-1304, must be used to update unit prices and various project cost features to current or future price levels. CWCCIS indices used for future projections are developed directly from the escalation factors provided to the Federal agencies by the Office of Management and Budget (OMB). The OMB factors are published by HQUSACE, Programs Division, in the Engineer Circular (EC) for the Annual Program and Budget Request for Civil Works Activities.

10. Cost Engineering Software Tools. The USACE approved estimating software programs, Microcomputer Aided Cost Engineering System (MCACES) and the Cost Engineering Dredge Estimating Program (CEDEP), are the required software programs for the preparation of Civil Works cost estimates throughout USACE. HQUSACE may mandate other industry software for applications in quantity development, project scheduling, and risk analyses. Construction schedules must be developed using standard industry recognized scheduling software. A statistically based Monte Carlo risk analysis software must be used for TPCS values greater than $40 million. Current mandated software systems should be confirmed from the latest guidance provided by HQUSACE, Cost Engineering office.

a. MCACES is a cost estimating program used by cost engineering to develop and prepare all Civil Works cost estimates. Using this system, estimates are prepared uniformly allowing cost engineering throughout USACE and the A-E community to function as one virtual cost engineering team. The latest HQUSACE approved version of MCACES is mandatory beginning at the feasibility phase for the Federal recommended plan.

(1) MCACES software is supported by the following cost-related databases:

(a) Equipment Library - Engineer Pamphlet (EP) 1110-1-8 presents construction equipment hourly ownership and operating costs. These hourly rates are one of the supporting databases in MCACES software and must be used in the preparation of all cost estimates. Public Law requires fair and reasonable costs are to be determined from Government estimates prepared as though the Government were a well-equipped contractor; as such, pamphlet hourly rates are based on ownership and operating costs, and are not rental rates. Rental costs typically found in modifications and claims are determined from the contractor's rental agreement.

(b) Labor Library. Labor market research including the minimum by law, Davis Bacon wage determinations establish the prevailing hourly wage and fringe rate estimates for the supporting MCACES labor library local to each project location.

(c) Unit Cost Book Library. The Unit Cost Book Library is a generic composition of construction tasks including associated crews (equipment and labor), materials, and assumed productivities. In general, these costs are presented at in national average pricing and require localizing through (1) published adjustment factors, (2) re-pricing of labor, equipment, and materials through local market research, or (3) a combination of methodologies as appropriate.

11. Quantity Development. Project scope, design documents, and associated assumptions are the basis of quantity take-offs and calculations. They are an important aspect of cost estimate development and serve as a critical basis of estimate data. Regardless of the source, the cost engineer must ensure quantities are supported by a defensible, documented source that reflects the project scope and design level that is traceable and can reasonably support an independent quality review. Design uncertainty and quantity variation must be considered within the cost and schedule risk analysis study.

12. Civil Works Work Breakdown Structure. All project cost estimates must be organized according to the CW-WBS format (Appendix B). As a minimum, each cost estimate must be developed to the sub-feature level of the CW-WBS. The TPCS and budget forms (for example, PB-3) used for budgeting and programming purposes are required to be developed to at least the WBS feature level. The lower CW-WBS estimate structure should be developed to reflect the required activity elements and the anticipated sequencing that logically support project schedule development and respective risks within a risk analyses.

13. Cost Estimate Classifications.

a. To support the Civil Works missions addressed in ER 1105-2-100, cost estimates are required for all phases of a project. Detailed cost estimates should be considered For Official Use Only (FOUO) and managed in accordance with AR 25-55 and FAR 36.203. In a typical project life, cost estimates can be divided into two types: budget estimates or IGEs. The budget estimate supports funding requests as well as comparisons made to current available funding. IGE's are estimates that are prepared to support a contract award. The basis of an estimate can range from no technical information (very high cost risk and contingencies for uncertainties, considered Class 5) to complete plans and specifications (very low cost risk and lower contingencies for uncertainties, Class 1). Level of estimate, schedule, and risk quality correspond directly to scope quality and many estimates can be a combination of quality, depending upon level of technical information for certain project construction elements. Class 3 estimates to Class 5 estimates (very limited technical information) carry greater risk in scope and estimate assumptions and details and fall into the category of budget estimates. The goal of any estimate is to develop to the greatest degree of confidence and accuracy for the given level of technical information. This can be accomplished through several estimating approaches such as parametric processes of various cost sources, using quotes, detailed calculations, crew-based unit pricing, cost books, or historical data supported by sufficient explanation. All scope, technical information, and cost estimates must be prepared, as a minimum, in accordance with the classes as prescribed in Table 1. Technical information quality, confidence and completion level must reflect requirements for project scope as the basis for estimate development. There can be circumstances, criteria or programs that require a greater degree of project development and cost product accuracy. Estimates must include not only costs, but also sufficient narrative and notes that clearly describe the estimated scope, anticipated acquisition strategy, estimate assumptions, methodology and intentions of constructing the major elements.

b. Estimate Class is a reflection of the technical information. Quality and confidence are based upon the provided project information, developed scope and ability to estimate quantities and make reasonable or confident assumptions in estimate preparation. Lesser confidence equals greater risks and resulting higher contingencies. Estimates of a Class 3 to Class 1 must be developed using MCACES software. Estimates developed to support funding requests must be developed in MCACES software, regardless of the cost value or the program.

(1) Class 5 – Preliminary technical information (0-5%). These estimates are commonly referred to as "Rough Order of Magnitude (ROM)." There is considerable risk and uncertainty inherent in a Class 5 estimate, resulting in high contingencies. These estimates are NOT recommended in reports because the extremely limited information and high risk poses credibility issues in quality and accuracy. Project designs, methods, and quantity development are unclear or uncertain. There is great reliance on broad-based assumptions, costs from comparable projects and data, cost book, cost engineering judgment and parametric cost data. Development may consist of lump sum cost. Detailed cost items are not required or captured. Each PDT must identify areas of risk and uncertainty in the project and describe them clearly in an effort to improve quality and confidence to a Class 4 estimate level for external reporting purposes. Establishing a credible contingency with qualifications is necessary. Typical Contingency Range could be 40% to 200%.

(2) Class 4 – Early concept technical information (5-10%). There is still substantial lack of technical information and scope clarity resulting in major estimate assumptions in technical information and quantities, heavy reliance on cost engineering judgment, cost book, parametric, historical, and little specific crew-based costs. While certain construction elements can be estimated in detail, there is still a great deal of uncertainty relative to major construction components. Although Class 4 estimates may be more accurate than Class 5 estimates, they are based on a very limited technical information. The PDT must identify areas of risk and uncertainty in the project and describe them to determine the amount of contingency that must be added to a cost estimate to reduce the uncertainty to an acceptable level of cost confidence. Typical Contingency Range could be 30% to 100%.

(3) Class 3 – Technical information (including designs) are approaching a 10-60% quality of project definition. There is greater confidence in project planning and scope, construction elements and quantity development. The estimates rely less on generic cost book items, greater reliance on quotes, recent historical and site-specific crew based details. Class 3 estimates are a reflection of improved technical documents. The estimates must be supported by a technical information (scope, design, acquisition and construction methods, etc.) discussion within the estimate and the uncertainties associated with each major cost item in the estimate. Special attention must be given to large construction elements and items that are sensitive to technical information change. Typical Contingency Range could be 20% to 50%.

(4) Class 2 – Technical information (including designs) quality and confidence approaching 60-80% definition. There is a confident plan and quantity development with fewer broad-based assumptions. There is minor reliance on cost book for low value items, major reliance on quotes, detailed quantities and site-specific crew based details. A Class 2 estimate may include a PDT project evaluation to determine if additional investigations or studies are necessary to reduce the uncertainties and refine the cost estimate. The evaluation must be accomplished as a joint analysis between the cost engineer and the designers or appropriate PDT members that have specific knowledge and expertise on all possible project risks. A risk analysis is recommended as it better defines PDT project path forward regarding risks and basis for determining contingencies. Typical Contingency Range could be 15% to 30%.

(5) Class 1 – Technical information (including scope & design) quality and confidence approaching 80-100%. The estimate is near IGE level. Quantity and installation confidence is strong. There is minimal reliance on generic cost book items, heavy reliance on quotes, heavy reliance on site-specific crew based details. Class 1 does not imply that all unknowns and risks are eliminated. Some estimates prepared to this level should include risk analysis to the degree described in Class 2 above. Results of the risk analysis will be the basis for determining contingencies which are used for the budgetary basis or special contract types. Typical Contingency Range could be 5% to 15%.

Table 1. Civil Works Estimates – Class Level Designation

Project Phase	Scope and Technical Definition		Risk Level	Minimum Estimate Class
Pre-Budget Development (not recommended for reports)	Extremely Limited		Extremely High	**5***
	Pre-Authorization			
Initial Alternatives	Very Limited		Very High	4*
Feasibility Alternatives	Very Limited		High	4*
Feasibility – Federal Recommended Plan	Limited-Fair		Moderate	3
National Economic Decision (NED)	Limited-Fair		Moderate	3
Locally Preferred Plan (LPP)	Limited-Fair		Moderate	3
Funding Request Decision Documents	Limited-Fair		Moderate	3
	Authorization			
Continuing Authorities Program	Limited		Moderate to High	3-4
Civil Emergency Management Program	Limited		Moderate to High	3-4
Alternative Studies	Limited		Moderate to High	3-4
General Re-Evaluation Report	Limited-Fair		Moderate	3
Limited Re-Evaluation Report	Limited-Fair		Moderate	3
Design Documentation Report	Limited-Fair		Moderate	3
Engineering Decision Report	Limited-Fair		Moderate	3
Post Authorization Change Reports	Fair		Moderate	2-3
Other Funding Decision Documents	Limited-Fair		Moderate	3
	Preconstruction, Engineering & Design (working estimates)			
PED 30%	Fair		Moderate	3
PED 60%	Fair-Good		Moderate to Low	2
PED 90%	Very Good		Low	1
IGE <100% Design	Fair-Good		Moderate to Low	2
IGE 100% Design	Very Good		Low	1
	Construction / Post Award			
Budgets (modifications / claims)	Fair-Good		Moderate to Low	2
IGEs (modifications / claims)	Very Good		Low	1

* Do not use in formal/Chief of Engineer's Reports

14. Cost Products by Phase.

a. Studies. For all studies during pre-authorization and post-authorization.

(1) Planning Stage – Alternative Formulation

(a) Federal Interest Determination. During this phase, many alternatives can be considered. Class 5 and 4 alternative cost estimates for this phase may be developed by applying parametric processes of various cost sources, using quotes, calculations, unit prices, cost books, or historical data as backup. Use of MCACES software tools is recommended but not required. The costs of the Planning, Engineering, and Design feature (30 account) and the Construction Management feature (31 account) are obtained through the PDT and may be percentage based upon historical cost data. The costs for the Lands and Damages feature are obtained through the PDT from the real estate office. Alternatives are developed to the same constant dollar basis for fair comparison. Project specific risk-based contingencies are identified for each alternative under comparison.

(b) Tentatively Selected Plan (TSP). During the alternative formulation stage, a final group of potential alternatives are identified for further study and comparison. For comparison purposes, this group of alternatives, including the resulting TSP must be minimum Class 4 cost estimates and supported by a risk analysis to include reasonable contingencies as part of the comparison and formulation. At the alternative formulation stage, use of MCACES software tools is recommended but not required. Estimates are developed to the same constant dollar basis. This screening process will likely determine the TSP, which the District will present to the vertical team for decision. Cost Engineering judgment with support from Parametric processes, properly escalated historical bid cost data, properly escalated corollaries and cost models, demonstrated experience, and/or unit prices adjusted to expected project conditions are acceptable methods of developing project costs for these alternatives. The cost estimate for each viable alternative must sufficiently describe the construction features and elements, the cost basis, type, and method of construction. Cost presentation must include all features at a consistent effective price level and risk-based contingencies. The TSP is an alternative, equal in development for comparison to the other alternatives. Use of MCACES software tools is required for the TSP. Once that TSP is approved by the vertical team, the TSP becomes the Federal Recommended Plan.

(2) Feasibility Phase. Federal and Local Plans. The feasibility level, Federal recommended plan supports funding requests within a Chief of Engineer’s Report. The Federal recommended plan will identify a National Economic Development (NED) and the National Ecosystem Restoration (NER) plan. In the civil works project planning context, NED analysis can be generally defined as economic benefit-cost analysis for plan formulation, evaluation, and selection that is used to evaluate the federal interest in pursuing a prospective project plan. The estimate(s) used to develop the total project cost must be a minimum Class 3 estimate supported by sufficient scoping documents. PDT involvement in establishing and communicating project construction scope and features for confident quantity development is necessary. The estimate(s) must be prepared using the MCACES tools and the established CW-WBS to at least the sub-feature level of detail. When the non-Federal sponsor requests a plan different from the Federally recommended plan, it is referred to as a “locally preferred” plan (LPP). Cost engineering products for both plans must be prepared of equal quality by using the required software and processes for estimates, schedules, and risk-based contingencies for inclusion in the feasibility report. In general and preferred, the unit costs for the major construction features will be computed by estimating the equipment, labor, material, and production rates suitable for the element being estimated. At feasibility stage, key construction elements may not be sufficiently designed to support a full crew-based estimate. With PDT support in defining project scope, alternate estimate approaches for less developed construction elements can include parametric, corollaries and models, quotes and comparisons, and historic data so long as the sources and assumptions are well documented and as recent as possible. If the Federal recommended plan is not the locally preferred plan then a separate TPCS is required for each of these plans. Both plans are updated as required for comparison and reimbursement.

(3) Estimates Submitted for Congressional Re-Authorization. All cost estimates submitted for Congressional reauthorization must be minimum Class 3. If the authorization bill does not pass in that year, the total estimated cost, reflecting the Constant Dollar estimate, must be updated for the next authorization opportunity. Refer to the requirements for updating cost engineering products.

(4) Authorized Projects. Authorized projects that are funded receive further study, more confident design, improved cost engineering products, and resulting lower risk. Projects that are authorized may not yet have the needed funding for project execution and in some cases are subject to appropriations that incrementally fund the project. In

these cases, formal funding requests or decision documents are still required for submission to the MSC and/or HQUSACE.

(5) Smaller projects destined for approval and funding at the MSC or Division, such as CAP, emergency management program and special programs, must be developed to a minimum Class 3 estimate using the MCACES software because they serve as the Federal Recommended Plan.

(6) Preconstruction, Engineering, and Design. As design refinements are made, reflective estimates of an appropriate class quality must also be developed to establish the current total project cost. These are referred to as a Current Working Estimate (CWE). The most recent CWE serves as a comparison check to the Baseline Cost Estimate (BCE). The CWE estimate must be prepared using the MCACES tools and the TPCS form. This is included as a part of any report submitted for reevaluation. A new cost risk analysis must be conducted upon major changes in acquisition strategy, design, and each update in the total project cost. A cost risk analysis report must be included as part of any post authorization report that presents a total project cost to MSC or HQ. The cost engineering product documentation for project submissions to MSC or HQUSACE will be the same as estimate products for the feasibility phase.

(7) Construction Phase. Federal and Local Plans Construction / Post Award Phase Estimates. This refers to estimates for authorized projects that have gone through the solicitation process and have received an initial construction contract award. During the project construction phase, multiple construction contracts and modifications may be required.

b. Operations and Maintenance (O&M). Development requirements for O&M estimates follow the same direction as “Authorized Projects” (see para. 14.a(4)).

(1) Independent Government Estimate. Initial IGEs may fall into two categories: less than 100 percent design and fully 100 percent design. Less than 100 percent design includes those such as design-build that vary in range of design detail and resulting risks and reflect a Class 3 estimate. The fully 100 percent design includes those such as design-bid-build and has lesser risk; it therefore must be developed as a Class 1 estimate. The IGE becomes the standard by which the Government determines whether contractor bid proposals appear fair and reasonable. The IGE is a representation of the best detailed level of design information at time of contract solicitation. The awarded contract becomes the construction contractor baseline in monitoring and management of the construction cost and schedule.

(a) Each IGE is based upon a defined set of plans and specifications and represents the cost of performing the work in the time allocated by determining the necessary labor, equipment, and materials. The bid schedule must be structured for the specific contract in coordination with the cost engineer. Each bid item on the bid schedule must be identified by the appropriate CW-WBS that will allow tracking of the cost needs and expenditures reflecting the appropriations and TPCS.

(b) An IGE of costs must be prepared and provided to the contracting officer prior to receipt of contractor proposals. The contracting officer may require an estimate when the cost of required work is anticipated to be less than the SAT. The estimate must be prepared in as much detail as though the Government were competing for award (FAR 36.203). Prior to opening of bids, access to information concerning the IGE must be limited to Government personnel whose official duties require knowledge of the estimate.

15. Dredging Estimates.

a. Dredging estimates using floating plants must utilize the CEDEP to prepare the estimate (see paragraph 14.c. below for special allowances). The CEDEP program contains proprietary data and NOT to be released to non-Government entities. Due to the proprietary nature of CEDEP tools, when an A-E is involved with developing estimates for projects that include dredging costs, the responsible district cost engineering office must develop all of the dredging unit costs that are CEDEP-based.

b. CEDEP is a supporting estimate for budget estimates and IGE. Most projects have a mixture of non-dredging construction and dredging. For these mixed construction projects, CEDEP must be used to develop the dredging cost, and this cost must be included in the MCACES estimate to calculate total construction cost estimate.

c. Dredging estimates using land-based equipment installed on a floating plant (e.g., crawler dragline on floating platform used for dredging) may use MCACES instead of CEDEP, with the floating plant rates developed using chapter 4 of EP 1110-1-8.

d. Regional Dredge Teams. The use of regional dredge team members is recommended for consultation or the development of dredge cost estimates. Members of regional dredge teams can be contacted for guidance on production rates, effective times, cost data, or other pertinent information. The regional dredge teams can be a valuable resource for estimate development, value engineering studies, and ATRs on projects requiring dredge estimating. Coordination and information can be made through the Cost MCX.

16. Estimating for Performance Specifications Contracts. This includes solicitations for Design-Build Contracting.

a. The selection of design-build or any other contracting method to acquire facilities is the responsibility of the contracting agency. USACE, as a Department of Defense construction agent, is responsible for selecting such methods. One of the requirements for proceeding with design-build contracting is that the project be fully defined, functionally and technically, by performance specifications as described in ER 1180-1-9.

b. For all design-build projects, district commanders will ensure that adequate funding and time are provided for all PDT members to fully develop both performance specifications and the design-build IGE.

c. PDT members must participate in assessing the functional and technical requirements of the project to determine and establish the physical components that comprise the project. The engineering assessment of project components must be based upon knowledge of standard analyses, operating experience, and sound engineering judgment. Senior engineering staff must be involved to provide experienced judgment in establishing the project scope and characteristics. Appropriate outside specialists should be consulted whenever the in-house engineering staff is not sufficiently trained or lacks experience in the type of work and components being considered. All members of the PDT must have input in the decision process for establishing the assumed physical properties to be used in preparing the cost estimate. These properties include size, dimensions, weights, amounts, and materials.

d. Project cost estimates and schedules should include cost and schedule risk-based assessment to address cost of work elements that could impact cost of project execution and construction. Preparation of a Monte Carlo simulated risk analysis is recommended for design-build projects that are deemed high risk, complex, or exceeding the project dollar limit established by USACE policy. A complete risk analysis must be conducted on the performance specifications, project physical properties, and schedule.

17. Profit.

a. Profit is defined as a return on investment and provides the contractor with an incentive to perform the work as efficiently as possible. Profit is applied for civil works budget estimates. Civil works IGE estimates do not include profit unless required to support a negotiated procurement.

b. For early design stage estimates such as feasibility, profit can be estimated as a percentage based on experience. For budget estimates of better developed projects, profit must be developed using an alternate structured approach, specifically the weighted guideline method, which considers the contractor's degree of risk, the relative difficulty of work, the monetary size of the job, the period of performance, the contractor's investment, assistance by the Government, and the amount of subcontracting.

c. Application of Profit. 33 U.S.C. section 624 provides that projects for river and harbor improvement not be performed by private contract if the contract price is more than 25 percent in excess of the estimated comparable cost of doing the work by Government plant or a fair and reasonable estimated cost (without profit) of a well-equipped contractor doing the work. The legislative history indicates profit is not included in the IGE. Profit is applied to negotiated procurement IGEs.

(1) Civil works construction contracts typically do not include profit. Refer to the contracting officer for recommendation of profit information.

(2) Non construction contracts should have profit included or as directed by contracting officer.

(3) For negotiated procurements, refer to the contracting officer.

18. Schedules.

a. Project and construction schedules are considered an integral part of cost development and the cost estimate is instrumental in defining the schedules. Simply stated, time is money relative to duration, escalation/inflation, delays, material lead-time, project acceleration and risks. As projects evolve, schedules become more critical in providing a clearer picture of anticipated events and expenditures. In early project development stages such as feasibility level, the schedule must be sufficiently developed to confidently present project duration to decision makers and partners, establish escalation/inflation, and support a Cost and Schedule Risk Analysis (CSRA).

As the project further evolves, the schedules must be sufficient to establish contract duration for contract solicitations. When projects are in construction phase, schedules should be well developed, possibly resource loaded, to support contractor schedule baselines, contractor progress payments, modifications, claims, project acceleration studies, and any further Federal funding needs.

b. The cost engineer must prepare reasonable construction schedules that reflect the construction estimates and timeframes used in the escalation/inflation calculations for the TPCS. The construction schedules must reflect the major construction elements and represent the MCACES estimate(s) including notice to proceed date, material lead-times, assumed productivities, work window limitations, etc. The schedules must be sufficiently developed using standard industry-recognized scheduling software, depicting major milestones, concurrent and sequential activities, predecessors, successors, and durations within a developed calendar and identifying a critical path. For projects requiring a Monte Carlo risk analysis, the schedule must be sufficiently developed to support the risk analysis related to seasonal risks, productivity assumptions, major construction elements, resourcing, acquisition strategy, environmental constraints, and assumed annual construction cost placement.

c. The PM may request the cost engineer to prepare the project schedule based on data developed by the PDT. Likely scheduling phases could include planning, receipt of funding, investigations and design, contract(s) acquisition, construction of project contracts.

19. Project Escalation and Inflation.

a. The CWCCIS must be used to update unit prices and various project cost features to specific price levels. Indexes used to escalate costs from the past to the present are developed from actual historic data. Indexes for future escalation are developed using the “Updating Factors” in Table 1, of the EC, Corps of Engineers Civil Works Direct Program – Program Development Guidance which are based on the current annual Office of Management and Budget (OMB) inflation factors. The CWCCIS presents a table that depicts the historic construction escalation and the projected OMB escalation rates measured from the date of the most current table. It reflects the CW-WBS construction elements. It is updated every March and September depicting current OMB annual escalation and semi-annual realized construction escalation.

20. Risk Identification for Determining Uncertainties and Contingencies.

a. Risk analyses will be performed during all project phases, appropriate to the level of available information.

b. Risk is broadly defined as a situation or event where something of value is at stake and the outcome is uncertain. Risk is typically expressed as a combination of the likelihood or probability of an event occurring, and attendant consequences should the event unfold, although it is too often used in actuality as a probability of an event occurring. Consequences are measured in terms of safety, cost, time, environmental harm, property damage and other metrics. Choosing the appropriate risk metrics and actively using them in decision making is critical to effective risk management in support of a vibrant economy, thriving ecosystems, and sustainable communities.

c. Risk Framework Components. The three components of the Civil Works Risk Framework are risk assessment, risk communication and risk management. As the life cycle of a project unfolds, risks must be continually assessed, then periodically updated and communicated in order to ensure the actual risks are accurately understood and properly applied as project conditions change. Key activities within each element are summarized in the diagram below.

(1) Risk Assessment is a systematic approach for describing the nature of the risk, including the likelihood and severity of consequences. Risk assessments are quantitative whenever possible; however, qualitative assessments may be appropriate for some activities. A risk register will be utilized to identify potential risk events. The PDT will support the cost facilitator in identifying the risk events. The risk register will identify probability of occurrence and severity of impact as relating to impacts on cost variance and schedule variance. The Cost MCX CSRA risk template will be utilized to assure consistency (or approved equal, by the chief Cost MCX). The risk register will also be the basis for identification of risk management decisions.

(2) Risk Communication is a two-way exchange of information between risk assessors and those who will use the risk assessment results or those who are affected by the risks and risk management actions. Open communication improves the understanding of the risks by all parties, and leads to improved risk assessments and risk management decisions and outcomes. Communication must occur early and repetitively throughout a project life cycle to ensure proper risk understanding and application.

(3) Risk Management is a decision-making process in which risk reduction actions are identified, evaluated, implemented, and monitored. The purpose of risk management is to take actions to effectively reduce and manage risks identified in the risk assessment. In simplest terms, there are four ways of adjudicating identified risks and often some combination of them is used for any given risk:

(a) Avoid the Risk. This may require a change in project scope or in program direction.

(b) Take Actions to Reduce (mitigate) the Risk. These actions would reduce the likelihood that the risk event occurs or the severity of impacts if the event does occur.

(c) Transfer the Risk Openly to Other Parties. Insurance is a common risk transfer mechanism for financial or hazard risks. Contracts are sometimes used to manage project risks, but a cost is typically incurred.

(d) Accept the Risk. This may be appropriate when consequences are not severe. Acceptance does not necessarily correlate to a lack of action. A response plan can be prepared and kept in hand, should the risk event occur.

Figure 1 - Risk Framework

d. HQUSACE requires using a cost risk analysis to determine contingency amounts for decision documents or in support of needed funding outside of the district funding authority. These include, but are not limited to, feasibility studies, design document reports, engineering documentation reports, general reevaluation reports, limited reevaluation reports, and post authorization change reports. A CSRA report and a risk management plan are required for all decision documents, regardless of project size.

e. Contingencies of cost and time must be included in the estimate and schedule to cover unknowns, uncertainties, and/or unanticipated conditions that are not possible to evaluate from the data on hand at the time the cost estimate is prepared but must be represented by a sufficient cost to cover the identified risks within the defined project scope. Added contingencies are not to be applied to project budgets as a means of replacing scope clarity of projects that fail to meet the required development stage or milestones.

f. Contingency values vary based on project phase and scope development. Limited information results in greater risks and higher contingencies. As projects evolve in scope and clarity, respective risks and contingencies will be typically reduced (Table 1, Civil Works Estimates – Class Level Designation). At construction contract award, a minimum contingency allowance of at least five percent of the contract amount must be available at the project level. Construction contracts with less than 100% design should be even greater, possibly supported by a risk analysis. As a project nears completion, this contingency allowance must be reduced accordingly. A cost and schedule risk analysis (CSRA) is the process of identifying, measuring, and forecasting the potential cost and time impacts of project uncertainties on the estimated total project cost during project delivery. Key components include record of PDT involvement, all cost features, a quality risk register, estimated contingencies and resulting report. As a minimum, a cost risk analysis is a formal process required for all Civil Works projects during the planning phase, regardless of project size or estimated cost value. It must be accomplished as a joint analysis between the cost engineer, PM or planner, real estate, contracting, engineering, construction, and other critical or appropriate PDT members that have specific knowledge and expertise on all possible project costs and risks. The risk analysis must consider all project features of the CW-WBS and four major project periods: funding, design and investigations, acquisition, and construction to complete. As a minimum, risks must include consideration for available or anticipated funding, known project scope and potential growth, acquisition strategy, construction complexity, volatile commodities, quantity development, special equipment, cost estimating methods and assumptions, and external risk factors.

g. Risk analysis processes and details will vary depending upon the complexity and size of the project. At the lowest extreme, the risk analysis may result in a single contingency value based on a simplified qualitative risk-based method, also referred to as an "Abbreviated" method. The abbreviated method does not address schedule, generally because the smaller dollar amounts are less dependent on schedule impacts in the form of cost. For projects where the total project cost including inflation is $40 million or greater, or for complex smaller projects having numerous work elements with differing unknown conditions and uncertainties, a "Detailed" risk analysis will be performed in accordance with current USACE requirements. This "Detailed" method includes risk identification, quantitative and qualitative study, and sensitivity analysis using a Monte Carlo simulation method. The risk analysis identifies and documents the conditions, uncertainties, and the evaluation methodology used to determine the assignment of contingency. Product results include CSRA report which includes PDT identifications, a risk register, risk model.

h. As project development progresses into design and construction, contingencies must be developed based upon the risks related to the uncertainties or unanticipated conditions identified by the investigation data and design detail available at the time the estimate is prepared (ER 1110-2-1150). In risk analysis studies using the Monte Carlo process for the larger, more complex projects, the contingencies should be presented with confidence levels and associated contingencies and confidence levels (10 percent confidence increments as a minimum). For cost product development, the contingencies reflecting an 80 percent confidence level will be reported. Management does have flexibility to use a different confidence level (higher or lower) with detailed justification documenting the rationale for variance from the 80 percent confidence level. Items to consider in the confidence level chosen could be life safety, project complexity, national priority, and/or likelihood of mitigating risks. In any case, the chosen value should be justified within the risk analysis and main reports.

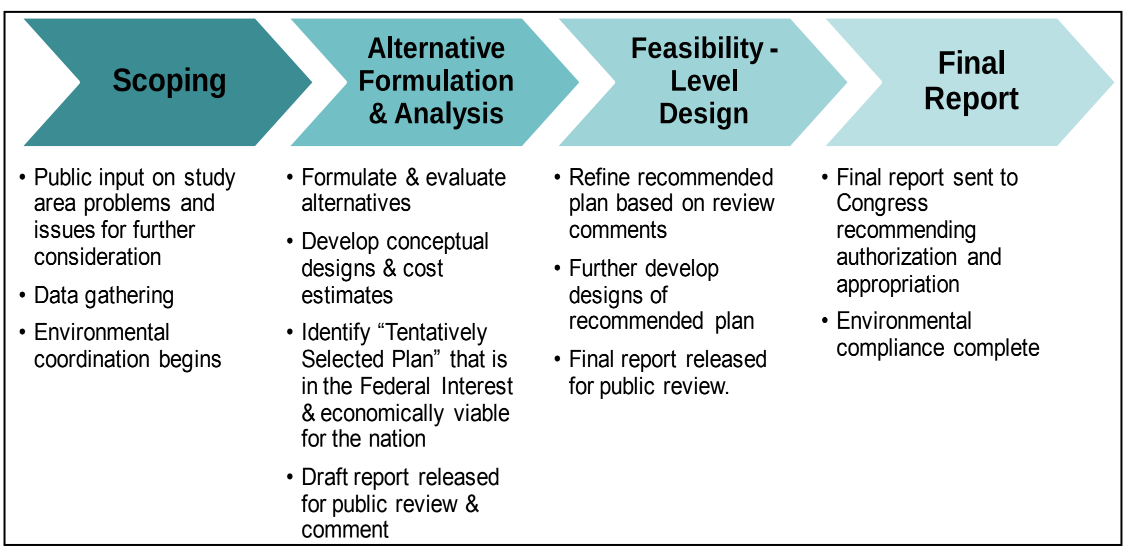
i. Estimates used for benefit-to-cost ratio calculation. The cost engineer will communicate with the economist to assure the economist understands the basis of the cost estimate and the corresponding confidence level. The goal is to assure the basis for the cost identification is comparable to the basis of the benefits.

(1) A CSRA and resulting report are not intended to serve as a risk management plan (RMP). Rather, the report serves as part of the RMP. The RMP must present the plan to manage, monitor, and mitigate risks accordingly; assigning responsibilities to PDT members to ensure the RMP is used as a living document and management tool.

j. Risk Analyses for Feasibility Phase.

(1) During the feasibility phase, a cost risk analysis approach and resulting contingencies must be applied to the final array of alternatives under a comparison study that establishes the tentatively selected or recommended plan. That final array is considered part of a decision document for the vertical team in establishing a Federal recommended plan. At this stage, a detailed Monte Carlo statistical method is not expected, but could be warranted for complex and large cost and schedule alternatives. The “Abbreviated” risk-based method is the recommended means to establish project alternative risks and contingencies for study comparison. For the Federal Plan, abbreviated processes can also be applied for projects where total project cost is less than the established $40 million threshold.

Figure 2 - Feasibility Process



(2) For the larger projects (greater than $40 million), the Federal recommended plan and the LPP, a Monte Carlo statistical method is required, addressing costs and schedules. The risk analysis must be performed, commensurate with project size and project complexity. The risk analysis must include a report that identifies the risk analysis processes, PDT member involvement, record of discussions, risk register, key assumptions, major concerns, justified contingencies, and recommended risk mitigation plans. The report will serve as part of the PDT's Risk Management Plan.

k. Risk Analyses for PED and Construction Phases. During the PED and construction phases, a risk analysis and updates must be conducted upon the remaining costs, major construction elements, further funding requests, major milestones, major changes in design scope, acquisition strategy, quantities, and contract acquisition strategy and for each update in the cost estimate. This is to satisfy the annual cost update requirements. The established project cost thresholds still apply for risk analyses processes during these phases relative to an abbreviated method or a Monte Carlo analysis. A cost risk analysis report must be included as part of any post authorization change report to support the revised authorized cost.

l. Risk Management. The project execution will be evaluated during the life of the project. The risk identified during the initial CSRA development will be monitored and responded to. In addition the PDT will identify potential new risk events during the various stages of development. The new risk events will be incorporated into the CSRA and analyzed for impact of likelihood of occurrence. The cost engineer will evaluate the cost risk model to communicate to the PM and PDT members the overall impact to the total project cost to decide response actions.

21. Total Project Cost Summary.

a. The TPCS is the product that is certified by the Cost MCX, because it presents the total project costs developed by the PDT rolled up into a single summary page. When the TPCS is updated, the update must include consideration for scope, current acquisition strategy, quantities, updated costs, schedules, inflation, risks, and contingencies.

b. The TPCS is prepared by the cost engineer with support from the PDT. The TPCS reflects all applicable project feature costs, contingencies, escalation and inflation to project completion and presents the Federal and non-Federal cost share (the cost share information is required for CAP projects, optional for Non-Cap). It includes spent and future costs. While the cost engineer prepares the basic construction cost elements of the form, the PM, Real Estate, and Construction offices play a major role in establishing program year presentation and Federal and non-Federal share, spent costs, 01 Lands and Damages, 30 PED, and 31 Construction Management. The Cost engineering will work closely with the PM to identify the breakout of the total project cost including cost per feature and contingency development. The Project First Cost and the Constant Dollar are required to be displayed in the feasibility report.

(1) Constant Dollar Cost (Price Level). Constant dollar analyses are utilized to determine an equivalent cost in the future or in the past by price indexing using CWCCIS data. Constant dollar cost is the estimated cost BROUGHT TO THE EFFECTIVE PRICE LEVEL. Constant dollar cost at current price levels is the cost estimate used in decision documents and chief's reports. The constant dollar cost does not include inflation to midpoint design and construction.

c. Project First Cost (Price Level). The cost estimate that will serve as the basis for providing the cost of the project for which authorization is sought. The cost estimate to be used in Chief's Reports and other decision documents is Estimated Cost represented at the current price level. The current price level is the current FY based on the submittal date. Certain costs that are excluded from the TPCS include (Appendix D):

a. The annualized estimate of Operations, Maintenance, Repair, Replacement, and Rehabilitation.

b. Associated financial costs that are not part of the recommended Federal project but are a necessary non-Federal responsibility.

c. Local service facilities that are for Commercial Navigation Only.

d. For decision documents and budget submissions, typically the TPCS must be completed no later than 31 May of the submitting year. The Project First Cost (Constant Dollar in the second column set) must be presented in program year 1 Oct 20XX in order to support the economic analysis and the budget request. The TPCS Project First Cost is be used for the programming Form PB-3.

22. Cost Product Report Submittals.

a. Formal project reports and supporting documents are required for decision documents that are processed through the vertical team, i.e., district commander, MSC/divisions, HQ, Assistant Secretary of the Army, and Congress. The cost reports are a subset of the main report and should at least address cost, schedule and risks.

The formal reports occur at various stages of project development or as directed. These include, but are not limited to, feasibility studies (alternatives, Federal recommended plan, locally preferred plan), design document reports, design deficiency reports, engineering documentation reports, general reevaluation reports, limited reevaluation reports, and post authorization change reports.

b. The cost engineering product submission includes a project narrative or introduction: level of design information, major project construction features, acquisition assumptions, general cost assumptions and qualifications. It also includes summary level costs (alternatives, Federal recommended plan and LPP where applicable), project and construction schedule, risk-based contingency presentation, and TPCS. These documents are also required to support the ATRs and external reviews.

(1) For the MCACES estimate, summary sheets must be provided for direct costs, indirect costs, and project (owner) costs to the CW-WBS feature account level. The estimate prepared (utilizing the latest approved MCACES software) must contain a narrative that presents the level of design information, acquisition and market assumptions, the major project construction features, key construction assumptions, contractor assignments and markups, quantity confidence and unknowns, and identified risks or uncertainties used in the development of contingencies utilizing risk analysis processes. For the MCACES estimate presentation, multiple CW-WBS folder levels may be necessary to present the project scope and cost of construction elements in the project. However, certain cost information is considered sensitive and AR 25-55 and FAR 36.203 govern its release. Release under the Freedom of Information Act (FOIA) should be coordinated with the FOIA officer.

(2) For public release reports and documents, a high level WBS summary shall be used. Cost sensitive data, such as quantities, unit costs, quotes and productivity rates, and CEDEP must be protected from public disclosure since they may serve as a basis for the IGE. Sensitive cost data must be removed from public documents or presentations.

(3) In presenting the project schedules, address the major components related to design phase, contracting solicitation, major construction components and their time relationships.

(4) In addressing the risks for the abbreviated risk method, the report should include a brief discussion of major construction elements, major risks, input and results, risk register and risk matrix. For the Monte Carlo risk method, a standalone risk report,

as part of the risk management plan, should provide an executive summary, brief report purpose and project scope, applied methodology, identified PDT members involved, key assumptions, risk register, sensitivity charts, contingency tables, and confidence curves, cost and schedule contingency presentation, major findings, and mitigation recommendations.

23. Cost Estimate Confidentiality.

a. Mature or well developed cost estimate data that is likely to be used in support of bid estimates must be considered as confidential, sensitive, and proprietary, and marked as For Official Use Only (FOUO), and so managed (reference AR 25-55). Typically, this occurs near the 90% design phase; however, earlier well developed detailed cost estimates can also include sensitive cost and pricing data regardless of design phase. Sharing of this data must be restricted since disclosure may easily compromise the integrity of competitive bidding processes. Sensitive data includes detailed quantities, detailed unit prices, crew or equipment productivity, and supplier and material quotes. This data must be restricted to within the USACE community shared only on an “as need to know basis” within the district and USACE cost community in support of estimate development and ATRs. Need to know basis is determined by the Contracting office and district command structure. Pre-Bid and IGE cost information must be protected, dissemination made carefully. Cost Data Sharing in and outside districts should only include higher level cost information related to project scope and features in use for programming and budget purposes. IGEs and cost data therein must remain restricted and marked as “For Official Use Only” (FOUO). The FOUO marking shall also be applied to any physical electronic storage media such as CDs. Any deviation must require a signed non-disclosure agreement with parties on a clear “need to know” basis. After contract award, ordinarily, only the title page, signature page, and price schedule are disclosed outside the Government. The IGE backup data should not be released since it contains sensitive cost data (e.g. contractor quotes, crews, and productivity) that are proprietary or might compromise costs for future similar procurement.

b. Non-IGE data may be shared within the USACE cost community to support cost development.

c. Detailed estimate data and its distribution must be submitted directly to the needed USACE parties through a secure means.

24. Cost Quality Management. Cost engineering offices must follow the established USACE Quality Management Regulation, ER 1110-1-12. Only qualified cost engineers, preferably certified estimators, must provide documented quality control reviews.

a. Accuracy and completeness of project scope and cost engineering products, including the necessary cost product updates, must be emphasized throughout the project life. Even in early phases, cost estimates should represent as complete and accurate a picture as is practicable. This is necessary for Federal and non-Federal planning, budgeting and management processes.

b. The division cost engineer is responsible for quality assurance of division cost engineering products. Part of the quality assurance process is to review a sampling of estimating products to ensure they comply with guiding policy. The division cost engineer, as a minimum, must sponsor an annual meeting with each constituent district's cost engineering chiefs and senior estimators to ensure the quality of the division estimating procedures complies with current USACE policy.

25. Technical Reviews for Cost Products.

In accordance with ER 1110-2-1150 and the Civil Works Review Policy, technical reviews are required and/or recommended during various phases of project development through the life of the project. Technical reviews consist of three levels of review: a District Quality Control (DQC), Agency Technical Review (ATR), and Independent External Peer Review (IEPR). The Design Review and Checking System (DrChecks) must be used throughout USACE as the formal system for ATR and IEPR. Cost comments are to be treated as For Official Use Only (FOUO). Refer specific update requirements including review requirements to the Cost MCX.

a. District Quality Control: A DQC review is a district responsibility, which is a documented review by a technical element as a quality control measure on decision documents. The DQC is a critical element in confirming district PDT acceptance of product presentation, quality, completeness, and readiness to support the ATR and IEPR. The Cost DQC, including comment and resolution, must be formally documented and performed by a technically qualified senior cost engineer; all cost products must be addressed: quantities, estimate(s), schedules, risk analyses, total project cost and cost report.

b. Agency Technical Review: All qualified Cost ATR reviewers must be senior cost engineers, trained and certified by the Cost MCX. For decision documents all reviewers will be assigned by the Cost MCX. Review comments must be addressed by qualified district cost personnel knowledgeable of the specific cost engineering products. Closure of critical comments or comments that cause a necessary change to the cost engineering products related to quality, cost, schedule, and contingencies must rely upon verification of the necessary revisions prior to comment closure by the cost reviewer.

(1) The Cost MCX has the responsibility for the quality performance of the Cost ATR[1] and for issuing a cost certification of the project cost products as identified by current regulations and policies. The RMO is required to coordinate with the Cost MCX for cost reviewer assignments and ATR of cost products. Review consideration is given to the project reports, investigations and design, DQC records, quantities, estimates, construction schedules, contingencies, and resulting total project cost. A Cost ATR is intended to confirm that such work is performed in accordance with established regulations and policies, professional principles, practices, codes, and criteria that result in a confident TPC. Regardless of product author (USACE, A-E, sponsor, or others), any report that is presenting or requesting Federal funds from higher authority such as MSC, divisions, HQ or Congress, must receive a Cost ATR and a Cost MCX Cost Certification. Other project milestone submissions may require a Cost ATR as defined by current HQ guidance or as specifically requested by HQ, MSC, or division offices. A Cost ATR Certification and its validity are based upon age of the estimate products as discussed in Section 11 – Cost Engineering Products and Updates. Cost ATRs and resulting Cost MCX Certifications should be current for budget requests.

(2) The Cost ATR(s) for the feasibility phase, as a minimum, must verify that the level of engineering is sufficient to substantiate both the screening level alternative or comparative cost estimates and the BCE with contingencies to support selection of the recommended plan and to establish the baseline schedule and cost estimate with contingencies. To accomplish this, each project submittal by the respective district must include with the submittal the draft main report, engineering products such as photos, design, drawings, and engineering appendices. The submission must also include native electronic files for the comparative estimates, MCACES estimates, project schedule depicting design, acquisition and construction, risk based contingency development, and the TPCS worksheets. Cost ATR for a PED stage of project

[1] Cost ATR – includes requirement for providing Cost Certification unless as otherwise identified.

development must still address the same products: scope definition, designs, quality controls, quantity development, estimates, construction schedules, risk analyses, and contingencies.

c. Independent External Peer Review: An IEPR is an independent review of the technical efficacy of a decision document by a review organization external to USACE. The term “external” implies non-USACE or non-governmental review. IEPR is conducted on projects that meet mandatory or discretionary triggers outlined in current HQ guidance similar to the ATR process, and a formalized comment resolution process must take place. Note this process may come under scrutiny through Freedom of Information Act requests. Document submittal requirements of section 21 also apply to IEPRs. Often times, the IEPR occurs at the same time as an ATR. IEPR coordination is critical regarding timeliness and funding, because funding the IEPR commonly requires a contractual process.

d. Types of Cost Certifications. The Cost MCX uses a certification method to communicate analysis of project cost development. The Cost MCX and respective reviewers take into consideration many key factors that contribute to accurately identification of cost, schedule and risk. Project Scope, technical information (design, acquisition methods, unique construction methods, etc.) and quality of development are reviewed. The Cost MCX has the authority assignment of certification level. Since many unique combinations of product development may occur, the Cost MCX assignment is based on the overarching goal of “Does the process used by the district produce accurate cost products which provide the district a high probability of execution within the authorization limits and is the risk level (Contingencies) appropriate?”

(1) Cost Certification Statement. Project Scope has been identified to accurately estimate project cost and schedule. Technical information is sufficient to allow for cost development combined with risk identification to appropriately account for cost and schedule. Product has been developed in accordance with quality standards as identified within current cost regulations and policy.

(2) Conditional Cost Certification Statement. Portions of the project scope, technical information or product quality are deemed at an insufficient level in accordance with regulations and policy, however not to the level where project cost cannot be identified with inclusion of risk identification. The Conditional Certification Statement will highlight basis for the Conditional Certification. This will allow the district to focus future resources on improvement. Projects will not be allowed multiple conditional cost certifications, without HQUSACE PM and HQUSACE Cost approval.

(3) Cost Non-Certification Statement. In cases where the project scope, technical information or quality of product are deemed to be at such an insufficient level where cost and/or schedule cannot be accurately identified. Rationale for Cost Non-Certification will be identified on the statement. Cost products assigned the Cost Non-Certification Statement are generally not acceptable for final planning reports, funding requests, or other circumstances for which the Cost Certification Statement is required. The non-certification letter and all comments will be forwarded to the MSC for review and evaluation. The MSC will forward its recommendations to HQUSACE for a final determination on subsequent action.

26. Total Cost Management.

a. Total cost management is the effective application of professional and technical expertise to plan and control resources, costs, schedules, and risk throughout all project phases. Total cost management is a systematic approach to manage and forecast costs, schedules and risks throughout the life cycle of any project, product, or service. A major tool in this application is the development and update of the total project cost and then updating and managing the cost products that support the total project cost comparison to the BCE. Applicable terms include project management, project controls and earned value management.

b. DFAR 234.201 presents the Department of Defense Policy regarding Earned Value Management System (EVMS) requirements in contracts. EVMS is another way of referring to Total Cost Management and should be considered/incorporated within the day to day business practices and management of USACE projects. A total project cost estimate, (reference TPCS forms), is required for documents supporting a funding request. This includes feasibility studies, design document reports, design deficiency report, engineering documentation reports, general reevaluation reports, limited reevaluation reports, and post authorization change reports.

c. During any phase of the project, as the PDT becomes aware of information that impacts project cost, schedule, or risks, the cost engineering office must update the cost engineering products. For total project cost development and updates, cost engineering products must include current project scope, reflect current acquisition strategy, quantities, labor, equipment, materials, escalation, schedules and risks. For cost engineering products older than 2 years, escalation application is not appropriate.

d. During the construction phase, the authorized BCE sets the target for managing and controlling project costs. As the design is refined, the uncertainties are reduced, and the costs associated with each feature become more specific towards satisfying the scope requirements. To identify these changing costs, a total project cost must be updated at each planning phase or milestone in the project development.

e. Project development can span multiple years. To ensure the project is still within the authorized or appropriated cost, annual total project cost estimates must be updated and compared with the BCE, current authorization, or appropriation. Subsequent to a Congressionally approved BCE (Section 902 of the Water Resources Development Act of 1986, Public Law 99-662), all total project costs must document the current computed total project cost at the appropriate price level, the total project cost escalated to the current programming year (constant dollar estimate), and the total project cost escalated through the construction periods based on a current project schedule. Estimate product updates must address current scope, current acquisition strategy, quantities, costs, schedules, and risks. The estimate must include re-pricing using current labor rates, equipment data, material rates, and use the appropriate cost indices found in EM 1110-2-1304.

f. For significant, ongoing construction projects that span multiple years, the cost engineering office must support in the monitoring, preparation, and update of quantities, Government cost estimates, schedules, and risk products. This is intended to support the project controls and monitoring of construction progress, invoice payments, potential modifications, negotiations, claims, and settlements.

g. Certain large projects that are greater than $300 million over a span of three years or more that are unique, higher acquisition risk, of national significance, multiple contractors and stakeholders may be qualified as “mega projects.” Management of these projects require greater oversight that includes Project Control teams utilizing experienced personnel responsible for managing project and integrated program schedules, project and program budgets, and document and communication controls. The team must include capable expertise in cost and schedule risk analysis, cost estimating and network scheduling. An independent Government estimate and related risks are still required to protect the Government’s interest in monitoring and reporting contractor progress, defending against contract modifications and claims and to support fair and reasonable invoice payments.

h. Cost and schedule metrics must use earned value processes to analyze and compare scheduled project progress and construction placement to contractor actuals, invoice validation, current TPC, authorizations and appropriations.

i. Reasonable separation must be made within the cost products regarding work breakdown structure, spent costs, ongoing efforts/contracts, and remaining efforts in order to identify specific risks and calculate the differing contingencies between the three phases of design, advertising, and construction. During the construction phase, greater consideration should be given to known, project-specific data, cost changes, and trends.

j. Value engineering is a mandatory method that supports cost management objectives. It can be performed during any phase of project development and execution. Refer to ER 11-1-321, Army Program Value Engineering.

FOR THE COMMANDER:

6 Appendixes
(See Table of Contents)

D. PETER HELMLINGER
COL., EN
Chief of Staff

APPENDIX A

References

Public Law No. 95-269 (91 Stat. 218-1-219)
Pertains to preparation of construction cost estimates as though the Government were a prudent and well-equipped contractor.

Public Law No. 99-662 (H.R.6)
The Water Resources Development Act of 1986.

Title 33 United States Code Section 624
Section 624 provides that projects for river and harbor improvement shall be performed by private contract if the contract price is less than 25 percent in excess of the estimated comparable cost of doing the work by Government plant or less than 25 percent in excess of a fair and reasonable estimated cost of a well-equipped contractor doing the work. The legislative history indicates the IGE shall not include profit.

5 U.S.C. 552, as amended by Public Law No. 104-231, 110 Stat. 3048
The Freedom of Information Act

AR 25-55 The Department of the Army Freedom of Information Act Program

33 Code of Federal Regulations Parts 209 and 335-338
Operations and Maintenance Regulations for Activities Involving the Discharge of Dredged or Fill Material in Waters of the United States and Ocean Waters.

Davis – Bacon Act

Federal Acquisition Regulation (FAR), Subpart 36.203
Construction and Architect-Engineer Contracts.

FAR, Subpart 15.404-4
Profit.

FAR, Subpart 36
Construction and Architect-Engineer Contracts.

FAR, Subpart 1.602
Contracting Officers.

USACE Acquisition Instruction (UAI)

Engineer Regulation (ER) 5-1-11
U.S. Army Corps of Engineers Business Process.

ER 11-1-321
Army Programs Value Engineering.

ER 1105-2-100
Planning Guidance Notebook.

ER 1110-1-12
Engineering and Design Quality Management.

ER 1110-1-1300
Cost Engineering Policy and General Requirements.

ER 1110-2-1150
Engineering and Design for Civil Works Projects.

ER 1180-1-9
Design-Build Contracting.

Engineer Manual (EM) 1110-2-1304
Civil Works Construction Cost Index System.

Engineer Pamphlet 1110-1-8
Construction Equipment Ownership and Operating Expense Schedule.

ASTM E 2516-06
Standard Classification for Cost Estimate Classification System, Reprinted, with permission, from the Annual Book of ASTM Standards, copyright ASTM International,

100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM, www.astm.org.

Project Management Institute, Inc. A Guide to the Project Management Body of Knowledge. PMBOK® guide, 3rd ed, 2004.

WATER RESOURCES DEVELOPMENT ACT (WRDA) (various years)

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APPENDIX B

Civil Works Work Breakdown Structure

(Feature and Subfeature Levels)

CW-WBS Number		Description of Item
01	**--**	**LANDS AND DAMAGES**
01	18	GENERAL REVALUATION REPORT (GRR)
01	19	LIMITED REVALUATION REPORT (LRR)
01	20	PROJECT DESIGN MEMORANDUM
01	21	FEATURE DESIGN MEMORANDUM
01	23	CONSTRUCTION CONTRACT(S) DOCUMENTS
02	**--**	**RELOCATIONS**
02	01	ROADS, Construction Activities
02	02	RAILROADS, Construction Activities
02	03	CEMETERIES, UTILITIES, AND STRUCTURES, Construction Activities
03	**--**	**RESERVOIRS**
04	**--**	**DAMS**
04	01	MAIN DAM
04	02	SPILLWAY
04	03	OUTLET WORKS
04	04	POWER INTAKE WORKS
04	05	AUXILIARY DAMS
04	06	MUNICIPAL AND INDUSTRIAL WATER DELIVERY FACILITIES
05	**--**	**LOCKS**
06	**---**	**FISH AND WILDLIFE FACILITIES**
06	01	FISH FACILITIES AT DAMS
06	02	FISH HATCHERY, (Including Trapping and Release Facilities)
06	03	WILDLIFE FACILITIES AND SANCTUARIES
07	**--**	**POWER PLANT**
07	01	POWERHOUSE
07	02	TURBINES AND GENERATORS
07	03	ACCESSORY ELECTRICAL EQUIPMENT
07	04	MISCELLANEOUS POWER PLANT EQUIPMENT
07	05	TAILRACE
07	06	SWITCHYARD
08	**--**	**ROADS, RAILROADS, AND BRIDGES**

(Feature and Subfeature Levels)		
08	01	ROADS
08	02	RAILROADS
09	**--**	**CHANNELS AND CANALS (Except Navigation Ports and Harbors)**
09	01	CHANNELS
09	02	CANALS
10	**--**	**BREAKWATERS AND SEAWALLS**
11	**--**	**LEVEES AND FLOODWALLS**
11	01	LEVEES
11	02	FLOODWALLS
12	**--**	**NAVIGATION, PORTS AND HARBORS**
12	01	PORTS
12	02	HARBORS
13	**--**	**PUMPING PLANT**
14	**--**	**RECREATION FACILITIES**
15	**--**	**FLOODWAY CONTROL AND DIVERSION STRUCTURES**
16	**--**	**BANK STABILIZATION**
17	**--**	**BEACH REPLENISHMENT**
18	**--**	**CULTURAL RESOURCE PRESERVATION**
19	**--**	**BUILDINGS, GROUNDS, AND UTILITIES**
20	**--**	**PERMANENT OPERATING EQUIPMENT**
30	**--**	**PLANNING, ENGINEERING, AND DESIGN**
30	11	PROJECT COOPERATION AGREEMENT
30	12	PROJECT MANAGEMENT PLAN
30	18	GENERAL REEVALUATION REPORT (GRR)
30	19	LIMITED REEVALUATION REPORT (LRR)
30	20	PROJECT DESIGN MEMORANDUM
30	21	FEATURE DESIGN MEMORANDUM
30	23	CONSTRUCTION CONTRACT(S) DOCUMENTS
30	24	VALUE ENGINEERING ANALYSIS DOCUMENTS
30	25	PROJECT OR FUNCTIONAL ELEMENT CLOSEOUT
30	26	PROGRAMS AND PROJECT MANAGEMENT DOCUMENTS
31	**--**	**CONSTRUCTION MANAGEMENT**
31	12	PROJECT MANAGEMENT PLAN
31	23	CONSTRUCTION CONTRACT(S) DOCUMENTS
31	26	PROGRAMS AND PROJECT MANAGEMENT DOCUMENTS
33	**--**	**HAZARDOUS AND TOXIC WASTE**

(Feature and Subfeature Levels)		
33	01	MOB, DEMOB & PREPARATORY WORK
33	02	SYSTEMS STARTUP/OPERATIONS/MAINTENANCE
33	03	INSTITUTIONAL ACTIONS
33	04	SURFACE WATER CONTROL
33	05	COLLECTION & INJECTION OF GROUND WATER
33	06	COLLECTION & DISPOSAL OF WASTES
33	07	CONTAIN & RESTORE CONTAMINATED GROUND WATER
33	08	CONTAINMENT FOR WASTES
33	10	TREAT-WASTES/CONTAMINATED SOIL & WATER
33	11	AIR POLLUTION AND LANDFILL GAS CONTROL
33	12	INNOVATIVE TECHNOLOGIES
33	13	SUPPORTING FACILITIES
33	14	PRIME CONTRACTOR'S INDIRECT COST

01. Lands and Damages. This feature includes all costs of acquiring for the project (by purchase or condemnation) real property or permanent interests therein, including Government costs, damages, and costs of disposal of real estate. Government costs include planning expenses for the real estate portion of the General Design Memo and for the detailed Real Estate Memo; and project real estate office administration, surveys, and marking for land acquisition purposes and appraisals.

For projects which require that costs be incurred on real estate activities, i.e., for records search, appraisals, and field inspection to assure compliance by local interests in the provision of local requirements on projects where no Federal land acquisition is involved, a memorandum statement will be provided with the PB-3 indicating the estimated costs of such real estate activities. These costs will be charged to feature 30, Engineering and Design and that feature will be properly footnoted to show the amount of such costs. A similar footnote will be shown on the PB-1s and PB-2a's for all such projects. This feature is credited with disposal receipts from sale of such items as standing crops, standing timber, structures, and improvements in place and acquired with the land. Disposal receipts from sale of excess land not turned in to the U.S. Treasury as miscellaneous receipts are credited to this feature. Lands or interests purchased for relocations and conveyed to others are included in the feature "Relocations." Temporary interests such as leases are included in the feature or distributive item benefited thereby.

02. Relocations. This feature includes removing and relocating, or reconstructing property of others, such as roads, railroads, cemeteries, utilities, buildings, and other structures; and lands or interests purchased for such relocations and conveyed to others, including real estate planning and acquisition expenses. The cost of removal of improvements from the reservoir area for disposal is included in the feature "Reservoirs." All alterations of railroad bridges in accordance with Section 3 of the 1946 Flood Control Act (22 USC 701p) are also included in this feature.

03. Reservoirs. This feature includes clearing lands in reservoirs and pools of debris, brush, trees, improvements, and structures. Any salvage, obtained by sale or disposal by the Government, of material removed in clearing operations is credited to this feature. This feature also includes bank stabilization, shoreline improvement, firebreaks, fencing, boundary line survey and marking of land which has been acquired or is to be acquired, rehabilitation of natural resources, erosion control, drainage, and rim grouting and mine sealing, etc., to prevent leakage. Site clearing, grouting, etc.,

incidental to and required for specific construction features is included as part of the construction features.

04. Dams. This feature includes dams and all other water collecting and storage facilities, whether man-made or natural, together with appurtenant diversion, regulation, and delivery facilities and spillways, outlet works, and power intake works, whether separate from the dam or not. In the case where the powerhouse is an integral part of the intake dam, the cost of the power intake dam is included in the feature "Power Plant." Any auxiliary dams or spillways detached from the main structures and floating trash and drift booms and barriers are included in this feature. The power intake works include such power items as forebay, penstocks, tunnels, surge tank, gates, operating equipment, and appurtenances. Service roads and service railroads on the dam are included in this feature. The additional cost of relocating highways and railroads across the dam is included in the feature "Relocations."

05. Locks. This feature includes facilities to provide for passage of waterborne traffic, including gates, valves, operating mechanisms, cribs, fills, lock walls, guide and guard walls, operating buildings, and excavation therefore. The lock structure is considered that part of the work within the limit lines extending from the upper end of the upper guide or guard walls to the lower end of the lower guide or guard walls, including dolphins within the lock approaches for tie up, guard, or guide purposes. Excavation or dredging· required in approaches outside of the limits defined above for the lock structure is included in the feature "Channels and Canals." The cost of a cofferdam or the properly allocable amount thereof, if required, is charged to this feature. Locks provided in connection with facilities for the prevention of encroachment of salt water are included in this feature. Locks in connection with fish facilities are included in the feature "Fish and Wildlife Facilities."

06. Fish and Wildlife Facilities. This feature includes items such as ladders, elevators, locks and related facilities for passage of fish at dams and navigation locks and maintenance of fish runs; and provision for wildlife preservation. In support of wildlife, this feature includes environmental mitigation and monitoring costs.

07. Power Plant. This feature includes those facilities specifically required for the production of power other than those included in the feature “Dams,” and consists of the following: powerhouse, turbines and governors, generators, accessory electrical equipment, miscellaneous power plant equipment, switchyard, and tailrace improvement for power. In the case where the powerhouse is an integral part of the

power intake dam, the cost of the power intake dam is included in this feature. Where the structure of a dam also forms the foundation of the powerhouse, such foundation is considered a part of the dam. Units for production of power for the operation only of power, for the operation only of navigation, flood control, or other purpose projects (excluding those projects with power as a feature) are included in other than this feature. The cost of a cofferdam or appropriate part is charged to this feature.

08. Roads, Railroads, and Bridges. This feature includes permanent roads, railroads, and bridges required for access and other purposes in connection with the construction and operation of the project. This feature does not include roads, railroads, and bridges chargeable to the feature "Relocations," access roads to recreation facilities and areas, which will be charged to the feature "14. Recreation Facilities," and service roads and service railroads on structures.

09. Channels and Canals. This feature includes all forms of excavation (including dredging, preparation of spoil disposal area, and attendant facilities) necessary for the development and construction of channels, harbors, and canals for navigation purposes; and deepening, providing new, or improving existing watercourses for flood control and major drainage. Excavation of natural watercourse to provide adequate depths for navigation is included. Excavation for specific structures, such as dams and locks used in the development of waterways and conservation of water resources, is included with such structures. The removal of trees, brush, accumulated snags, drift, debris, water hyacinths and other aquatic growths from canals, harbors, and channels in navigable streams and tributaries thereof for navigational included in this feature. Excavation, clearing, and removal of accumulated snags, drifts, debris, and vegetable growth from streams for flood control and major drainage purposes also is included. Included in this feature are revetments, linings, dikes, and bulkheads constructed as channel improvement works for flood control or navigation, as against such items constructed for bank stabilization only. Also included are jetties constructed in connection with flood control channel improvements.

10. Breakwaters and Seawalls. This feature includes breakwaters, seawalls, piers, and like improvements constructed in connection with the protection of beaches, harbors, shores, and port facilities against the force of waves and encroachment of seas or lakes by direct wave action. Jetties, groins, and like structures provided in seas, lakes, tidewater reaches of rivers and canals, and harbors to control water flow and current, to maintain depth of channels, and to provide protection, are included in this feature.

11. Levees and Floodwalls. This feature includes embankments and walls constructed to protect areas from inundation by overflow from creeks, rivers, lakes, canals, and other bodies of water. This feature consists of such items as: service roads on levee crown or landside berms, road ramps, closure structures, seepage control measures, erosion protection measures on levee slopes and on berms and bank slops when an integral part of the levees or floodwalls; and drainage facilities, constructed to provide means for the passage of accumulated drainage and seepage water and sewage from the protected area over or through levees and floodwalls, comprising such items as interceptor and collection sewers and ditches, and pressurized sewers and drainage structures, including outfalls through levees or floodwalls. Pumping plants are included in the feature "Pumping Plants." Levees locally called dikes are included in this feature.

12. Navigation Ports and Harbors. This feature includes all forms of excavation (including dredging, preparation of spoil disposal area, and attendant facilities) necessary for the development and construction of coastal ports and harbors for navigation purposes. This includes bulkheads, jetties, piers, and docks constructed in connection with navigation improvements and basins or water areas for vessel maneuvering, turning, passing, mooring, or anchoring incidental to the navigation improvements. It also includes dredged material disposal areas (except those for the inland navigation system, the Atlantic Intracoastal Waterway, and the Gulf Intracoastal Waterway), and sediment basins. These are eligible for development as general navigation features of harbor or waterway projects. The removal of trees, brush, accumulated snags, drift, aquatic, and vegetable growths, and debris from harbors, and ports for navigation are included in this feature.

13. Pumping Plants. This feature includes pumping plants construction to pass accumulated drainage and seepage water and sewage from the protected area over or through levees and floodwalls.

14. Recreation Facilities. This feature includes access roads; parking areas; public camping and picnicking areas, including tables and fireplaces; water supply; sanitary facilities; boat launching ramps; directional signs; and other facilities constructed primarily for public recreational use, including essential safety measures in connection therewith. The latter includes, as appropriate, sheltered anchorage areas for small craft, bathing areas readily accessible and reasonably safe, and safety provisions for visitors and fishermen in the project area. (Boat launching ramps, anchorage areas and beaches should be provided during construction to the extent they will definitely be needed and can be accomplished more economically than at a later date.)

15. Floodway Control and Diversion Structures. This feature includes floodway control and diversion structures to provide for the release of flood waters from streams where discharges exceed flood capacity of the stream, including items such as diversion dams, gated or ungated discharge structures, training walls, stilling basin, and those adjacent embankment sections forming part of the control structure. Construction of channels and levees not forming part of the main control structure, but necessary for operation of such structures is included in the appropriate feature "Channels and Canals" or "Levees and Floodwalls."

16. Bank Stabilization. This feature includes revetments, linings, training dikes, and bulkheads for stabilization of banks of watercourses to prevent erosion, sloughing, or meandering. Bank stabilization constructed in navigation channels or in connection with flood control channel improvement is included in the feature "Channels and Canals."

17. Beach Replenishment. This feature includes replacement of eroded beaches, for purposes of recreation and shore protection, by direct deposit of materials obtained by dredging or land excavation.

19. Buildings, Grounds, and Utilities. This feature includes permanent facilities such as operators' quarters, administration and shop buildings, storage buildings and areas, garage buildings and areas, community buildings, local streets and sidewalks, landscaping, and electric, gas, water, and sewage facilities. Where space in a dam, powerhouse, or other basic structure is used in lieu of construction of any of the above-mentioned buildings, such allocated space is not separated from the basic structure. Communication systems are included in the feature "Permanent Operating Equipment."

20. Permanent Operating Equipment. This feature includes all project-owned operation and maintenance tools and equipment, such as laboratory, shop, warehousing, communications, and transportation equipment, and office furniture and equipment. The cost of installing sedimentation and degradation measuring facilities, including the surveys requisite to locating and monumenting range layouts, is charged to this feature. The cost of planning the installation of sedimentation and degradation ranges is charged to the feature "Engineering and Design."

30. Planning, Engineering and Design. This feature includes all engineering, design, surveys, preparation of detailed plans and specifications, and related work required for the construction of the project, including relocations. Surveys and planning required in connection with land acquisition are charged to the features "Lands and Damages" or

"Relocations," as applicable. Engineering and design performed by hired labor or as a pay item under a contract is included in this feature.

31. Supervision and Administration. This feature includes such functions as inspection, supervision, project office administration, and distributive costs of area office and general overhead charged to the project. Costs for Office of the Chief of Engineers CE and Division Office Executive Direction and Management are not charged to Construction, General but to the General Expenses appropriation title.

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APPENDIX C

Total Project Cost Summary

Total Project Cost Summary

Project: **Example Project (Non-CAP)**
Location: Walla Walla River
District: NWW -Walla Walla District
POC: Callan

P2: **101010**
Report Type: **Feas Stdy**
Contingency Development: Crystal Ball
CWCCIS Issue: **9/1/2015**

Authority: **Section 1135**
TPCS Preparation Date: 27-Oct-15
FY: 2016

Scope Synopsis: Flood Control along upper reach of the Walla Walla River.

WBS		ESTIMATED COST				PROJECT FIRST COST CONSTANT DOLLAR BASIS				TOTAL PROJECT COST (FULLY FUNDED)			
	Civil Works	Risk Based				Program Price Level Date: 2016-1Q							
WBS	Feature Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	INFLATED (%)	COST ($K)	CNTG ($K)	TOTAL ($K)
02	RELOCATIONS	500	125	25%	625		500	125	625	6%	531	133	664
06	FISH & WILDLIFE FACILITIES	41.525	8,381	20%	49,906		41,525	8,381	49,906	4%	43,267	8,734	52,000
	S/T	42,025	8,506	20%	50,531		42,025	8,506	50,531	4%	43,798	8,866	52,664
01	LANDS AND DAMAGES	50	13	25%	63		50	13	63	6%	53	13	66
	S/T	50	13	25%	63		50	13	63	6%	53	13	66
30	PLANNING ENGINEERING AND DESIGN	10.716	2,170	20%	12,886		10,716	2,170	12,886	9%	11,673	2,364	14,038
	S/T	10,716	2,170	20%	12,886		10,716	2,170	12,886	9%	11,673	2,364	14,038
31	CONSTRUCTION MANAGEMENT	6.386	1,289	20%	7,675		6,386	1,289	7,675	9%	6,959	1,405	8,364
	S/T	6,386	1,289	20%	7,675		6,386	1,289	7,675	9%	6,959	1,405	8,364
	Totals	59,178	11,977	20%	71,155		59,178	11,977	71,155	6%	62,484	12,648	75,132

CHIEF, COST ENGINEERING

PROJECT MANAGER

CHIEF, REAL ESTATE

CHIEF, PLANNING

CHIEF, ENGINEERING

CHIEF, OPERATIONS

CHIEF, CONSTRUCTION

CHIEF, CONTRACTING

CHIEF, PM-PB

CHIEF, DPM

	Cost ($k)	Contingency ($k)	Totals ($k)
Project First Cost for Report:	$59,178	$11,977	$71,155
Total Project Cost used to provide Sponsor information:	$62,484	$12,648	$75,132

Project: *Example Project (Non-CAP)* Page 1 of 4 27-Oct-15

Contract Summary

WBS		ESTIMATED COST Estimate Class Level: Class 3				PROJECT FIRST COST CONSTANT DOLLAR BASIS				TOTAL PROJECT COST (FULLY FUNDED)				
Contract: **Phase I**		Est Preparation Date: 27-Oct-15				Program Yr: 2016								
		Est Price Level: 2016-1Q				Prog Level Date: 2016-1Q								
				Risk Based										
Location: Walla Walla River		COST	CNTG	CNTG	TOTAL	ESC	COST	CNTG	TOTAL	MID-PT	INFLATED	COST	CNTG	TOTAL
District: NWW -Walla Walla District		($K)	($K)	(%)	($K)	(%)	($K)	($K)	($K)	(DATE)	(%)	($K)	($K)	($K)
02 RELOCATIONS		500	125	25.0%	625	.%	500	125	625	2019-2Q	6.2%	531	133	664
06 FISH & WILDLIFE FACILITIES		25	6	25.0%	31	.%	25	6	31	2019-2Q	6.2%	27	7	33
Construction Activities *Total*		525	131		656		525	131	656			558	139	697
01 LANDS AND DAMAGES		50	13	25.0%	63	.%	50	13	63	2019-2Q	6.2%	53	13	66
Lands and Damages *Total*		50	13		63		50	13	63			53	13	66
30 Planning Engineering and Design														
Project Management	*2.5%*	13	3	25.0%	16	.%	13	3	16	2019-2Q	13.1%	15	4	19
Planning & Environmental Compliance	*1.0%*	5	1	25.0%	7	.%	5	1	7	2019-2Q	13.1%	6	1	7
Engineering & Design	*15.0%*	79	20	25.0%	98	.%	79	20	98	2019-2Q	13.1%	89	22	111
Engineering Tech Review ATR & VE	*1.0%*	5	1	25.0%	7	.%	5	1	7	2019-2Q	13.1%	6	1	7
Contracting	*1.0%*	5	1	25.0%	7	.%	5	1	7	2019-2Q	13.1%	6	1	7
Engineering During Construction	*3.0%*	16	4	25.0%	20	.%	16	4	20	2019-2Q	13.1%	18	4	22
Planning During Construction	*2.0%*	11	3	25.0%	13	.%	11	3	13	2019-2Q	13.1%	12	3	15
Planning Engineering and Design *Total*		134	33		167		134	33	167			151	38	189
Construction Management	*10.0%*	53	13	25.0%	66	.%	53	13	66	2019-2Q	13.1%	59	15	74
Project Operation:	*15.0%*	79	12	15.0%	91	.%	79	12	91	2019-2Q	13.1%	89	13	102
Construction Management *Total*		131	25		156		131	25	156			149	28	177
Phase I *Total*		840	202		1,042		840	202	1,042			911	219	1,130

Contract Footnote: For Example Only

Project: *Example Project (Non-CAP)* Page 2 of 4 27-Oct-15

Contract Summary

WBS		ESTIMATED COST Estimate Class Level: ***Class 3***				PROJECT FIRST COST ***CONSTANT DOLLAR BASIS***				TOTAL PROJECT COST (FULLY FUNDED)				
Contract: **Phase II**		Est Preparation Date: 27-Oct-15				Program Yr: 2016								
		Est Price Level: 2016-1Q				Prog Level Date: 2016-1Q								
Location: Walla Walla River		COST	Risk Based CNTG	CNTG	TOTAL	ESC	COST	CNTG	TOTAL	MID-PT	INFLATED	COST	CNTG	TOTAL
District: NWW -Walla Walla District		($K)	($K)	(%)	($K)	(%)	($K)	($K)	($K)	(DATE)	(%)	($K)	($K)	($K)
06 FISH & WILDLIFE FACILITIES		40,000	8,000	20.0%	48,000	.%	40,000	8,000	48,000	2018-2Q	4.2%	41,663	8,333	49,995
Construction Activities *Total*		40,000	8,000		48,000		40,000	8,000	48,000			41,663	8,333	49,995
30 Planning Engineering and Design														
Project Management	*2.5%*	1,000	200	20.0%	1,200	.%	1,000	200	1,200	2018-2Q	8.8%	1,088	218	1,306
Planning & Environmental Compliance	*1.0%*	400	80	20.0%	480	.%	400	80	480	2018-2Q	8.8%	435	87	522
Engineering & Design	*15.0%*	6,000	1,200	20.0%	7,200	.%	6,000	1,200	7,200	2018-2Q	8.8%	6,528	1,306	7,833
Engineering Tech Review ATR & VE	*1.0%*	400	80	20.0%	480	.%	400	80	480	2018-2Q	8.8%	435	87	522
Contracting	*1.0%*	400	80	20.0%	480	.%	400	80	480	2018-2Q	8.8%	435	87	522
Engineering During Construction	*3.0%*	1,200	240	20.0%	1,440	.%	1,200	240	1,440	2018-2Q	8.8%	1,306	261	1,567
Planning During Construction	*2.0%*	800	160	20.0%	960	.%	800	160	960	2018-2Q	8.8%	870	174	1,044
Planning Engineering and Design *Total*		10,200	2,040		12,240		10,200	2,040	12,240			11,097	2,219	13,317
Construction Management	*10.0%*	4,000	800	20.0%	4,800	.%	4,000	800	4,800	2018-2Q	8.8%	4,352	870	5,222
Project Operation:	*5.0%*	2,000	400	20.0%	2,400	.%	2,000	400	2,400	2018-2Q	8.8%	2,176	435	2,611
Construction Management *Total*		6,000	1,200		7,200		6,000	1,200	7,200			6,528	1,306	7,833
Phase II *Total*		56,200	11,240		67,440		56,200	11,240	67,440			59,288	11,858	71,146

Contract Footnote: For Example Only

Project: *Example Project (Non-CAP)* Page 3 of 4 27-Oct-15

Contract Summary

WBS		ESTIMATED COST Estimate Class Level: ***Class 3***				PROJECT FIRST COST *CONSTANT DOLLAR BASIS*				TOTAL PROJECT COST (FULLY FUNDED)				
Contract: **Phase III**		Est Preparation Date: 27-Oct-15				Program Yr: 2016								
		Est Price Level: 2016-1Q				Prog Level Date: 2016-1Q								
Location: Walla Walla River		COST	CNTG	Risk Based CNTG	TOTAL	ESC	COST	CNTG	TOTAL	MID-PT	INFLATED	COST	CNTG	TOTAL
District: NWW -Walla Walla District		($K)	($K)	(%)	($K)	(%)	($K)	($K)	($K)	(DATE)	(%)	($K)	($K)	($K)
06 FISH & WILDLIFE FACILITIES		1,500	375	25.0%	1,875	.%	1,500	375	1,875	2018-4Q	5.1%	1,577	394	1,972
Construction Activities	*Total*	1,500	375		1,875		1,500	375	1,875			1,577	394	1,972
30 Planning Engineering and Design														
Project Management	*2.5%*	38	9	25.0%	47	.%	38	9	47	2018-4Q	11.%	42	10	52
Planning & Environmental Compliance	*1.0%*	15	5	30.0%	20	.%	15	5	20	2018-4Q	11.%	17	5	22
Engineering & Design	*15.0%*	225	56	25.0%	281	.%	225	56	281	2018-4Q	11.%	250	62	312
Engineering Tech Review ATR & VE	*1.0%*	15	4	25.0%	19	.%	15	4	19	2018-4Q	11.%	17	4	21
Contracting	*1.0%*	15	4	25.0%	19	.%	15	4	19	2018-4Q	11.%	17	4	21
Engineering During Construction	*3.0%*	45	11	25.0%	56	.%	45	11	56	2018-4Q	11.%	50	12	62
Planning During Construction	*2.0%*	30	8	25.0%	38	.%	30	8	38	2018-4Q	11.%	33	8	42
Planning Engineering and Design	*Total*	383	96		479		383	96	479			424	107	531
Construction Management	*10.0%*	150	38	25.0%	188	.%	150	38	188	2018-4Q	11.%	166	42	208
Project Operation:	*7.0%*	105	26	25.0%	131	.%	105	26	131	2018-4Q	11.%	117	29	146
Construction Management	*Total*	255	64		319		255	64	319			283	71	354
Phase III	*Total*	2,138	535		2,673		2,138	535	2,673			2,285	572	2,857

Contract Footnote: For Example Only

Total Project Cost Summary

Continuing Authorities Program

In addition to specifically authorized projects, Congress recognized a need to address small water resources and ecosystem restoration projects of limited scope and complexity.

1. The continuing authorities program (CAP) provides the authority for the Secretary of the Army, acting through the Chief of Engineers, to plan, design, and construct projects of limited size, scope, cost, and complexity without additional specific Congressional authority.

2. Congress provides annual appropriations for legislative CAP authorities up to the annual program limit.

3. CAP projects must be implemented in two phases: Feasibility, and Design and Implementation. Each phase is carried out under a separate cost-sharing agreement.

4. Feasibility study costs are NOT included in the Project First Costs or the Total Project Costs of the WBS table. Check current CAP guidance for further information. In most cases the study cost is not part of the "total project cost" but IS included in the federal spending limit/ceiling. The cost share percentage may vary-often the first 100K is fully federally funded.

The following pages are an example of a CAP TPCS.

**** TOTAL PROJECT COST SUMMARY ****

Printed:10/28/2015
Page 1 of 2

PROJECT: **Washout Creek Bridge Protection - Section 14**
PROJECT NO: **P2 172233**
LOCATION: **Somewhere, WA**

DISTRICT: **NWW WALLA WALLA** PREPARED: **4/1/2014**
POC: **CHIEF, COST ENGINEERING, xxx**

This Estimate reflects the scope and schedule in report; CAP Feasibility STUDY - WASHOUT CREEK

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC):				2016					
						Effective Price Level Date:				1-Oct- 15					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	REMAINING COST ($K)	Spent Thru: 10/1/2013 ($K)	TOTAL FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
09	CHANNELS & CANALS	$3,221	$741	23%	$3,962	1.3%	$3,263	$750	$4,013		$4,013	1.4%	$3,308	$761	$4,069
16	BANK STABILIZATION	$458	$165	36%	$623	1.8%	$466	$168	$634		$634	1.4%	$473	$170	$643
	CONSTRUCTION ESTIMATE TOTALS:	$3,679	$906		$4,585	1.4%	$3,729	$918	$4,647		$4,647	1.4%	$3,781	$931	$4,712
01	LANDS AND DAMAGES	$5	$2	30%	$7	0.6%	$5	$2	$7		$7		$5	$2	$7
30	PLANNING, ENGINEERING & DESIGN	$1,050	$227	22%	$1,277	2.3%	$1,074	$232	$1,306		$1,306	3.3%	$1,110	$240	$1,350
31	CONSTRUCTION MANAGEMENT	$534	$94	18%	$628	1.6%	$543	$95	$638		$638	3.3%	$560	$99	$659
	PROJECT COST TOTALS:	$5,268	$1,228	23%	$6,496		$5,351	$1,247	$6,598		**$6,598**	2.0%	$5,456	$1,271	$6,727

______________________ CHIEF, COST ENGINEERING, xxx

______________________ PROJECT MANAGER, xxx

______________________ CHIEF, REAL ESTATE, xxx

______________________ CHIEF, PLANNING, xxx

______________________ CHIEF, ENGINEERING, xxx

______________________ CHIEF, OPERATIONS, xxx

______________________ CHIEF, CONSTRUCTION, xxx

______________________ CHIEF, CONTRACTING, xxx

______________________ CHIEF, PM-PB, xxxx

______________________ CHIEF, DPM, xxx

ESTIMATED TOTAL PROJECT COST:		**$6,727**
ESTIMATED FEDERAL COST:	65%	$4,373
ESTIMATED NON-FEDERAL COST:	35%	$2,354
22 - FEASIBILITY STUDY (CAP studies):		**$200**
ESTIMATED FEDERAL COST:		$165
ESTIMATED NON-FEDERAL COST:		$35
ESTIMATED FEDERAL COST OF PROJECT		**$4,538**

Filename: CAP Example TPCS Sep 2015 r0.xlsx
TPCS

****** TOTAL PROJECT COST SUMMARY ******

Printed:10/28/2015
Page 2 of 2

****** CONTRACT COST SUMMARY ******

PROJECT: Washout Creek Bridge Protection - Section 14
LOCATION: Somewhere, WA
This Estimate reflects the scope and schedule in report; CAP Feasibility STUDY - WASHOUT CREEK

DISTRICT: NWW WALLA WALLA
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 4/1/2014

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 3/15/2014				Program Year (Budget EC): 2016								
		Estimate Price Level: 41913				Effective Price Level Date: 1-Oct-15								
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	PHASE 1 or CONTRACT 1													
09	CHANNELS & CANALS	$3,221	$741	23.0%	$3,962	1.3%	$3,263	$750	$4,013	2016Q4	1.4%	$3,308	$761	$4,069
16	BANK STABILIZATION	$458	$165	36.0%	$623	1.8%	$466	$168	$634	2016Q4	1.4%	$473	$170	$643
	CONSTRUCTION ESTIMATE TOTALS:	$3,679	$906	24.6%	**$4,585**		$3,729	$918	$4,647			$3,781	$931	$4,712
01	LANDS AND DAMAGES	$5	$2	30.0%	$7	0.6%	$5	$2	$7	2016Q1		$5	$2	$7
30	PLANNING, ENGINEERING & DESIGN													
0.025	Project Management	$92	$20	21.6%	$112	2.3%	$94	$20	$114	2016Q4	2.6%	$97	$21	$117
0.02	Planning & Environmental Compliance	$74	$16	21.6%	$90	2.3%	$76	$16	$92	2016Q4	2.6%	$78	$17	$94
0.15	Engineering & Design	$552	$119	21.6%	$671	2.3%	$565	$122	$687	2016Q4	2.6%	$579	$125	$705
0.01	Engineering Tech Review ITR & VE	$37	$8	21.6%	$45	2.3%	$38	$8	$46	2016Q4	2.6%	$39	$8	$47
0.01	Contracting & Reprographics	$37	$8	21.6%	$45	2.3%	$38	$8	$46	2016Q4	2.6%	$39	$8	$47
0.03	Engineering During Construction	$110	$24	21.6%	$134	2.3%	$113	$24	$137	2017Q4	6.7%	$120	$26	$146
0.02	Planning During Construction	$74	$16	21.6%	$90	2.3%	$76	$16	$92	2017Q4	6.7%	$81	$17	$98
0.02	Project Operations	$74	$16	21.6%	$90	2.3%	$76	$16	$92	2016Q4	2.6%	$78	$17	$94
31	CONSTRUCTION MANAGEMENT													
0.1	Construction Management	$368	$65	17.6%	$433	1.6%	$374	$66	$440	2017Q4	3.3%	$386	$68	$454
0.02	Project Operation:	$74	$13	17.6%	$87	1.6%	$75	$13	$88	2017Q4	3.3%	$78	$14	$91
0.025	Project Management	$92	$16	17.6%	$108	1.6%	$93	$16	$110	2017Q4	3.3%	$97	$17	$113
	CONTRACT COST TOTALS:	$5,268	$1,228		**$6,496**		$5,351	$1,247	$6,598			$5,456	$1,271	**$6,727**

Filename: CAP Example TPCS Sep 2015 r0.xlsx
TPCS

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APPENDIX D

Cost Engineering Within the Planning Modernization Paradigm

1. Objective: The objective of preparing a feasibility report is to identify the recommended plan within the prescribed 3x3x3: project scope, economic benefit, and an accurate cost and schedule baseline identified with potential project risks. Analysis of specific design alternatives, selection of a final recommended technical design solution, and development of confident cost estimates, schedule products, and risk identification are part of project formulation, and are critical elements that enable informed decision making.

2. Guidance: For all Civil Works studies utilizing the new Planning paradigm as directed must consider the Uncertainty and Level of Detail, ensure Vertical Team Integration, determine Federal Interest, perform Alternative Comparison and Selection, and ensure necessary Funding and Resources.

a. Uncertainty and Level of Detail. The new paradigm will require increased use of critical thinking (i.e. engineering judgment) in the analysis and cost estimates supporting plan formulation and selection for both alternative level as well as final recommendation. The Project Development Team (PDT) must analyze minimum design/technical information requirements to assure functionality and life safety for the project. The PDT must also determine minimum design/technical information requirements needed to develop accurate cost and schedule information (cost, schedule and risk). The appropriate level of detail must be determined with design personnel as the lead for determining design/technical information levels for function and safety, and cost personnel as the lead for the design/technical detail requirements pertaining to cost and schedule development. Based on the previous requirements corresponding PDT members will support cost personnel for defining technical assumptions where needed. Within the design effort in feasibility, the PDT will develop a work breakdown structure, which sufficiently identifies the project scope, features, and tasks to a level necessary to develop an accurate baseline cost and schedule, and enables identification and management of cost and schedule risks. Each project will utilize a “risk register” organized by project features to assess their likelihood of impacting cost, schedule and/or function/safety. The planning study risk register will be utilized for efforts required for the study execution. Risk Events identified within planning study risk identification process which could have an impact on cost and/or schedule will be included in the cost and schedule risk register. The goal is to minimize data collection and analysis for low impact features during the feasibility phase. High impact features should be carefully scoped such that data collection and analysis is commensurate with risk and adds value to the decision making process, accuracy to the cost and schedule, or reduces risk. The Project manager along with PDT must work closely with the cost engineer to identify areas where clarifying/modification of design/technical information details would be beneficial to reduce uncertainty. For items with significant cost and schedule risk, mitigation strategies shall be identified and discussed in the project's Risk Management Plan. While this approach must not lead us to accept additional life safety risk in projects, it may be appropriate to make a risk informed decision to defer some details or analysis to the Preconstruction Engineering and Design (PED) phase, provided that proper plan formulation can be accomplished.

APPENDIX E

Release of Government Estimates under Freedom of Information Act (FOIA)

1. This guidance establishes procedures for responding to FOIA requests for *Government estimates* and *Government estimate back-up data.* The *Government estimate* and *Government estimate back-up data,* prepared for construction contracts and modifications, are sensitive procurement information and should in many cases be withheld under the FOIA exemptions. FAR 36-203(c) states “Access to information concerning the Government estimate shall be limited to Government personnel whose official duties require knowledge of the estimate. An exception to this rule may be made during contract negotiations to allow the contracting officer to identify a specialized task and disclose the associated cost breakdown figures in the Government estimate, but only to the extent deemed necessary to arrive at a fair and reasonable price. The overall amount of the Government's estimate shall not be disclosed except as permitted by agency regulations.”

2. Definitions:

a. Government estimate*.* The Government estimate consists of a title page, signature page and bid schedule.

b. Government estimate back-up data*.* The Government estimate back-up data is the detailed cost data, which includes production and crew development methodology, labor, equipment and crew back-up files, subcontractor quotes and all other data identified on MCACES software as detail sheets.

c. Fair market price determinations, under the Small Business Program (FAR 19.202 6), will be treated as Government estimates for purposes of this guidance.

d. Supporting documents that are publicly available, as part of the solicitation, such as plans, specifications and project description, or that contain no cost information, such as sketches, soil borings and material classifications, are not part of the Government estimate or back-up.

3. Government estimates and Government estimate back-up data are intra-agency memoranda which may be withheld under FOIA Exemption 4 and 5,

"confidential commercial information" and "deliberative process" privileges. Proper use of FOIA Exemption requires a showing that release of information will harm the Government's interests. Therefore, requests for Government estimates and back-up data will be reviewed on a case-by-case basis, based on the following guidance, to determine whether release will harm the Corps' interests. In reviewing requests the FOIA Officer will seek the assistance of the cost engineer. If the FOIA Officer determines that release will harm the Corps' interests, the information will be withheld.

a. Before Contract Award.

(1) When sealed bidding is used, neither the Government estimate nor the Government estimate back-up data should be released prior to bid opening, in accordance with FAR 36.203 and 36.204. It is well established that release of Government estimates and back-up data before contract award would harm the interests of the Government.

(2) The Government estimate will normally be released when bids are opened. In some instances, however, the *Government estimate* will not be released at that time, such as when all bids received are non-responsive and a re-procurement is envisioned.

(3) In negotiated procurement for construction under FAR Parts 15 and 36, the Government estimate should not be released prior to contract award, except that Government negotiators may disclose portions of the Government estimate in negotiating a fair and reasonable price, see FAR 36-203(c).

(4) Government estimate back-up data should not be released.

b. After Contract Award Through Contract Completion.

(1) The Government estimate may be released.

(2) The Government estimate back-up data should not be released. Release of Government estimate back-up data after contract award and before completion of a construction contract may also result in harm to the Government. The Government estimate back-up data is used to develop cost estimates for modifications and claims. Release of the back-up data prior to contract completion provides the contractor with the details of the Government's position and would

allow the contractor to develop a biased price proposal. This could harm the Government's ability to negotiate a fair and reasonable price for the modification or claim, putting the Government at a serious commercial disadvantage. Moreover, knowledge of the construction methods contemplated by the Government might reduce the contractor's incentive to discover less expensive methods. This could also reduce the contractor's incentive to locate and charge out materials at a lower cost, or to achieve project goals using less labor and equipment.

c. After Contract Completion (and after all claims have been resolved).

(1) Generally, the Government estimate back-up data may be released after the contract is completed. All sensitive information such as actual quotes and contractor reference shall be redacted from the data. Situations where the information should not be released include multiple-phased projects where a series of similar contracts are awarded in sequence and frequently recurring contracts (for example: dredging contracts). In those cases, each Government estimate is based upon the same or similar back-up data and the same or similar analysis of how to perform the work.

4. Bid Protests and Litigation. This guidance should be considered when the Corps is involved in bid protests or litigation. If appropriate and to the extent possible, Counsel should have the Government estimate and the Government estimate back-up data placed under a "protective order." There are valid reasons for not releasing the back-up data supporting the Government estimate to the contractors. In the case of a bid protest, there is a possibility that the contract could be re-advertised or converted to a negotiated procurement . Release of the back-up data would provide bidders with the detailed cost data that supports the Government estimate. If, however, the apparent low bidder protests the reasonableness of the Government estimate, the Command may provide the details of the Government estimate and Government estimate back-up data, to the protester only, upon receipt of complete details of the protester's estimate.

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GLOSSARY

Terms and Abbreviations

GLOSSARY

Term	Definition
Architect-Engineer (A-E)	Architectural/engineering firms that provide services such as planning, architecture, engineering, estimating, surveying, and other technical services related to planning, designing, and construction.
Agency Technical Review (ATR)	A mandatory effort to improve and ensure the quality and credibility of U.S. Army Corps of Engineers decision and implementation documents by employing an independent review from subject matter experts outside the home district.
Baseline Cost Estimate (BCE)	The cost estimate based on constant dollars is used for authorization/appropriation purposes. The congressionally authorized amount becomes the baseline cost estimate and may differ from the total project cost.
Budget Estimate	The budget estimate supports funding requests as well as comparisons made to current available funding. Comparisons to the available funding are also referred to as current working estimates (CWE).
Continuing Authorities Program (CAP)	Congress has given the U.S. Army Corps of Engineers the authority to plan, design, and construct certain flood risk management and navigation improvements without specific congressional authorization. The basic objective of this program is to allow the Corps to respond more quickly to problems or needs where the apparent project scope and costs are small. The amount of federal participation is limited by congress, and varies for each individual authority.
Cost Engineering Dredge Estimating Program (CEDEP)	A U.S. Army Corps of Engineers program that allows the user to estimate dredging projects using mechanical, pipeline, and hopper dredge plant.

Term	Definition
	The center is established to develop new cost database items that represent the current construction practices and technologies, to maintain and biennially update EP 1110-1-8, Construction Equipment Ownership and Operating Expense Schedule, and to semiannually update EM 1110-2-1304, Civil Works Construction Cost Index System (CWCCIS).
Civil Works Cost Engineering and Agency Technical Review Mandatory Center of Expertise (Cost MCX)	Walla Walla District's Cost Engineering Branch has been established as the Mandatory Center of Cost Engineering for Civil Works Review. The Cost MCX serves a critical role in all Civil Works and Support for Others Program cost support activities for the USACE cost community. The Cost MCX provides the cost community estimating services for the construction features on all projects from the planning phases through construction, maintenance, and rehabilitation of facilities. Walla Walla's diversified cost team strives to provide expert technical support for all customers, both Corps and other governmental agencies.
Constant Dollar Cost (Price Level)	Constant dollar analyses are utilized to determine an equivalent cost in the future or in the past by price indexing using CWCCIS data. Constant dollar cost is the estimated cost BROUGHT TO THE EFFECTIVE PRICE LEVEL. Constant dollar cost at current price levels is the cost estimate used in decision documents and chief's reports. The constant dollar cost does not include inflation to midpoint design and construction.
Cost and Schedule Risk Analysis (CSRA)	A risk analysis is the process of identifying and measuring the cost and time impacts of project uncertainties on the estimated TPC. The risk analysis results in two main products: Identified risks and contingency dollars to fund risk occurrence.
Civil Works Work Breakdown Structure (CW-WBS)	A hierarchical structure that defines tasks that can be completed independently of other tasks, facilitating resource allocation, assignment of responsibilities, and measurement and control of the project.
Civil Works Construction Cost Index System (CWCCIS)	Historical and forecasted cost indexes for use in escalating U.S. Army Corps of Engineers civil works project costs.

Term	**Definition**
Current Working Estimate (CWE)	An update comparison to the appropriated amount or BCE. Commonly referred to as total project cost, the update reflects the total project scope and estimated cost with current effective date pricing plus spent cost from authorization amount. The CWE reflects the associated project costs in quantities, estimates and supporting databases, duration, and risk at any point in time within the funded project's life.
DrChecks^{SM}	"Design Review and Checking System." Enables an actionable collaboration among the reviewers and design team of capital improvement projects.
District Quality Control (DQC)	All work products and reports, evaluations, and assessments shall undergo necessary and appropriate district quality control/quality assurance.
Economic Cost	Monetary equivalent cost used by the economist in determining the benefit-to-cost ratio (BCR). The economic cost includes all of the opportunity costs, both explicit (out of pocket to realize project benefits) and implicit (noncash), of using the resource and is expressed in average annual equivalent terms. It is also referred to as the constant dollar cost. The economic cost should not be confused with the financial cost and should be clearly and separately described in reports.
Effective Price Level (EPL)	Date of the point in time of the pricing used in the cost estimate.
Estimated Cost (Price Level)	Initially developed cost estimate which includes contingencies. The effective price level date for estimated cost is usually the date of preparation of the cost estimate.

Term	Definition
Financial Cost	Monetary outlay, both federal and non-federal, of constructing a project. It includes design and construction outlays, transfer payments such as replacement housing payments as specified in 42 United States Code 4623 and 4624, and the value of lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas (LERRD) and work in kind provided by non-federal sponsors. This cost is developed by cost engineering, in close coordination with the economist and other members of the PDT, and is typically presented in the TPCS.
Independent External Peer Review (IEPR)	Most independent level of review and is applied in cases that meet certain criteria where the risk and magnitude of the proposed project are such that a critical examination by a qualified team outside of USACE is warranted.
Independent Government Estimate (IGE)	Formal, approved cost estimate prepared to support a contract award, which is signed by the chief of cost engineering.
Independent technical review (ITR)	A review by a qualified person or team not involved in the day-to-day production of a project/product, for the purpose of confirming the proper application of clearly established criteria, regulations, laws, codes, principles and professional practices. Predecessor to agency technical review on civil works .
Microcomputer Aided Cost Estimating System (MCACES)	Mandatory U.S. Army Corps of Engineers estimating software.
MII	MCACES second generation
National Economic Develop-ment (NED)	In the civil works project planning context, NED analysis can be generally defined as economic benefit-cost analysis for plan formulation, evaluation, and selection that is used to evaluate the federal interest in pursuing a prospective project plan.

Term	**Definition**
Peer Review	The process of subjecting research, assumptions, analyses, and conclusions to the scrutiny of others who are experts in the same field. Peer review requires a community of experts in a given (and often narrowly defined) field, who are qualified and able to perform impartial review.
Project	Each project is a temporary endeavor undertaken to create a unique product, service, or result. Internal services are discrete projects when they are unique and non-recurring (ER 5-1-11).
Project Delivery Team (PDT)	An interdisciplinary group formed from the resources of the implementing agencies, which develops the products necessary to deliver the project.
Project Manager (PM)	Responsible for the planning, execution, and closing of any project, typically relating to construction.
Project Management Plan (PMP)	A formal, approved document used to guide both project execution and project control.
Project First Cost (Price Level)	The cost estimate that will serve as the basis for providing the cost of the project for which authorization is sought. The cost estimate to be used in chief's reports and other decision documents is estimated cost represented at the current price level. The current price level is the current FY based on the submittal date.
Risk management plan (RMP)	A document that a project manager prepares to foresee risks, estimate impacts, and define responses to issues.
Simplified acquisition threshold (SAT)	As defined in FAR 2.101
Total Cost Management	The effective application of professional and technical expertise to plan and control resources, costs, schedules, and risk. A systematic approach to managing cost throughout the life cycle of any project, product, or service.

Term	Definition
Total Project Cost	The constant dollar cost FULLY FUNDED WITH ESCALATION to the estimated midpoint of construction. Total project cost (or total cost of construction of GNFs when discussing navigation projects) is the cost estimate used in project partnership agreements and integral determination reports. Total project cost is the cost estimate provided non-federal sponsors for their use in financial planning as it provides information regarding the overall non-federal cost sharing obligation.
Total Project Cost Summary (TPCS)	The required cost estimate document to be submitted with all projects sent for either division or HQUSACE approval. Since it addresses all project features, it is considered a PDT product. Both the PM and chief of the cost engineering office must review, approve, sign, and date all TPCS documents. Real estate estimates included in the TPCS must be reviewed, approved, and the TPCS signed by the chief, or their designee, of the real estate office.

Petitioners’ Attachment No. JCK-3R

Estimating Soft Costs for Major Public Transportation Fixed Guideway Projects

DETAILS

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TRANSIT COOPERATIVE RESEARCH PROGRAM

TCRP REPORT 138

Estimating Soft Costs for Major Public Transportation Fixed Guideway Projects

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TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2010
www.TRB.org

TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions,* published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), Transportation 2000, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA, the National Academies, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at any time. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel, appointed by the Transportation Research Board. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired impact if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended end users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

The TCRP provides a forum where transit agencies can cooperatively address common operational problems. The TCRP results support and complement other ongoing transit research and training programs.

TCRP REPORT 138

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THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. On the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Charles M. Vest is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, on its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both the Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. Charles M. Vest are chair and vice chair, respectively, of the National Research Council.

The **Transportation Research Board** is one of six major divisions of the National Research Council. The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied activities annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. **www.TRB.org**

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COOPERATIVE RESEARCH PROGRAMS

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FOREWORD

By Dianne Schwager
Staff Officer
Transportation Research Board

TCRP Report 138: Estimating Soft Costs for Major Public Transportation Fixed Guideway Projects: Part 1: Guidebook; Part 2: Final Report is an important resource that addresses the costs for professional services for major transit investments. The *Guidebook* is a resource intended for project managers and cost estimators working for transit agencies or other organizations in the early phases of planning a major fixed guideway public transportation project. It defines and describes soft costs and provides a new methodology to estimate soft costs based on historical projects. The *Final Report* presents more detailed technical information about this project's data collection, methodology, and statistical analysis. While the *Final Report* may be used by transit agencies, it will also be used by regional governments, state and national departments of transportation, researchers, project sponsors, and cost estimators.

The costs of a new fixed guideway public transportation project line are extremely important in the public deliberation over whether to build the project. While considerable information is available on the "hard costs" of transit capital construction (such as steel, concrete, rail cars and buses, or construction labor), prior to this research, transit systems had few resources that addressed professional services or "soft costs." These costs have ranged from as low as 11% to as high as 54% of hard costs for U.S. light and heavy rail transit projects. On average, soft costs for federally funded fixed guideway transit projects account for about 30% in additional cost above hard costs—a significant part of the ever-important estimate of total project cost.

The ***Guidebook*** is designed to help practitioners in two ways:

1. ***By Providing Information.*** The first sections supply basic information about what soft costs are, how transit agencies and their contractors estimate soft costs, how the estimates fit into the Federal Transit Administration's New Starts process, and how project characteristics such as guideway length or project delivery method have tended to drive soft costs up or down in the past.
2. ***By Presenting a Soft Cost Estimation Methodology.*** The final sections of the Guidebook provide a new tool to estimate project soft costs, based on both the characteristics of the project and the organizational attributes of its sponsor agency. This methodology is based on industry surveys, interviews, and an extensive analysis of the "as-built" costs of nearly 60 rail transit projects over the past three decades.

The ***Final Report*** presents the research, data sources, and analysis underlying the *Guidebook*. To support the development of the *Guidebook* on soft costs, this report:

- Identifies a working definition of soft costs through a literature review and industry outreach;
- Describes the current industry practice of estimating soft costs through a questionnaire of the transit industry and interviews with industry professionals; and
- Statistically analyzes the as-built costs of 59 past transit projects to determine how project characteristics have driven soft costs historically.

CONTENTS

PART 1

Guidebook

CONTENTS

Introduction

The purpose of TCRP Project G-10 was to research soft costs in major public transportation infrastructure projects, with the goal of producing a guide for transportation project sponsors to learn more about these costs and better estimate them in the future. This Guidebook is one of two final products from the project and is intended to summarize how the project's research can be applied to practice. For more detailed information about Project G-10's data collection, methodology, and statistical analysis, please refer to the Final Report in Part 2, which follows the Guidebook.

CHAPTER 1

What Are Soft Costs and Why Do They Matter?

The price tag of a new urban fixed guideway transit line is one of the most visible and critical pieces of information in the public deliberation over whether to build the project. The project's cost factors prominently in deciding mode and alignment during the project's alternatives analysis (AA) and preliminary engineering (PE) phases, is repeated in the media, is debated by the stakeholders, and is a crucial input to the "cost-effectiveness" evaluation that forms the basis for the project's eligibility and recommendation for federal funds.

But what do these cost estimates really consist of? Most professionals are familiar with the "hard costs" of transit capital construction such as steel, concrete, rail cars and buses, or construction labor. But what about costs for designing the project, obtaining permits, and managing the construction project? What about the cost of settling a real estate legal issue or testing a mechanical system before the project opens? These are included in the category called professional services or "soft costs" and have ranged from as low as 11% to as high as 54% of hard costs. On average, soft costs for federally funded transit projects account for about a 30% additional cost above hard costs—a significant part of the ever-important estimate of total project cost.

Despite the importance and magnitude of professional services or soft costs, project managers may not always understand precisely why soft costs' percentage of total project cost can span such a broad range, how to best estimate them early in project development, or even what types of soft costs there are. Furthermore, transit agencies may face tough public scrutiny over the accuracy and consistency of their cost estimates, scrutiny that is driven by perceptions that transit project capital costs have been underestimated in the past. Finally, while a great deal of research has targeted hard cost estimation techniques, very little literature exists on the composition and estimation of soft costs for transit projects.

This Guidebook is designed to help fill that gap. It is intended to help transportation project sponsors better understand and estimate soft costs, especially during the initial phases of developing a rail project.

CHAPTER 2

How and Who This Guidebook Helps: Audience and Circumstances

This Guidebook is geared toward project managers and cost estimators working for transit agencies or other organizations attempting to plan and construct new rail transit projects. Projects will benefit most from this Guidebook during early planning phases, typically during alternatives analysis or preliminary engineering as the draft environmental impact statement (DEIS) is prepared. Exhibits 1 and 2 describe this document's intended audience and circumstance. The definition and discussion of soft costs presented here is relevant to almost all kinds of major public transit capital infrastructure projects, but the methodology to estimate soft costs in Chapter 6 applies only to new rail construction projects.

This Guidebook is designed to help practitioners in two ways:

1. **By providing information.** The first sections of this document supply basic information about what soft costs are, how transit agencies and their contractors estimate soft costs, how the estimates fit into the Federal Transit Administration's New Starts process, and how project characteristics such as guideway length or project delivery method have tended to drive soft costs up or down in the past.
2. **By presenting a soft cost estimation methodology.** The final sections of this Guidebook provide a new tool to estimate project soft costs, based on both the characteristics of the project and the organizational attributes of its sponsor agency. This methodology is based on industry surveys, interviews, and an extensive analysis of the "as-built" costs of nearly 60 rail transit projects over the past three decades.

By the end of this Guidebook, the reader should be armed with a clear understanding of what soft costs are and how they are estimated, a new way to approximate soft costs for themselves using a blend of art and science, and a resulting estimate of soft costs for a given project firmly rooted in historical experience.

This Guidebook is intended for:
- A project manager or cost estimator
- An employee or contractor for a transit agency or other sponsor agency (department of transportation, airports authority, planning board, etc.)
- Anyone responsible for high-level budgeting and/or New Starts application

Exhibit 1. Who this Guidebook addresses.

This Guidebook addresses the following types of projects:
- Urban public transit construction projects
- Projects that are early in planning stages, such as alternatives analysis or preliminary engineering
- Heavy or light rail
- Projects that potentially need federal funding

Exhibit 2. Projects this Guidebook addresses.

CHAPTER 3

What Are Soft Costs?

Generally, soft costs are the capital expenditures that are required to complete an operational transit project, but which are not spent directly on activities related to brick-and-mortar construction, vehicle and equipment procurement, or land acquisition. Instead, these expenses are incurred on professional services that are necessary to complete the project.

Generally, soft costs are the capital expenditures that are required to complete an operational transit project but that are not spent directly on activities related to brick-and-mortar construction, vehicle and equipment procurement, or land acquisition. Instead, these expenses are incurred on professional services that are necessary to complete the project, as described under the Standard Cost Categories (SCCs) below. Soft costs are the expenditures necessary to *plan, design,* and *manage* the project, while hard costs are the expenditures required for *construction.*

As an analogy, a homeowner planning to build an addition to his or her house might hire a surveyor to measure the land and an architect to design the project and oversee construction. Fees for these professional services are soft costs to the project. Similarly, a transit agency seeking to expand or renew its infrastructure will hire surveyors, planners, engineers, architects, project and construction managers, and other professionals to plan, design, and develop the transit construction project.

Standard Cost Categories

The Federal Transit Administration (FTA) requires that all candidate and recipient projects for New Starts funds organize and report their project cost estimates in the same way, using the Standard Cost Category structure. This structure consists of ten major cost *categories* (as shown in Exhibit 3), each of which is further broken down into *components.* For example, the SCC 50 Systems cost category includes separate components for Train Control, Traction Power, Communications, and Fare Collection. This common cost-estimating structure allows FTA to compare cost estimates from different kinds of projects across the country on a consistent basis.

Standard Cost Category 80, Professional Services, consists of eight separate components (see Exhibit 1), which together encompass all services and activities commonly associated with project soft costs (although some exceptions are discussed below). For this reason, this Guidebook has adopted the definition and structure of FTA SCC 80, Professional Services, as being equivalent to the definition of soft costs. Based on a review of existing literature, this definition is reasonable, consistent, and comprehensive for estimation purposes. Furthermore, using the SCC structure and the definition of SCC 80 is consistent with the historical analysis that underpins the new soft cost estimation methodology discussed later.

Definition of Soft Costs

This Guidebook considers soft costs to be equivalent to SCC 80 Professional Services, which FTA (U.S. Federal Transit Administration, 2008) defines as follows:

> [Soft costs include] all professional, technical and management services (and related professional liability insurance costs) related to the design and construction of fixed infrastructure during the preliminary

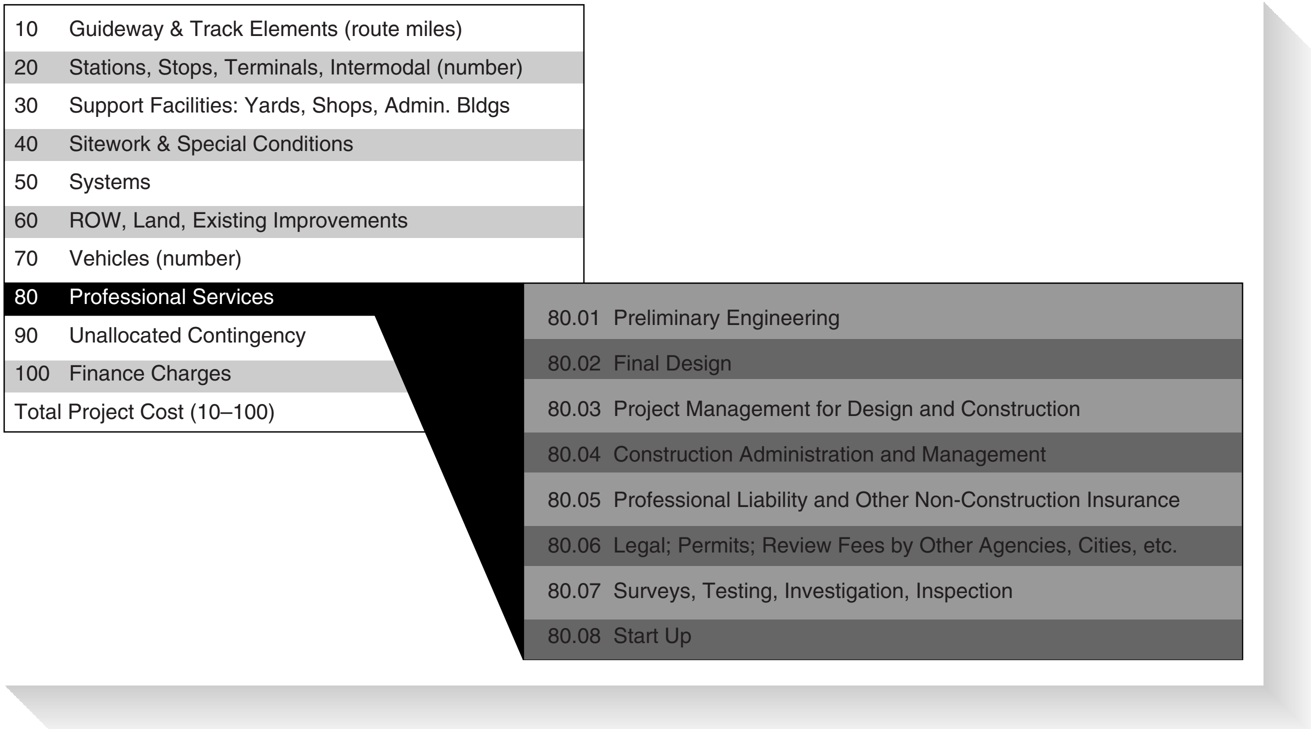


Exhibit 3. FTA Standard Cost Categories with Category 80 components.

> engineering, final design, and construction phases of the project. This includes environmental work, design, engineering and architectural services; specialty services such as safety or security analyses; and value engineering, risk assessment, cost estimating, scheduling, before and after studies, ridership modeling and analyses, auditing, legal services, administration and management, etc. by agency staff or outside consultants.

The FTA directs applicants to classify any professional services directly related to right-of-way (ROW) acquisition (such as for appraisals and legal services) and vehicle procurement (such as engineering and design work) in their respective categories (SCC 60 and 70), *not* in SCC 80.

What Are the Components of Soft Costs?

Following the FTA's Standard Cost Category structure, most rail transit project soft costs are divided into the eight components of Category 80 shown in Exhibit 3. While all costs in SCC 80 are primarily for professional services, they may be incurred by agency staff or outside consultants, depending on the project. Soft costs are classified into components based on either the timing or purpose of the cost, as follows:

- **80.01–Preliminary Engineering**—All costs are included in this stage of the project development process. This includes the costs of early design, negotiations for operations and/or maintenance, developing financial plans, and ridership studies. Under alternative project delivery arrangements, the contractor's soft costs for preliminary engineering should be captured here, and the project sponsor may request that the contractor invoice and report costs under the SCC structure.
- **80.02–Final Design**—All costs associated with the final design (FD) stage. Costs for services similar to the above description are captured here.
- **80.03–Project Management for Design and Construction**—Project management oversight costs. Costs to support design, management, and administrative efforts for legal, technical, and environmental consultants are reported here.

- **80.04–Construction Administration and Management**—Quality control, quality assurance, and construction management during the construction phase.
- **80.05–Insurance**—Project insurance to cover professionals' liability insurance, owner-provided builder's risk, other agency insurance, etc. This component does not include construction contractors' liability or general insurance. All construction contractors' insurance costs should be reported in a corresponding hard cost category.
- **80.06–Legal; Permits; Review Fees by Other Agencies, Cities, etc.**—Costs associated with the local and state project approval process, and any legal costs.
- **80.07–Surveys, Testing, Investigation, Inspection**—Costs of alignment and facility surveys, security and safety inspections, material and geological testing, and inspection services.
- **80.08–Start Up**—Costs associated with the operational initiation of services and training of operations, maintenance, and supervisory staff.

Timing of Soft Costs

While some components of soft costs tend to relate to specific phases of project development over time, others tend to reflect costs incurred throughout the life of the project. For instance, most projects will incur all of their Preliminary Engineering expenses (SCC 80.01) early in their lifecycle, and Startup costs (SCC 80.08) will be spent near the end of the project. In contrast, Insurance costs (SCC 80.05) may be incurred over the life of the project.

Typical versus Less Typical Soft Costs

The types of soft costs encountered in rail transit construction projects in the United States can vary widely depending on project characteristics, local and state regulations, and the project administration practices and experience of the sponsor agency. As shown in Exhibit 4, certain typical soft cost components are normally required for any new rail construction project, while other soft cost components are encountered less frequently and may be unique to the project. As a result, some projects may incur no costs in some components, while other projects may incur costs in many or even all components.

For example, most projects will incur significant soft costs for hiring a contractor or assigning employees to prepare preliminary engineering and design plans and help obtain environmental approval for a project. Similarly, nearly all projects require project administration and management.

To take a contrasting example, most agencies take on significant soft costs to manage the construction project once the "shovel hits the dirt." However, the exact nature of these costs depends on the agency: these costs could include salaries and wages of employees in the transit

TYPICAL SOFT COSTS INCURRED IN MOST PROJECTS	LESS TYPICAL SOFT COSTS INCURRED IN SOME PROJECTS, DEPENDING ON CHARACTERISTICS
Design and engineering services for preliminary engineering and final design	Professional services to support acquiring real estate for right-of-way
Transit agency staff managing project, development, construction, and customer information	Third-party contractor managing construction
Reimbursement to external entities such as police, utilities, and other costs of local and state government	Design and engineering services to re-design a project, due to unforseen circumstances
Insurance	

Exhibit 4. Types of soft costs encountered in rail transit construction.

agency's construction department or could be for an outside contractor managing construction. For projects that must connect with existing transit service when complete, such as a line extension, agency staff time may be required for train safety and testing procedures. The form and type of soft costs are not always applicable to all projects.

Issues in Categorization

Despite FTA's clear classification of soft costs within SCC 80, situations may arise where it is not clear how or where a specific cost should be recorded, or whether a cost is considered soft. Much of this uncertainty is driven by inconsistencies in how certain types of costs have been understood and categorized in past projects and, by extension, how to budget for these costs in the future. Several potential issues arise. Two key examples are discussed below:

Force Account

Different agencies account for the salaries and wages of their employees supporting a new capital project (sometimes called "force account") in different ways. Force account costs can range from a construction department manager in charge of the project, to a bus operator who works a weekend to provide alternative bus service around a temporary disruption caused by the project's construction, to administrative employees who work primarily on capital projects, to rail maintenance-of-way employees who connect the new project to existing track. Some agencies will choose to pay these expenditures from their operating budget, while others will charge the costs directly to the capital project. In addition, the distinction between an employee overseeing overall construction and an employee directly supporting construction can be a difficult one and can affect whether the cost is assigned to SCC 80 or to a construction category (SCC 10–50). Regardless of past practices, FTA directs grantees to classify the costs of agency staff for flagging, alternative bus service, and access/protection costs in SCC 10–50 (or SCC 40.08, Temporary Facilities and Other Indirect Costs During Construction), *not* in Professional Services (SCC 80).

In addition, the distinction between an employee overseeing overall construction and an employee directly supporting construction can be a difficult one.

Real Estate and Vehicle Soft Costs

Many new rail projects incur the cost of professional services associated with acquiring real estate and procuring vehicles, which are typically distinct from the construction project. Examples of these services include agency staff overseeing and administering procurement, real estate and relocation consultants, vehicle engineers, property assessors, legal counsel, court expenses, insurance, warranty costs, and so on.

These professional services are comparable to those found in SCC 80 in that they represent service costs that do not directly support construction. However, current FTA guidance requires that all soft costs related to real estate and vehicle procurement should be assigned to their respective cost categories (SCC 60 and 70, respectively), *not* Professional Services (SCC 80).

FTA's guidance, by excluding the costs for professional services associated with real estate and vehicles, establishes a relationship between soft costs or Professional Services (SCC 80) and costs for fixed infrastructure (SCC 10 through 50) that is comparable to the relationship found in any building project.

What Soft Costs Are Not: It Depends on Perspective

The term "soft costs" can mean different things to different people, depending on their institutional—or contractual—perspective. For example, the project sponsor will likely view soft costs as all expenditures on those professional services identified in Standard Cost Category 80.

The term "soft costs" can mean different things to different people, depending on their institutional—or contractual—perspective.

Expenditures in other categories reflect the sponsor's expenditures on direct activities, perhaps primarily composed of payments to construction contractor(s) or a vehicle vendor.

In contrast, general construction contractors may view their costs of contract administration, overhead, and related expenses as soft costs for *their* organization. Although these activities sound very similar to the types of services identified in SCC 80, they are the contractor's (not the sponsor's) costs and are therefore considered hard costs outside of SCC 80.

To keep matters clear, this Guidebook defines soft costs from the perspective of the project sponsor.

Note that in design–build (DB) or other turnkey contracting situations where the division between a contractor's design and construction costs may be less transparent to a project sponsor, FTA still directs grantees to report design costs incurred by the design–build contractor in SCC 80.

Petitioner's Attachment No. JCK-3R

CHAPTER 4

How Does the Federal New Starts Process Relate to Soft Costs?

The FTA's New Starts grant program makes available new funding per year to project sponsors (also called grantees) to construct transit infrastructure. The FTA requires candidate projects to adhere to a well-defined development and planning process, meeting multiple requirements and following a structured schedule of set milestones that can affect soft costs. Major transit capital project planning in the federal process involves the development of projects from an initial concept through final design, construction, and operation, and continuing through the eventual replacement of the project.

The FTA requires candidate projects to adhere to a well-defined development and planning process, meeting multiple requirements and following a structured schedule of set milestones that can affect soft costs.

Along with estimating hard project costs comes the estimation of soft costs. Over time, as a project becomes better defined, the soft cost estimation process increases in sophistication from the proportionate approximation to the more detailed or "bottom up" estimation for each functional aspect of soft costs.

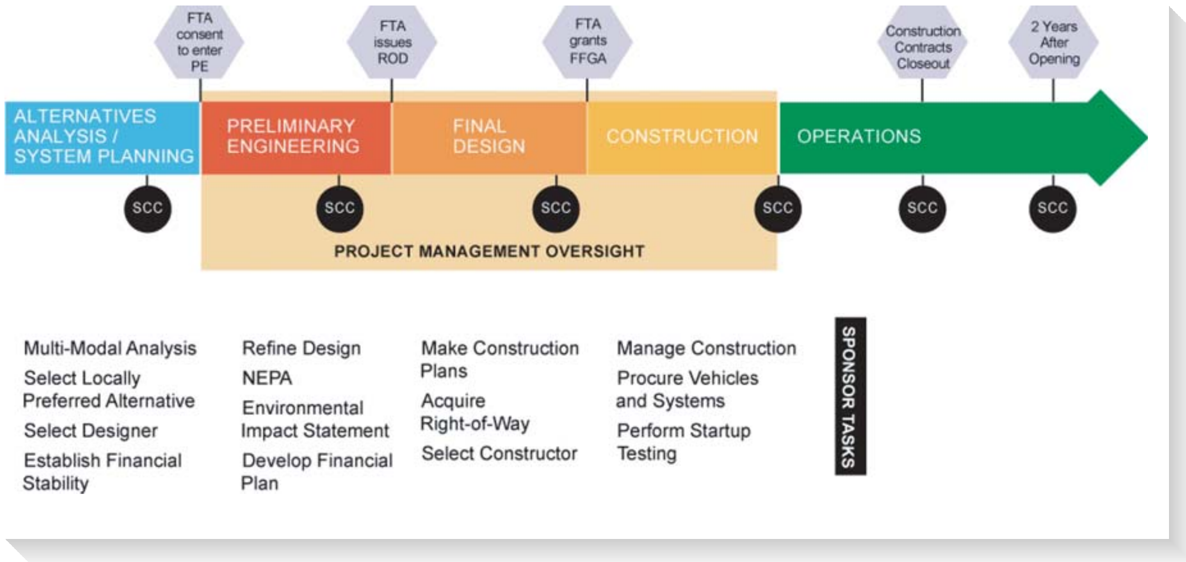
Sponsors seeking federal funds, typically from FTA's New Starts or Small Starts grant program, usually follow a structured process to define, plan for, and build a transit project. Projects join a pipeline of other candidate projects to compete for federal funds, submitting a New Starts application every year in which the project and its sponsor are evaluated on a variety of criteria. Provided that grantees meet certain requirements, FTA periodically authorizes project sponsors to proceed to the next stage of planning or design, often funded in part by federal funds.

Exhibit 5 describes these phases schematically and indicates where in the process the sponsor typically makes an estimate of all project costs, including soft costs, with the FTA Standard Cost Category workbook structure. FTA New Starts, the largest federal program for funding major new capital investments in public transportation, has several decision points for proceeding, also shown here. Each of these decision points requires an estimate of project capital costs, including the estimation of soft costs.

Prior to these decision points, stages of technical analysis are required as shown in the development of each project. Sponsoring agencies are required to submit documentation, including detailed estimates for project capital costs, for evaluation by the FTA under the New Starts criteria process and the Project Management Oversight (PMO) process. Other initiatives, such as the Fixed Guideway Modernization Program, provide funds for rehabilitation or improvement of existing transit systems through similar means.

When Does FTA Ask for Soft Cost Estimates?

FTA requests cost estimates in the SCC format at each of the stages of project development: Planning, Alternatives Analysis, Preliminary Engineering, Final Design, and Construction. As noted above, grantees report soft cost estimates in SCC 80, Professional Services. Specific federal



ROD = Record of Decision
FFGA = Full Funding Grant Agreement

Exhibit 5. Phases in FTA New Starts process timeline.

Specific federal requirements trigger the estimation of soft costs, such as the project evaluations required at each stage before approval to enter the next stage of project development. In addition, the ongoing project oversight and evaluation process requires additional project support efforts, which are included in soft costs.

requirements trigger the estimation of soft costs, such as the project evaluations required at each stage before approval to enter the next stage of project development. In addition, the ongoing project oversight and evaluation process requires additional project support efforts that are included in soft costs. These include, for example, project performance measure reporting, financial planning, environmental impact review, and stakeholder outreach efforts.

FTA first asks grantees for an estimate of project cost, including soft costs, before they allow the project to enter into PE. This initial estimate is typically a rough approximation. Sponsors usually issue a cost estimate once the project is in the PE phase as well, where again the soft cost estimates are typically conceptual in nature. Later, if and when the project progresses into final design, estimates of project cost become more accurate and well developed as the project itself becomes better defined. Chapter 5 describes how the industry normally estimates soft costs at these stages.

Characteristics of the Federal Process That Affect Soft Costs

The FTA's New Starts (and Small Starts) process affects soft costs in several ways.

First, as the project advances into PE, the FTA typically has discretion over when "the clock starts" and early planning costs begin to be attributed to the project. Many New Starts candidate projects grow out of broad transportation planning activities covering an entire metropolitan region, or an alternatives analysis analyzing a range of modes and projects within a transportation corridor. Because of this, the time at which a general planning activity becomes a singular project with a Locally Preferred Alternative is not always clear. Any costs incurred before FTA approves a grantee to enter PE are not included in a Full Funding Grant Agreement and the project's SCC estimate. Because the FTA helps pinpoint this time, the federal process can "define in or out" some early soft costs.

Second, the federal process for new transit capital projects imposes some unique requirements on project sponsors that usually result in soft costs. For example,

- The FTA requires grantees to estimate "transportation system user benefits" of the project by following certain procedures, typically resulting in some professional services soft costs for travel demand modeling.
- During PE, the federal process tends to encourage grantees to analyze environmental impacts in concert with developing engineering plans, which can advance some engineering soft costs.
- The FTA requires grantees to analyze the environmental justice impacts of a project, conduct a risk assessment process, and develop a project management plan, usually resulting in some soft costs.

Federal versus Non-Federal Projects

Despite the impact of the FTA's New Starts project development process on soft costs, its impacts are probably not unique. Even if a project sponsor chooses to forego federal funds, the project may face state and local requirements that can affect soft costs in very similar ways to the FTA's process throughout the project's life:

- During PE, the environmental reviews required at the state level can be as stringent as federal requirements. However, the sponsor may not be required to estimate ridership or develop a project management plan in the same way.
- During final design, the amount of time required to develop construction plans is typically the same, although state and local review times can be shorter than federal.
- In the construction phase, the major soft costs for managing the construction project are probably equivalent to a federal project.

Even if a project sponsor chooses to forego federal funds, the project may face state and local requirements, which may affect soft costs in very similar ways to the FTA's process throughout the project's life.

CHAPTER 5

How Does the Construction Industry Estimate Soft Costs?

Sponsors of major new transit projects approach estimating soft costs differently, depending on how far along the project is in the planning process.

Early Phases

During the early phases of planning (alternatives analysis or preliminary engineering), a transit project is only conceptually defined, as are the soft costs. At these early stages, transportation planners usually identify a single corridor for construction but develop a range of options for more specific details such as mode, alignment, station locations, and, as a result, construction costs.

Therefore, soft costs are usually treated as percentage add-ons to estimates of hard construction costs, as shown in Exhibit 6. Cost estimators apply default unit costs to approximate construction quantities, remediation, and other hard costs, and then simply add a percentage of hard costs for an initial soft cost estimate.

How do cost estimators choose these percentages? They typically apply values for each soft cost component from a range based on historical experience and project characteristics, or soft cost "drivers." For example, most estimators will choose higher multipliers for heavy rail than for bus rapid transit and lower multipliers if the sponsor plans to contract the project with an alternative delivery mechanism such as design–build. Exhibit 7 provides a more complete list, and Chapter 6 demonstrates a technique to tailor a soft cost estimate to a project.

How large are the soft cost percentages? Based on a survey of cost estimators at transit agencies and consultants across the country, most cost estimators start with a midpoint for these add-ons representing around 25–35% of construction costs, as Exhibit 8 indicates. However, cost estimators almost always adjust up or down from these midpoints, so the ranges from which estimators choose the percentages extend higher or lower than these midpoints.

Later Phases

During the final design phase and as construction begins, estimates of soft costs based on a percentage of construction cost are replaced with more closely tailored, bottom-up estimates that are based on a more detailed understanding of the project than was available in earlier stages. Rather than simply multiplying a construction cost estimate by a percentage, project managers usually develop their own soft cost estimates based on project characteristics that are known with better certainty at this stage, such as the project's work breakdown structure, staffing plans, design contract(s), and even the number and complexity of design drawings. For instance, administration costs may be estimated based on an estimated headcount and project duration, which are in turn based on the construction schedule and number of contracts.

Construction Cost	
Guideway	$
Stations	$
Maintenance Yard	$
Etc.	$
TOTAL	$
Soft Costs	
x Percentage =	**$**
Vehicle Cost	
Vehicles	$
Vehicle Soft Costs	$
TOTAL	$
Real Estate Cost	
Acquisitions	$
RE Soft Costs	$
TOTAL	$
TOTAL PROJECT COST	**$**

Exhibit 6. Cost estimation in early project phases.

Since the project's specific characteristics are more well-defined in these later stages, sponsors also have a better idea of soft costs that are highly dependent on the specific project sponsor, such as:

- Whether a third party will be managing construction;
- How the sponsor will account for agency staff salaries and wages;
- Who will bear insurance costs (sponsor agency or contractors); and
- If the project will require significant effort for environmental work, permits, or public involvement.

	LOWER % SOFT COSTS	MIXED/MID-RANGE % SOFT COSTS	HIGHER % SOFT COSTS
MODE	Bus Rapid Transit	Commuter Rail Light Rail	Heavy Rail
PROJECT DELIVERY	Design–Build Design–Build–Operate–Maintain Full Turnkey	Design–Bid–Build	
ALIGNMENT		Elevated Alignment	Tunnel Alignment
OTHER CONDITIONS		New Right-of-Way	Differing Subsurface Conditions

Exhibit 7. Project characteristics guiding soft cost percentage estimates within a range.

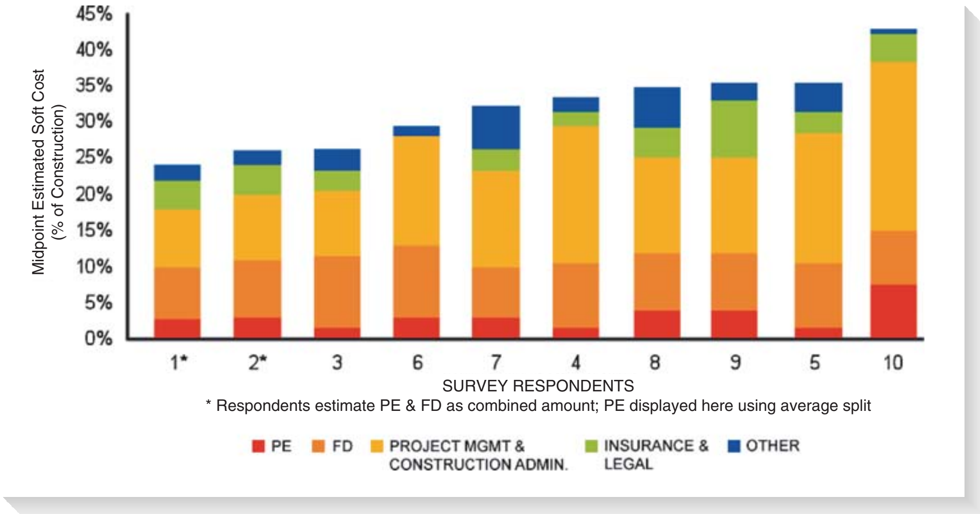


Exhibit 8. Midpoint soft cost estimates for all components during project planning phases.

By entry into final design, the costs for PE are known, and the costs for final design, bidding, and construction should be estimated or quantified through an assessment of the projects' contracting methodology, the contract packages anticipated, the staff or consultants required, the project length, and other factors.

In sum, the industry currently takes two different approaches to estimating soft costs, depending on how far along the project is, as illustrated in Exhibit 9.

How Does This Practice Compare with Actual Costs?

On average, the construction industry's current approach to estimating soft costs in early project phases corresponds fairly well to actual historical soft costs in past projects. This Guidebook relies on an examination of actual as-built cost data for 59 urban heavy and light rail transit projects

IN EARLY PHASES (PLANNING & PE)	IN LATER PHASES (FD & CONSTRUCTION)
More art than science	More science but still art
Top down	Bottom up
Use default percentage add-ons to construction costs Change from the default within a range based on prior experience and knowledge of project characteristics	Use real data available • Most design/engineering costs already spent • Headcount • Construction schedule and traffic impacts • Number of drawings • Quantity and value of real estate
Uncertain—could be within margin of error of the construction cost estimate itself	More certain—major changes to total SCC 80 line item are rare, but some components introduced later

Exhibit 9. Soft cost estimation approach by project phases.

	SURVEY* Average of Midpoints Used	AS-BUILT COST DATA** Average Actual
Preliminary Engineering	2.6%	2.7%
Final Design	9.0%	9.7%
Project Management & Construction Administration	14.1%	15.1%
Insurance	3.5%	2.2%
Other Costs	2.9%	1.6%
TOTAL	32.0%	31.3%
Range of Total	24% to 43%	11% to 54%

*Representing 10 responses

**Representing 51 past projects (outliers removed)

Exhibit 10. Comparing industry practice to actuals: Soft costs as a percentage of construction costs.

adapted from capital cost databases developed for the FTA. As shown in Exhibit 10, this dataset shows that, on average, transit construction projects have historically incurred soft costs amounting to 31.3% of construction costs. The average survey response had as a beginning estimate a midpoint of 32.0% of construction costs for soft costs. The components of soft costs are fairly consistent as well.

However, past projects have shown a much wider range of actual soft costs than estimators report. Most estimators surveyed for this Guidebook use ranges, or an "uncertainty band," of total soft cost estimates of around 10% of construction costs. In fact, past transit construction projects have shown a much wider range of actual costs of around 20%.

How can such a wide range of actual soft costs be explained so that a project manager can better estimate them? The answer lies in the differences between projects, and the next section presents a tool to address these differences.

Petitioner's Attachment No. JCK-3R

CHAPTER 6

How to Estimate Soft Costs for a New Project

This Guidebook presents a new method, firmly rooted in historical experience, for estimating soft costs for a planned transit project. This section demonstrates a step-by-step process to estimate the relationship between hard costs and soft costs of a given transit project, based on certain known characteristics about the project and its sponsor.

What This Method Is for and When to Use It

It is important to note the kinds of projects this method is designed for:

- **Heavy and light rail.** This method was developed based on actual historical costs for heavy and light rail projects, with only limited data for commuter rail and Bus Rapid Transit (BRT) projects. *Therefore, the following mathematical steps should not be applied to other public transportation capital infrastructure projects, such as commuter rail or BRT projects.*
- **A project in early, conceptual phases.** This method is best applicable to projects in early planning phases, approximately until the project has completed an environmental impact statement. After that time, more defined information is likely available for a more bottom-up estimate tailored to the project. This Guidebook's process can then offer a "test of reasonableness" on the detailed, bottom-up estimate.

Art versus Science

Just as a homeowner cannot tell precisely how much an architect will charge for designing a new kitchen until the kind of remodeling desired is determined, a transit agency cannot tell exactly how much its hard and soft costs will be until the project is defined down to the last turnstile. In addition, every new rail construction project will be slightly different from the last and will encounter unforeseen events along the way, making it impossible to estimate future costs based on historical costs with absolute precision.

Therefore, soft cost estimation must blend art with science. Part of a soft cost estimate can be built up in a fairly objective and numerical way by relying on past experience and the known relationships between a project's characteristics and historical costs, and this methodology applies such relationships. For example, a statistical analysis of historical costs demonstrates that heavy rail incurs higher soft costs as a percentage of construction cost—about 6% more (as demonstrated later in Exhibit 27), all other things being equal, so cost estimators can comfortably adjust their figures accordingly.

Still another part of an estimate can be generated based on known cost relationships, using some judgment about the project and its context. For instance, history shows that an unusually long planning phase typically drives up soft cost's percentages. A long planning phase indicates that a higher soft cost percentage may be warranted. But how can an estimator know how long the planning process will take if that phase is still underway? Judgment, or art, is required.

In the end, historical evidence and relationships cannot tell the whole story. Statistical analysis alone cannot explain the entire range of soft cost percentages shown in past projects, nor should it be relied on alone when developing a comprehensive estimate. Experienced construction managers have indicated that an estimate from a planning process cannot predict some important causes of soft costs, like the working relationship between a sponsor and contractor in the field. A good soft cost estimate needs the art of human judgment to complement the science of cost relationships.

Soft Cost Drivers

To better quantify soft costs, it is important to understand what characteristics or variables can explain the relationship between construction costs and soft costs. This Guidebook takes as a starting point a survey of cost estimators and follows up with analysis of actual historical costs.

The cost estimating tool described in this Guidebook is based on an extensive analysis of the primary drivers of soft costs in past transit projects and the strength of the relationship between drivers and actual soft cost expenditures for projects constructed over the past four decades in the United States. With soft cost data on 59 urban rail transit projects adapted from capital cost databases developed for the FTA, the Guidebook analysis measures the cumulative effect of how changes in a variety of project attributes affect resulting soft cost expenditures.

The cost estimating tool described in this Guidebook is based on an extensive analysis of the primary drivers of soft costs in past transit projects and the strength of the relationship between drivers and actual soft cost expenditures for projects constructed over the past four decades in the United States.

In particular, this Guidebook identifies three different kinds of drivers of soft costs, which correspond to steps in this new methodology:

- Some drivers of soft costs in past projects can be measured **mathematically,** and their effects on soft costs can be statistically analyzed (e.g., mode, length, construction cost estimate, delivery method, or the percent of the project's alignment below grade).
- Some soft cost drivers must be measured **categorically** or qualitatively with some degree of judgment based on knowledge of the project (e.g., whether the project development phase is unusually long or the degree of political influence).
- Some drivers are very difficult to measure objectively and can only be measured **with judgment,** since industry experience shows that they can have significant impacts on soft costs (e.g., the working relationship between agency and contractors, the quality of engineering expertise, or agency accounting policies).

Although a multitude of characteristics were tested to develop this Guidebook, only the combination of attributes that best explained the changing relationship between construction and soft costs is presented here.

Although a multitude of characteristics were tested to develop this Guidebook, only the combination of attributes that best explained the changing relationship between construction and soft costs is presented here.

Quantifying Soft Costs

First, how should soft costs be measured for cost estimating purposes? Soft costs can be expressed in different terms: as a percentage of the total project, as a percentage of hard costs, as a nominal dollar amount, or in nominal dollars per linear foot of guideway constructed in the project. Soft costs can easily be quantified in nominal terms, but predicting future soft costs using such a measure may not account for differences in project size. In addition, predicting soft costs as a share of the overall project cost is arithmetically problematic since the project manager typically has only a construction cost estimate at this stage.

PE	80.01 Preliminary Engineering
FD	80.02 Final Design
PM/CA	80.03 Project Management for Design and Construction
	80.04 Construction Administration and Management
Ins.	80.05 Professional Liability and Other Non-Construction Insurance
Other	80.06 Legal; Permits; Review Fees by Other Agencies, Cities, etc.
	80.07 Surveys, Testing, Investigation, Inspection
	80.08 Start Up

Exhibit 11. Mapping SCC 80 components to categories applied in this Guidebook.

Therefore, while each of these indicators quantifies soft costs in some way, it is suggested that the most appropriate measure for a soft cost *estimate* is as a percentage of hard construction costs (excluding real estate and vehicle costs).[1]

Four-Step Process

The recommended estimation technique contains four steps:

1. **Begin with default averages.** As a starting point, begin with average actual historical soft costs for each component.
2. **Adjust based on mathematical relationships.** Next, adjust the soft cost estimate following the numerical relationship between the project's characteristics and historical soft costs.
3. **Adjust based on categorical relationships.** Next, increase or decrease the soft cost percentages based on how the project fits into any of several unique situations.
4. **Apply judgment.** Finish the estimate by applying some degree of discretion based on knowledge about the unique and intangible qualities of the project and its sponsor.

To simplify the analytical procedure, this technique consolidates the eight components in FTA's Standard Cost Category 80 into five basic components for estimation purposes, as shown in Exhibit 11. Once estimation of these components is completed, the five categories are converted back into FTA's structure.

The five components broadly align with FTA's SCC structure, but they combine some categories that are either a relatively small cost (e.g., Other) or are so similar to other categories that many agencies lump them together for estimating purposes (e.g., Project Management for Design and Construction, and Construction Administration and Management).

The following describes the four steps in more detail:

Step 1: Begin with Default Averages

Begin with 29.5% TOTAL for the starting default soft cost:

COST TYPE	COST %
PE	2.0 %
FD	12.0 %
PM/CA	12.5 %
Insurance	2.0 %
Other	1.0 %
TOTAL	29.5 %

Exhibit 12. Default soft cost averages.

As a first step in estimating soft costs, begin with the default soft cost percentages as defined in Exhibit 12. These values are based on average actual historical as-built costs. They are consis-

[1]Because the FTA instructs project sponsors to classify professional services costs related to vehicles and real estate into SCC 60 and 70, it is inappropriate to include real estate and vehicle costs as hard costs for the purposes of this Guidebook.

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tent with average midpoint estimates currently used in the industry, and so provide a safe and well-established starting point for estimation purposes.

It is important to continue past this step, however. These default averages only begin to estimate a project's expected soft costs. The averages are a "naïve" starting point from which to quantify soft costs, because they only describe a "typical" project sponsored by a "typical" agency in "typical" conditions. Transit construction projects and their sponsors come in all shapes and sizes, and no project is entirely "typical."

Step 2: Adjust Based on Mathematical Relationships

In this step, adjust the default percentages based on the project's characteristics that have been shown mathematically.

Alignment Length

Transit capital projects with alignments (length of track or guideway) that stretch for longer distances tend to incur somewhat higher soft costs as a percentage of construction cost. Recommended adjustments to the default values are summarized in Exhibit 13. Add 1.3% to the total soft costs percentage estimate for every 10,000 linear feet of guideway[2] constructed, with 0.9% added to PM/CA and 0.4% to Other. Be sure to perform this calculation proportionately if the project would construct more or less than 10,000 linear feet of guideway. For example, for 5,000 linear feet, add 0.45% to PM/CA and 0.2% to Other.

Add 1.3% TOTAL for every 10,000 feet of guideway:

COST TYPE	COST %
PM/CA	+ 0.9 %
Other	+ 0.4 %
TOTAL	+ 1.3 %

Exhibit 13. Alignment length formula.

Construction Costs

Other things being equal, more expensive construction projects tend to display somewhat smaller soft cost percentages than less costly projects, mostly because their construction administration, project management, insurance, and other costs do not rise proportionally to construction costs. Recommended adjustments to the default values are summarized in Exhibit 14. For every $1 billion in construction cost estimate, subtract 6.0%: 4.5% from PM/CA, 1.0% from Insurance, and 0.5% from Other.

It may seem counterintuitive to adjust up for alignment length and down for construction cost, since both measures broadly describe the magnitude of the project. Historically, however, these two measures in tandem are good predictors of soft costs and will capture the special cases where short, expensive projects (such as a tunnel project) or long, less-expensive projects (such as service on existing right-of-way or in less developed areas) tend to demonstrate differing soft costs.

Subtract 6.0% TOTAL for every $1 billion in estimated construction costs:

COST TYPE	COST %
PM/CA	- 4.5 %
Insurance	- 1.0 %
Other	- 0.5 %
TOTAL	- 6.0 %

Exhibit 14. Construction costs formula.

Mode

Heavy rail projects tend to incur somewhat higher soft costs than light rail, perhaps due to their relative complexity. Heavy rail projects can typically involve constructing guideway and systems that have been designed to more rigorous engineering standards that support more complex systems, move higher passenger volumes, and operate at higher speeds relative to light rail. Therefore, recommended adjustments to the default values are summarized in Exhibit 15. If the project is heavy rail, add 6.0% to the total soft cost percentage: add 1.5% to PE, 3.5% to PM/CA, and 1.0% to Insurance.

Add 6.0% TOTAL for heavy rail:

COST TYPE	COST %
PE	+ 1.5 %
PM/CA	+ 3.5 %
Insurance	+ 1.0 %
TOTAL	+ 6.0 %

Exhibit 15. Mode formula.

[2]Length of guideway should measure only the length of the construction from beginning to end, regardless of double tracking, track miles, etc.

Subtract 4.0% TOTAL for project installation under no active adjacent or adjoining rail service:

COST TYPE	COST %
PE	- 3.0 %
FD	- 1.0 %
TOTAL	- 4.0 %

Exhibit 16. Installation conditions formula.

Installation Conditions

A project to construct a new, stand-alone transit line that is not adjacent to any previous service will usually require less design costs than projects to extend or expand an existing rail line. When a construction project interacts with existing transit service in any way, more engineering and design work has typically been required in the final design phase. Working on or near an active rail right-of-way poses additional logistical challenges that must be planned for, and may also trigger additional safety requirements. Extending a rail line will mean integrating the new track and station(s) into the older infrastructure, and additional work is usually required to ensure that signal, power, safety, and other systems operate compatibly. Recommended adjustments to the default values are summarized in Exhibit 16. If the project is to be installed under no active adjacent or adjoining rail service, subtract 4.0%: 3.0% from PE and 1.0% from FD.

Delivery Method

When sponsors choose to procure their projects through an alternative delivery mechanism such as design–build, design–build–own–maintain, or construction manager/general contractor, these projects have historically incurred lower soft costs. In addition, these alternative delivery methods tend to frontload more design and planning costs in preliminary engineering.

Follow the formula below for non-traditional delivery methods:

COST TYPE	COST %
PE	+ 1.0 %
FD	- 1.0 %
PM/CA	- 7.0 %
TOTAL	- 7.0 %

Exhibit 17. Delivery method formula.

However, these project's lower soft costs may be partially the result of differences in measurement rather than a real reduction in cost. Contractors may simply categorize their costs in different ways than transit agencies (in the construction line item, for example), which makes that project's soft costs as a percent of construction appear low. Recommended adjustments to the default values when estimating soft costs in early project phases are summarized in Exhibit 17. If the project is to be delivered through a non-traditional (i.e., outside of design–bid–build) mechanism, add 1.0% to PE, subtract 1.0% from FD, and subtract 7.0% from PM/CA.

Note that in a design–build or other alternative project delivery method where the division between a contractor's design and construction costs may be less transparent to a project sponsor, FTA still directs grantees to report design costs incurred by the design–build contractor in SCC 80.

A word of caution on delivery method: alternative project delivery methods entail a cultural shift in the way the sponsoring agency develops and executes these projects. Because these alternative methods are not yet very common in the United States, the project's sponsor may not fully understand them. For example, being unfamiliar with the required level of design or the heavy focus on performance-based/functional specification under a design–build, some transit agencies may continue to work in a more traditional mode (i.e., prescriptive specifications and higher level of design), unknowingly duplicating soft costs.

If the alternative delivery method is relatively new to the project sponsor, subtract a lower percentage (e.g., 3.0 or 4.0%) from PM/CA, depending on the level of project sponsor support required.

Economic Conditions

The overall health of the economy, as well as the level of construction activity, can affect the construction bids a transit project sponsor can expect to receive. If the construction sector or economy at large is in a downturn when a project sponsor accepts bids, contractors may reduce their bids due to economic forces. In this case, soft costs computed as a percentage of the engineered construction cost estimate might look relatively higher simply because the bid construction cost is lower. Historically, some change in soft costs can be attributed to the rate of Gross Domestic Product (GDP) growth when construction contracts are bid, after accounting for other variables. Although GDP growth rises and falls with the economy, it has historically risen an average of 2.5% to 3.0% per year.

It is difficult to use this driver to estimate soft costs for a project years away from construction since future GDP growth is difficult to predict. If the project is to be advertised for bid within a year, however, for every percentage point the U.S. GDP has grown since the previous year, subtract 1.5% from the soft cost percentage: 1.0% from FD and 0.5% from PM/CA. Conversely, for every percentage point the U.S. GDP has shrunk since the previous year, add 1.5 percentage points to the soft cost estimate to the same components. These recommended adjustments to the default values are summarized in Exhibit 18.

Subtract 1.5% TOTAL for every percentage point the U.S. GDP has grown since the previous year, if project to be advertised for bid within one year:

COST TYPE	COST %
FD	- 1.0 %
PM/CA	- 0.5 %
TOTAL	- 1.5 %

Exhibit 18. Economic conditions formula.

For example, suppose a project will be advertised within months, but the economy is strong and this year's GDP is 4% higher than last year's. A transit agency sponsor might expect relatively higher construction bids because of the market demand for construction expertise. If construction costs are high, soft costs as a percent of construction costs will likely fall, so an estimator using this methodology might subtract up to 4 × 1.5% = 6.0% from the soft cost estimate.

Step 3: Adjust Based on Categorical Relationships

In this step, adjust the soft cost percentages based on characteristics of the project or its context. These characteristics may be more difficult to assess for a given project, and cannot always be measured as a "yes" or "no." Therefore, with this methodology it is recommended to adjust percentage estimates up to a certain limit. Deciding to what degree any project fits into the categories shown in this section will require some degree of judgment and professional experience.

Unusually Long Project Development Phase

A significant component of engineering and design cost is simply the salaries and benefit costs of planners working on the project. When the early project development phases for a project take an unusually long time, these costs tend to continue to be charged to the project, increasing overall soft costs. Historically, when more than approximately five to seven years elapse between entering preliminary engineering and the beginning of construction, projects have shown higher soft cost percentages on the order of 7.0% of construction costs.

Some judgment will be required to predict a construction date and determine when the planning stages begin. If the overall project development phases will likely continue longer than seven years, and if planning and engineering work continue steadily, make the recommended adjustments to the default values summarized in Exhibit 19. Add up to 1.0% to PE costs and up to 6.0% to FD. Apply fewer percentage points depending on the length of the planning process.

Add up to 7.0% TOTAL if the overall planning phase will continue longer than five to seven years. Apply fewer percentage points for shorter planning phase:

COST TYPE	COST %
PE	+ 1.0 % max
FD	+ 6.0 % max
TOTAL	+ 7.0 % max

Exhibit 19. Unusually long project development phase formula.

Unusual Political Influence

When public involvement or political pressures are high, such as in a contentious design and planning process, soft costs tend to rise relative to construction costs, as much as 6.0%. When, for example, multiple planning boards, citizen advisory councils, and officials must approve the design, and could even call for a redesign, make the recommended adjustments to the default

Add up to 6.0% TOTAL when public involvement or political pressures are high:

COST TYPE	COST %
FD	+ 1.5% max
PM/CA	+ 4.5% max
TOTAL	+ 6.0% max

Exhibit 20. Unusual political influence formula.

values summarized in Exhibit 20. Add up to 6.0%: up to 1.5% to FD and up to 4.5% to PM/CA. While intuitively a more contentious planning process would tend to drive up costs earlier in project development (such as PE), the data on which this Guidebook is calibrated indicate that actual cost percentage increases occur earlier—in FD and PM/CA.

Agency Tendency to Minimize Capital Charges

When a transit agency sponsors a construction project, it usually contributes some of its own labor and even materials. Agency employees often inspect construction activities, monitor safety, administer the contract, acquire property, manage the project, and perform many other tasks. As opening day approaches, agency staff contribute time coordinating testing, training, safety inspections, and shared tasks with other agencies. The agency chooses whether to charge these expenditures to the capital project (either directly or as an overhead-type allocation) or to absorb them into the operating budget, and project sponsors each have different internal policies for this. In the past, agencies that have strongly tended to minimize capital expenditures have shown a reduction of up to 6.0% in soft costs as a percentage of construction. Recommended adjustments to the default values are summarized in Exhibit 21. Depending on the sponsor agency's internal policy on capitalizing costs, subtract 3.0% from the PM/CA, 1.0% from Insurance, and 2.0% from Other.

Subtract up to 6.0% TOTAL depending upon the sponsor agency's internal cost capitalization policy:

COST TYPE	COST %
PM/CA	- 3.0% max
Ins.	- 1.0% max
Other	- 2.0% max
TOTAL	- 6.0% max

Exhibit 21. Capital minimization formula.

Step 4: Apply Judgment

At this point, this methodology has produced a set of five soft cost percentages for PE, FD, PM/CA, Insurance, and Other that are tailored to a given project based on its characteristics and some judgment about its context. However, these more objective techniques must always be tempered with some degree of discretion based on knowledge about the unique and intangible qualities of the project and its sponsor. Rely on the characteristics in Exhibit 22 to add to or subtract from the resulting soft-cost percentage estimate.

However, these more objective techniques must always be tempered with some degree of discretion based on knowledge about the unique and intangible qualities of the project and its sponsor.

If this methodology has resulted in an unintuitive or unusually low percentage estimate, use judgment to adjust to a more reasonable percentage. For example, any negative values could

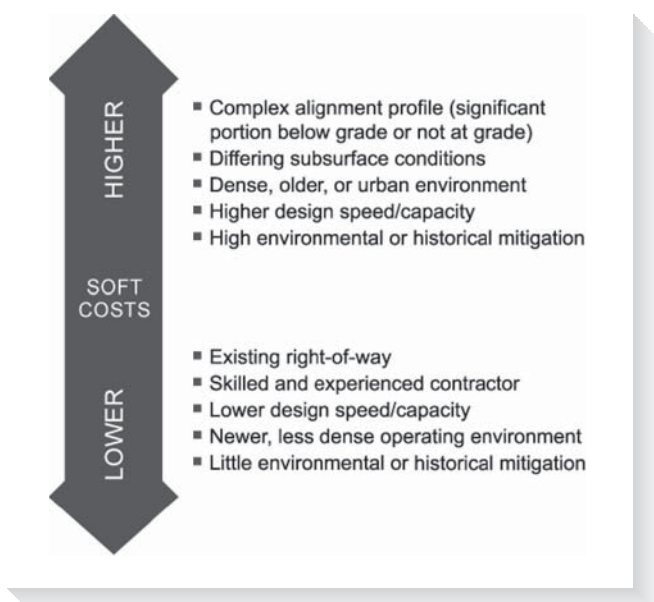


Exhibit 22. Characteristics influencing soft cost percentages.

be restored to zero. Further, if the net effect of adjustments suggested here results in soft cost estimates below 15% or above 50%, apply judgment as well. In the decades of historical experience analyzed to support this Guidebook, no transit project has shown soft costs lower than 11% or higher than 54% of construction costs.

Finally, convert the soft cost percentages from the five components estimated here back into the eight components called for in FTA's SCC structure.

- For Project Management and Construction Administration, divide the soft cost percentage estimate between SCC Components 80.03 and 80.04, 60% of the estimate to Project Management, and 40% to Construction Administration. This ratio is based on a consistent pattern with historical projects over time.
- For Other soft costs, some judgment will be required based on knowledge of the project sponsor. However, this estimate is relatively small, making the sub-allocation to SCC components less precise. Begin by dividing the soft cost percentage estimate for Other costs developed here into even thirds between SCC components 80.06, 80.07, and 80.08. Then, adjust using the following guidelines:
  - *80.06 Legal; Permits; Review Fees by Other Agencies, Cities, etc.* If the project falls under the purview of multiple municipalities, counties, or other political jurisdictions, or if the project requires multiple difficult permits, increase this component's share. Otherwise, leave this component with roughly one-third of the Other costs.
  - *80.07 Surveys, Testing, Investigation, Inspection.* The base one-third allocation is likely sufficient for this component.
  - *80.08 Start Up.* If the sponsor agency capitalizes startup and operations testing, maintain or possibly increase the estimate. Otherwise, decrease this component's share, potentially to zero.

Applying These Steps: Two Example Projects

How might this four-step process be applied to a real project? The following provides a case study on two hypothetical but nevertheless "typical" situations:

Shelbyville Light Rail

Springfield's Metropolitan Transit Authority (MTA) has just finished an alternatives analysis on the Shelbyville corridor. As a result of this process, the MTA has selected light rail as a Locally Preferred Alternative and believes that the project can use an existing freight right-of-way. This will be Springfield's first rail transit service. The planned 7.5-mile alignment begins at an intermodal hub in downtown Springfield with connections to Amtrak, and extends north through several neighborhoods in another county before terminating in Shelbyville. The new rail service will leave downtown on a new flyover from the terminal, and then the new tracks will be laid parallel to an existing freight line, with additional grade crossings constructed or reconstructed as needed, as shown in Exhibit 23. The project will require some re-grading and mitigation work that will impact the Pockomock Swamp, an environmentally sensitive area.

MTA plans to construct the project using a construction manager/general contractor (CM/GC) project delivery approach with a guaranteed maximum price, and hopes to open the line for service by 2014.

MTA has a preliminary construction cost estimate of $425 million based on construction quantities and unit costs, and a ridership forecast from a forecasting model from the design consultant team. The construction cost estimate includes a contingency and is expressed in year-of-expenditure dollars, escalated at 3.75% per year.

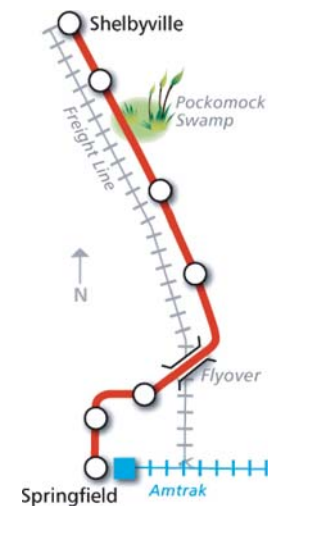


Exhibit 23. Schematic map of Shelbyville Light Rail.

MTA feels the project may be a good candidate for federal New Starts funds. Therefore, the project manager's next task is to assemble a capital cost budget in FTA's SCC format. But while MTA has chosen an alignment, many details are still left to be decided. . . . To estimate a value for SCC 80, MTA turns to this Guidebook's methodology.

Based on this information, MTA feels the project may be a good candidate for federal New Starts funds. Therefore, the project manager's next task is to assemble a capital cost budget in FTA's SCC format. But while MTA has chosen an alignment, many details are still left to be decided, such as the exact location of the new rail maintenance facility, coordination with the existing freight railroad, and traffic impacts downtown from the flyover construction. To estimate a value for SCC 80, MTA turns to this Guidebook's methodology.

Step 1: Begin with Default Averages

Begin with the default averages suggested in Exhibit 12, totaling 29.5 percentage points.

Step 2: Adjust Based on Mathematical Relationships

- *Alignment length.* The Shelbyville line will be approximately 39,200 linear feet, so MTA adds $3.92 \times 1.3\% = 5.1\%$ to PM/CA and Other, for a total of 34.6%
- *Construction costs.* A construction price tag of $425 million implies a reduction of $0.425 \times 6.0\% = 2.6\%$ points across PM/CA, Insurance, and Other, to total 32.0%.
- *Mode.* This project is light rail, so no adjustment is necessary.
- *Installation conditions.* The project is sharing the right-of-way with an active railroad, which may create challenges for design and construction teams. Therefore, MTA makes no reduction to the soft cost estimate.
- *Delivery method.* Since MTA expects to hire a CM/GC, this will likely reduce MTA's costs of project oversight but may require some extra effort during preliminary engineering. Deduct 8.0% from PM/CA and FD, and add 1.0% to PE, for a total of 25.0%.
- *Economic conditions.* The project manager hopes to advertise the project for bid within the next year, and the economy is currently growing after recovering from a fairly strong recession. The project manager looks up the U.S. GDP from the U.S. Bureau of Economic Analysis website. Since the latest quarter's data shows that the GDP has increased by 1% since last year, MTA subtracts 1.5% from FD and PM/CA, for a new total of 23.5%.

Step 3: Adjust Based on Categorical Relationships

- *Long development phase.* This project has so far been progressing quickly, so no adjustment is necessary.
- *Political influence.* This project is subject to review from both the Shelbyville and Springfield City Councils, who have historically disagreed on many issues. Because of this uncertainty, MTA adds 2.0%, 1.51.% to PM/CA and 0.5% to FD, for a new total of 25.5%
- *Agency tendency to minimize capital charges.* This is MTA's first rail project, and the project manager has no reason to expect this tendency of the agency, so no adjustment is necessary.

Step 4: Apply Judgment

After arriving at an estimate of soft costs at 25.5% of construction costs, MTA's project manager reviews the estimate for reasonableness based on the project sponsor's knowledge. Relying on judgment, the project manager makes the following changes:

- Deducts 2.0% from FD because of existing right-of-way. The existing freight railroad company has so far been a cooperative partner in the project, and the project manager expects to rely

SCC	COMPONENT	SOFT COST ESTIMATE AS PERCENTAGE OF CONSTRUCTION COST
80.01	Preliminary Engineering	3.0%
80.02	Final Design	8.5%
80.03	Project Management for Design and Construction	5.5%
80.04	Construction Administration and Management	3.6%
80.05	Professional Liability and Other Non-Construction Insurance	1.6%
80.06	Legal; Permits; Review Fees by Other Agencies, Cities, etc.	1.0%
80.07	Surveys, Testing, Investigation, Inspection	1.0%
80.08	Start Up	0.4%
80.00	Total Professional Services	24.5%*

*Total slightly off due to rounding.

Exhibit 24. Hypothetical Shelbyville Light Rail soft cost estimate.

on their technical expertise throughout the project, saving some professional service costs. The new total is 23.5%.

- Adds 1.0% to PE to account for environmental mitigation. The project manager is uncertain about what the state's Department of Environmental Protection will require to mitigate any impacts on the Pockomock Swamp and expects the planning process will take time and money. The MTA's new total is now 24.5%.

Finally, the five component estimates need to be split between SCC 80 components. The estimate of 9.1% for PM/CA is split $9.1\% \times 6.0\% = 5.5\%$ to SCC 80.03, and $9.1\% \times 4.0\% = 3.6\%$ to SCC 80.04.

MTA splits the base estimate of 2.4% for Other as follows: 1.0% to SCC 80.06, 1.0% to SCC 80.07, and 0.4% to SCC 80.08. MTA's final estimate is shown in Exhibit 24.

West County Light Rail Project

The XYZ Transit Agency (XTA) is planning a light rail transit project to serve communities in parts of West County. The project, known as the West County Light Rail Transit (WCLRT) project, is a 10.4-mile extension of the existing XTA Light Rail Transit North/South Line, including seven new stations. Planning initially began in 1998 when XTA envisioned the project as a busway along an arterial roadway, but the original design met with some public opposition and controversy. XTA has since refined its plans and is now advancing the project.

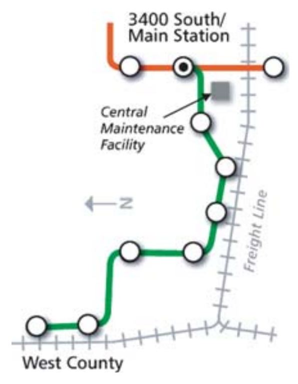


Exhibit 25. Schematic map of XTA's West County Light Rail transit project.

The design is at the conceptual level. After XTA circulated the draft environmental impact statement (EIS) and held public hearings, the light rail build alternative was selected as the Locally Preferred Alternative in October 2003. Since then, XTA designers and planners have revisited and refined the build alternative, have begun detailing stations, and have decided on two-track operations. The project will extend from the 3400 South/Main Station, follow the lead track to the Central Maintenance Facility, proceed along XTA right-of-way through several cities, and then turn south for the final two stations, as shown on Exhibit 25. The project will include 18 additional light rail vehicles and additional storage tracks at the Central Maintenance Facility. This configuration requires the light rail system to share tracks with freight trains in several areas, necessitating a temporal separation of passenger and freight operations.

XTA plans to complete preliminary engineering and final design under a traditional design–bid–build delivery method. XTA hopes to complete design by October 2004, sign a full funding grant agreement with the FTA in June 2005, and complete construction by June 2008. Most of the guideway is at the street level, with only a very short tunnel (about 400 feet) near one of the stations.

In March 2004, at the end of the conceptual design phase, XTA prepared a cost estimate that established a target budget of $302 million for SCC 10–70 (expressed as year-of-expenditure dollars escalated at 3.75% per year).

Now, XTA wants to apply the methodology described in this Guidebook to estimate the WCLRT project's soft costs as a percentage of the construction costs:

Step 1: Begin with Default Averages

As a first step in estimating soft costs for the project, XTA begins with the default soft cost percentages as defined in Exhibit 12, totaling 29.5% of construction costs. These numbers are based on average actual historical as-built costs.

As a first step in estimating soft costs for the project, XTA begins with the default soft cost percentages as defined in Exhibit 12, totaling 29.5% of construction costs. These numbers are based on average actual historical as-built costs.

Step 2: Adjust Based on Mathematical Relationships

- *Guideway alignment length:* The project is 10.4 miles long, or approximately 54,900 linear feet. This will require an upward adjustment of 5.49 × 1.3% = 7.1% to the soft-cost percentage estimate.
- *Construction costs:* Construction costs for the project (the sum of SCC 10–70) are estimated at $302 million; however, SCC 70 accounts for $55 million to purchase 18 new vehicles, and no costs are estimated for real estate in SCC 60. Therefore, the construction cost estimate (SCC 10–50) totals $302 − $55 = $247 million. Since the Guidebook calls for subtracting 6.0% for every $1 billion in construction costs, XTA decreases the soft cost estimate by 0.247 × 6.0% = 1.5%.
- *Mode:* This is a light rail project, so no adjustment is necessary.
- *Installation conditions:* Since this project will share a freight right-of-way in some areas and will connect with existing light rail service on the North/South line, no adjustment is made.
- *Delivery method:* The project is using a traditional design–bid–build delivery method, so no adjustment is made.
- *Economic conditions:* The economy in West County is in relatively good shape, and construction companies have steady business. GDP has grown 3% over the past year, so XTA deducts 3 × 1.5% = 4.5%, suspecting that construction bids may be somewhat high.

Step 3: Adjust Based on Categorical Relationships

In this step, XTA adjusts soft cost percentages based on certain characteristics of the project that may be more difficult to measure.

- *Unusually long project development phase:* Given the past delays and controversy, XTA does not know if the project will progress as quickly as it would hope. Therefore, XTA decides to add 2.0% to the soft cost estimate for final design.
- *Unusual political influence:* No extraordinary political influence is expected, so no adjustment to soft cost is necessary.
- *Agency tendency to minimize capital charges:* The XTA has constructed light rail projects before and supports a fairly large construction staff through its operating budget. (These costs are not charged to specific capital projects.) Because of this, a −3.0% adjustment is applied.

SCC	COMPONENT	SOFT COST ESTIMATE AS PERCENTAGE OF CONSTRUCTION COST
80.01	Preliminary Engineering	2.0%
80.02	Final Design	11.0%
80.03	Project Management for Design and Construction	8.0%
80.04	Construction Administration and Management	5.3%
80.05	Professional Liability and Other Non-Construction Insurance	1.3%
80.06	Legal; Permits; Review Fees by Other Agencies, Cities, etc.	0.7%
80.07	Surveys, Testing, Investigation, Inspection	0.7%
80.08	Start Up	0.0%
80.00	Total Professional Services	29.0%

Exhibit 26. Hypothetical XTA West County Light Rail soft cost estimate.

Step 4: Apply Judgment

XTA refers to Exhibit 16 and judges that the WCLRT project has several attributes that could increase or decrease soft costs as a proportion of construction costs.

On the one hand, the West County area is fairly dense and growing rapidly, and the short tunnel section near one of the stations is under a historic district. These characteristics could increase soft costs.

On the other hand, no environmental mitigation is required, the alignment is fairly straightforward, and differing subsurface conditions present only a moderate risk.

Therefore, XTA uses its judgment and does not consider any adjustment to its soft cost estimate at this step. Finally, XTA converts the resulting estimate for Other into the SCC components 80.06, 80.07, and 80.08. Because XTA does not normally capitalize startup and operations testing, SCC component 80.08, Start Up, is reduced to zero.

Based on its analysis so far, XTA estimates soft costs for the WCLRT project at 29.6% of construction costs, as shown in Exhibit 26.

APPENDIX A

FTA Capital Cost Database

The starting percentages and numerical adjustments established in this Guidebook were developed from univariate and multivariate regression analyses based and calibrated on detailed cost and project data for 59 past transit capital projects. The 59 projects in this database represent a wide range of rail projects constructed in the United States over the past four decades, with detailed costs roughly conforming to the SCC structure developed from FTA Capital Cost Databases. The projects:

- Comprise 29 light rail and 30 heavy rail projects;
- Have construction dates ranging from 1974 to 2008;
- Have capital costs ranging from around $50 million to $2 billion in the year of construction, equivalent to a range of $90 million to over $5 billion in constant 2008 dollars; and
- Are new rail lines, extensions of existing networks, and rehabilitation projects.

Because this dataset contains soft costs for a broad distribution of projects, it provides a reasonable statistical basis for the estimation of future rail projects based on the analysis of actual, as-built soft costs for completed projects.

Analytical Approach

The analytical process applied to examine these past projects to develop a new soft cost estimation methodology is briefly summarized below. For a more detailed description, please see the Final Report in Part 2, which follows this Guidebook.

First, the projects were plotted on a frequency distribution of soft costs as a percentage of construction costs, resulting in several projects being rejected as outliers due to extraordinarily high costs or other circumstances. Please refer to the Final Report for further details.

Second, a set of characteristics was gathered for the projects, including the following:

1. Physical attributes, such as alignment length, profile (below grade, at grade, aerial, etc.), number of stations, or whether the project initiated new service or extended an existing line;
2. Installation conditions, such as whether the project interacted with other active rail transit lines;
3. Schedule information, including major milestones in the project lifecycle;
4. Characteristics of the project sponsor, such as experience level, internal policies on capital costs, and use of outside contractors; and
5. The context of the project development process, such as the level of public involvement, delivery method, or whether a significant redesign was necessary.

For these last two characteristics, the definition and determination of values required some judgment based on knowledge of the project development process.

VARIABLE NAME	UNIT	COEFFICIENT	t-STAT*
Guideway Alignment Length	10,000 linear feet	1.4%	2.69
Construction Costs	Billions, 2008$	-5.9%	-2.49
Mode	Dummy, Heavy Rail = 1	6.0%	1.64
Installation Conditions	Dummy, No Active Service = 1	-3.8%	-1.25
Delivery Method	Dummy, Non-DBB = 1	-7.2%	-2.10
Economic Conditions	GDP % Annual Growth	-1.4%	-2.34
Unusually Long Project Development Phase	Dummy, Yes = 1	7.1%	2.08
Unusual Political Influence	Dummy, Yes = 1	6.6%	2.22
Agency Tendency to Minimize Capital Charges	Dummy, Yes = 1	-6.0%	-1.65

*Higher absolute value of t-Stat implies a stronger statistical relationship.

Exhibit 27. Multivariate regression results on soft costs as a percentage of hard costs.

Third, many additional measures were derived from this primary dataset that were intended to capture other project characteristics, such as project magnitude (e.g., construction costs per linear foot), complexity (e.g., percent of alignment below grade), unique circumstances (e.g., real estate acquisition costs, project occurred prior to certain federal requirements), and many others.

Fourth, this research analyzed each indicator's statistical ability to predict the project's actual soft costs, in total and as individual components. After several hundred univariate and multivariate regressions, a single multivariate regression was developed that can explain approximately 60% of the change in soft cost percentages by variations in the projects' characteristics ($R^2 = 0.58$). Exhibit 27 shows the resulting coefficients from this regression, where the dependent variable is total soft costs as a percentage of construction costs.

Using the projects contained in this FTA Capital Cost Database, the strongest correlation that could be produced is the regression described above. After testing many combinations of explanatory independent variables, these nine could best predict the relationship between soft and hard costs. Although the strength of this correlation is not ideal, the relationship does highlight the importance of judgment in cost estimation. In addition, as more projects are included in this cost database, it may be possible to perform analysis with stronger cost relationships.

Fifth, alternative multivariate regressions were examined that used different actual soft cost components (rather than total soft costs) as the dependent variable. The coefficient from the overall soft cost analysis was distributed to the soft cost components that correlated to the project characteristics in a statistically significant way. For example, alignment length showed an overall coefficient of around 1.4% per 10,000 linear feet regressed against overall soft costs, and this relationship was strongest when regressed against project management and other soft costs, so this Guidebook recommends adjusting the percentage estimate for those two components to a total of 1.4% per 10,000 linear feet.

Finally, the starting points and recommended percentage adjustments were validated against the original projects to gauge how far off this Guidebook's new methodology would have been. Some minor adjustments to the coefficients were made to minimize the sum of each component's root mean square error (defined in the Glossary in Appendix C) for all projects.

APPENDIX B

Soft Cost Estimation Worksheet

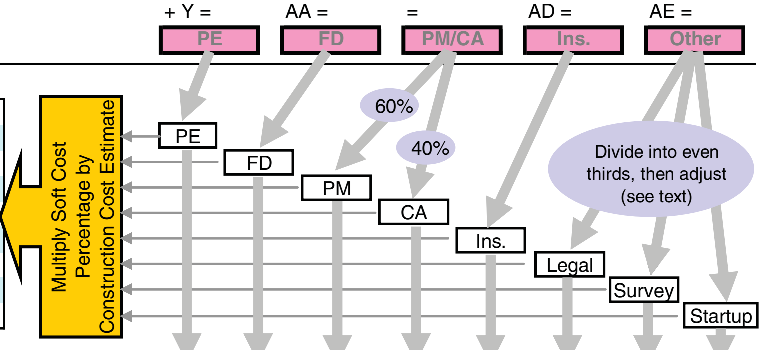
This worksheet describes the methodology for estimating soft costs for a transit infrastructure project outlined in *Estimating Soft Costs for Major Public Transportation Fixed Guideway Projects.* The worksheet begins with a default soft cost estimate as a percentage of construction costs, and makes several adjustments based on the characteristics of the project and its sponsor. Finally, the worksheet converts these percentages into the components of Standard Cost Category 80, Professional Services.

Note: The Guidebook text forms an integral part of the calculations described below. Please refer to that document for more detailed instructions for completing this soft cost estimation.

	Input	PE %	FD %	PM/CA %	Ins. %	Other %
Starting Defaults		2.0	12.0	12.5	2.0	1.0
Alignment Length Enter one-way length of alignment in linear feet divided by 10,000 (not track-miles)	A			0.9 ×A = J		0.4 ×A = K
Construction Cost Estimate Enter SCC 10 through 50 only, in $ billions	B			-4.5 ×B = L	-1.0 ×B = M	-0.5 ×B = N
Mode Enter 1 for heavy rail, zero for light rail	C	1.5 ×C = O		3.5 ×C = P	1.0 ×C = Q	
Installation Conditions Enter 1 if project will be installed under no active adjacent or adjoining transit service	D	-3.0 ×D = R	-1.0 ×D = S			
Delivery Method Enter zero for Design-Bid-Build, 1 for other non-traditional delivery method	E	1.0 ×E = T	-1.0 ×E = U	-7.0 ×E = V		
Economic Conditions Enter percentage point annual change in U.S. GDP for the latest quarter (e.g., "2.5" for 2.5%)	F		-1.0 ×F = W	-0.5 ×F = X		
Long Project Development Phase If planning phase likely to continue longer than 5-7 years, enter up to 1	G	1.0 ×G = Y	6.0 ×G = Z			
Unusual Political Influence If public involvement or political pressures are high, enter up to 1	H		1.5 ×H = AA	4.5 ×H = AB		
Tendency to Minimize Capital If sponsor agency's internal policies tend to minimize capital charges, enter up to 1	I			-3.0 ×I = AC	-1.0 ×I = AD	-2.0 ×I = AE
TOTAL Soft Cost Component Estimate		O + R + T + Y = PE	S + U + W + Z + AA = FD	J + L + P + V + X + AB + AC = PM/CA	M + Q + AD = Ins.	K + N + AE = Other

Convert to SCC Components

80 PROFESSIONAL SERVICES	
80.01	Preliminary Engineering
80.02	Final Design
80.03	Project Mgmt. for Design and Const.
80.04	Construction Administration & Mgmt.
80.05	Insurance
80.06	Legal; Permits; Review Fees
80.07	Surveys, Testing, Investigation, Insp.
80.08	Start up



TOTAL Soft Cost Estimate PE + FD + PM/CA + Insurance + Other = TOTAL

APPENDIX C

Glossary

Alignment: The specific route or path of a new transit line (horizontal alignment), and whether the line travels through a tunnel, at grade, or is on an aerial structure or other infrastructure (vertical alignment).

Alternatives Analysis (AA): An early phase in planning for a major new transit construction project, where a project sponsor, with local community involvement, evaluates a transportation corridor and considers a range of fixed guideway and other transit alternatives.

Construction Manager/General Contractor (CM/GC): Sometimes referred to as CM-at-Risk, a project delivery method whereby the construction manager acts as a consultant to the project sponsor for all pre-construction activities (e.g., project development and design phases), but as an equivalent of a general contractor during the construction phase. In most cases this project delivery method entails a commitment by the construction manager to deliver the project within a guaranteed maximum price.

Cost-Effectiveness (CE): One metric by which FTA evaluates a potential New Starts project for funding. The measure is defined as: incremental annualized capital cost, plus incremental operating and maintenance cost, divided by the Transportation System User Benefits the project would provide. (Previously termed by the FTA as the Cost-Effectiveness Index, or CEI)

Delivery Method: The structure and timing of a project sponsor's relationships with its contractor(s) for design and construction. These methods describe how a project sponsor intends to implement a project, and typically include design–bid–build, design–build, and others.

Design–Bid–Build (DBB): A traditional project delivery method whereby a project sponsor produces and finalizes design before receiving bids to construct the project.

Design–Build (DB): A less traditional project delivery method whereby a project sponsor advances design work to a preliminary stage, and then the contractor (design builder) agrees to complete the work of finishing the design and then the building, facility, or systems installation to the point of readiness for operation or occupancy.

Design–Build–Operate–Maintain (DBOM): Under this project delivery method, the design builder is also responsible for the operation and maintenance of the project, usually for a specified period of time.

Dummy Variable: A type of variable included in a multivariate regression to represent a value of true (1) or false (0).

Environmental Impact Statement (EIS): When planning a major federally funded transit project, the project sponsor may be required by the National Environmental Policy Act to study and predict environmental impacts resulting from the project.

Final Design: A project planning phase where the project sponsor brings preliminary engineering plans and designs to a finer level of detail before construction begins.

Fixed Guideway Modernization: A federal capital grant program managed by the FTA designed to assist grantees to invest in existing rail and other fixed guideway infrastructure. Grants are apportioned by formula.

Force Account: The compensation and benefits of a transit agency's employees who are supporting a new capital project.

Gross Domestic Product (GDP): The total value of goods and services produced by a nation. GDP is a measure of a country's national income and outputs, and a good indicator of broad economic performance.

Locally Preferred Alternative (LPA): The alignment and mode of a new transit project chosen during an alternatives analysis.

New Starts: A federal capital grant program managed by the FTA designed to assist grantees to construct new public transportation infrastructure.

National Environmental Policy Act of 1969 (NEPA): A comprehensive federal law requiring project sponsors to analyze the environmental impacts of any federally funded action, such as a New Start transit project.

PM/CA: Abbreviation used in this Guidebook for project management and construction administration soft costs.

Preliminary Engineering (PE): The initial phase in the project development process where the project sponsor brings conceptual designs to a finer level of detail, to approximately 30% design.

Professional Services: FTA's SCC 80, Professional Services, covers all of those services and activities commonly associated with project soft costs. This Guidebook considers FTA's definition of professional services and soft costs as being equivalent.

Project Management Oversight (PMO): The process by which the FTA oversees grantees' project development process to ensure the grantee is meeting all federal requirements.

Project Management Plan (PMP): A plan that documents the roles, responsibilities, procedures, and processes in place to manage and deliver a federally funded transportation project.

Right-of-Way (ROW) Acquisition: The process of acquiring the real estate or property easements necessary for the transit project's alignment.

Root Mean Square Error: A statistical measure of the differences between actual values and the values predicted by a model.

Small Starts: A federal capital grant program managed by the FTA, similar to New Starts but aimed at smaller transit infrastructure projects.

Sponsor: The agency or organization with the responsibility of planning and constructing a major new transit infrastructure project.

Standard Cost Categories (SCC): FTA's standard structure for reporting and managing project costs. In the SCC, a project's total capital budget is broken down into categories and components of expenditures.

Transportation System User Benefits: One metric FTA examines when evaluating an application for New Starts funds; the incremental estimated mobility impacts (in terms of weighted travel time) as compared to a baseline of a proposed New Starts project.

Turnkey: A variation of a design–build project delivery method that includes financing or leasing mechanisms.

Work Breakdown Structure: A structure to break down the work (and resulting costs) of a new transit project into discrete work elements or tasks.

Petitioner's Attachment No. JCK-3R

PART 2

Final Report

CONTENTS

SUMMARY

Estimating Soft Costs for Major Public Transportation Fixed Guideway Projects

This report presents the research, data sources, and analysis underlying *Estimating Soft Costs for Major Public Transportation Fixed Guideway Projects, Part 1: Guidebook*, which came out of TCRP Project G-10. This Final Report is one of two final products from the project and is intended to support the information summarized in the Guidebook in Part 1. Please refer to the Guidebook for a summary of how the results of the research presented here can be applied to practice, including an introduction to "soft costs" and a new methodology to estimate these soft costs based on historical projects.

To support the development of a guidebook for agencies on soft costs, this report:

- Identifies a working definition of soft costs,
- Describes the current industry practice of estimating soft costs through a questionnaire of the transit industry and interviews with industry professionals,
- Statistically analyzes the as-built costs of 59 past transit projects to determine how project characteristics have driven soft costs historically, and
- Introduces a new methodology for estimating soft costs based on actual past expenditures, presented in the Guidebook.

S.1. Definition of Soft Costs

Generally, soft costs (or indirect costs) are the capital expenditures that are required to complete an operational transit project but that are not spent directly on activities related to brick-and-mortar construction, vehicle and equipment procurement, or land acquisition. Instead, these expenses are incurred on ancillary professional services that are necessary to complete the project.

After reviewing a variety of financial, engineering, academic, and other literature, this study concludes that the Federal Transit Administration's (FTA) definition of Standard Cost Category (SCC) 80, Professional Services, is an equivalent operational definition of soft costs for the purposes of this project. FTA (U.S. FTA, 2008) defines SCC 80 as follows:

> *[Soft costs include] all professional, technical and management services (and related professional liability insurance costs) related to the design and construction of fixed infrastructure during the preliminary engineering, final design, and construction phases of the project. This includes environmental work, design, engineering and architectural services; specialty services such as safety or security analyses; and value engineering, risk assessment, cost estimating, scheduling, before and after studies, ridership modeling and analyses, auditing, legal services, administration and management, etc. by agency staff or outside consultants.*

Petitioner's Attachment No. JCK-3R

Table 1. Types of soft costs encountered in rail transit construction.

TYPICAL SOFT COSTS INCURRED IN MOST PROJECTS	LESS TYPICAL SOFT COSTS INCURRED IN SOME PROJECTS, DEPENDING ON CHARACTERISTICS
Design and engineering services for preliminary engineering and final design	Professional services to support acquiring real estate for right-of-way
Transit agency staff managing project, development, construction, and customer information	Third-party contractor managing construction
Reimbursement to external entities such as police, utilities, and other costs of local and state government	Design and engineering services to re-design a project, due to unforseen circumstances
Insurance	

The kinds of soft costs encountered in rail transit construction projects in the United States can vary widely depending on project characteristics, local regulations, and the administration practices of the sponsor agency. Most new rail construction projects will incur certain "typical" soft cost expenditures, while other soft cost components can be unique to the project, as shown in Table 1.

Evidence suggests that European cost estimators are also trying to standardize a definition of soft costs, but the term is rarely comparable to how it is used in U.S. practice. The definition of soft costs to a transit agency can differ from a construction contractor or other stakeholders, depending on institutional context. The point of view of a U.S. transit agency is taken in this report.

S.2. Soft Cost Estimation: State of the Practice

Interviews with and a questionnaire administered to estimators revealed that cost estimators for transit construction projects follow different approaches to estimating soft costs depending on the phase of the project.

During early phases of planning [alternatives analysis (AA) or preliminary engineering (PE)], a transit project is only conceptually defined, and the soft costs are as well. At these early stages, transportation planners usually identify a single corridor for construction but develop a range of options for more specific details such as mode, alignment, station locations, and, as a result, construction costs. Most attention is on construction costs at this phase since soft costs are difficult to predict given the conceptual nature of the project. Estimators apply default costs to approximate construction quantities, remediation, and other "hard" costs, and then simply add a set of percentages of hard costs (e.g., 30%) to approximate an initial soft cost estimate, as shown in Figure 1.

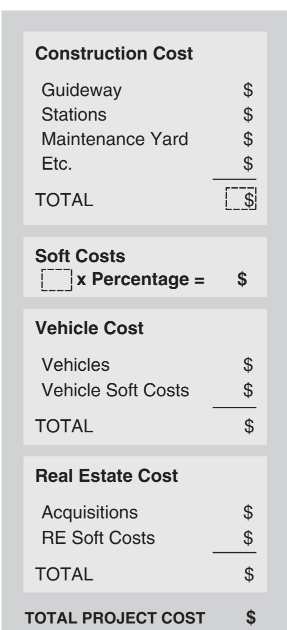


Figure 1. Cost estimation in early project phases.

At this phase, the central question is what percentages to apply. Based on interviews and an industry questionnaire, most estimators report that they choose percentages from within a range for each soft cost component based on historical experience and project characteristics. Figure 2 shows the midpoint percentages used by 10 cost estimators representative of the transit industry, broken down by the soft cost component. Typically, these "add-ons" represent an additional cost to the project of around 25–35% of construction costs.

However, these midpoints are not applied blindly. Estimators may begin with these averages but choose higher or lower percentages from within a range based on their knowledge

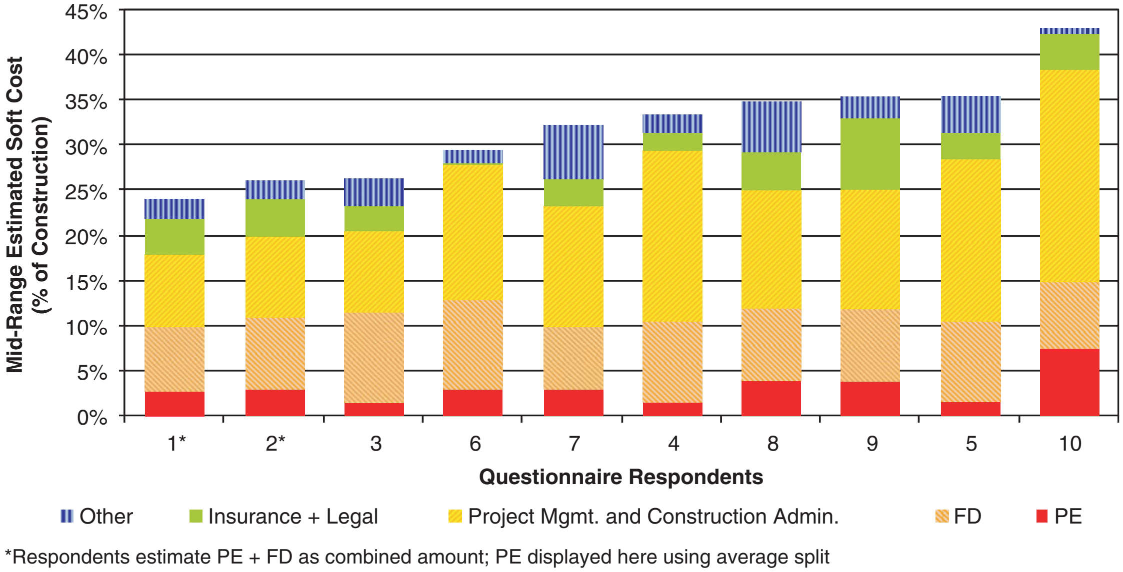


Figure 2. Midpoint soft cost estimates for all components during project planning phases.

of the project, the sponsor, and their experience with similar past projects. Table 2 lists some of the project characteristics that estimators generally use to guide their choice of a percentage within a range during planning phases. Estimators report that they may choose figures up to 10% higher or lower than their starting points based on judgment and the characteristics of the project.

During the final design (FD) and construction phases, estimates of soft costs based on a percentage of construction cost are replaced with more closely tailored, bottom-up estimates relying heavily on past experience with similar projects. For instance, administration costs may be estimated based on headcount multiplied by the duration of the project, as determined from construction schedules. Also at this stage, more costs are known: preliminary engineering work is largely complete, and the sponsor's contracts for construction management and any remaining design work may already be executed for an agreed-upon cost.

Table 2. Project characteristics guiding soft cost percent estimates within a range.

	LOWER % SOFT COSTS	MIXED/MID-RANGE % SOFT COSTS	HIGHER % SOFT COSTS
MODE	Bus Rapid Transit	Commuter Rail Light Rail	Heavy Rail
PROJECT DELIVERY	Design–Build Design–Build–Operate–Maintain Full Turnkey	Design–Bid–Build	
ALIGNMENT		Elevated Alignment	Tunnel Alignment
OTHER CONDITIONS		New Right-of-Way	Differing Subsurface Conditions

Petitioner's Attachment No. JCK-3R

S.3. Soft Cost Expenditures: As-Built Analysis

This report analyzes a database assembled by the Federal Transit Administration of as-built costs for 59 rail transit construction projects in the United States over the past four decades (summarized in Figure 3) and concludes that:

- The current industry practice of using percentage add-ons for soft costs appears to be a valid approach to estimating soft costs. Project characteristics such as complexity, magnitude, mode, context, and others identified by industry estimators are correlated with soft costs in dollar and percentage terms.
- Soft cost expenditures have averaged around 30% of construction costs, with a range across all projects of between 11% and 54%, depending on the characteristics of the project, as Figure 3 indicates (outliers excluded).
- Cost estimators typically begin estimating soft costs with average percentages that correspond closely to historical averages for each soft cost component, as Table 3 shows.
- However, actual soft costs in past projects have shown a wider range of variability than estimators currently use. While estimators report choosing from within a range of around 20 percentage points, past projects have varied within a range of around 40 percentage points (outliers excluded).
- Some variability in soft costs cannot be explained solely with information available to the estimator prior to construction. The statistical analysis applied in this research was able to explain around 60% of the changing relationship between hard and soft costs with data available during planning phases. This suggests that the remaining variability in soft costs must be estimated with a blend of science, judgment, and art.

S.4. A New Approach to Estimate Soft Costs

This report is accompanied by a guidebook that presents a new method to estimate soft costs for a planned transit project that is firmly rooted in historical experience. The Guidebook also serves as a primer on soft costs and takes the reader through a step-by-step process to estimate the relationship between a given transit project's hard costs and its likely soft costs, given certain characteristics about the project and its sponsor.

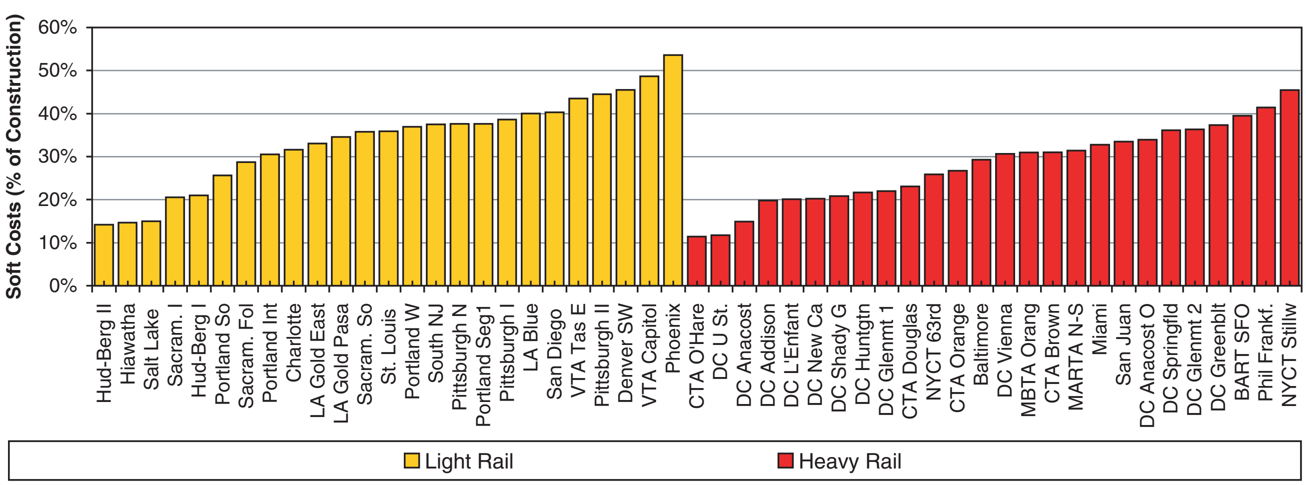


Figure 3. Historical soft costs by project and mode (outliers excluded).

Table 3. Comparing industry practice to historical actuals: soft costs as a percentage of hard costs.

	SURVEY* Average of Midpoints Used	AS-BUILT COST DATA** Average Actual
Preliminary Engineering	2.6%	2.7%
Final Design	9.0%	9.7%
Project Management & Construction Administration	14.1%	15.1%
Insurance	3.5%	2.2%
Other Costs	2.9%	1.6%
TOTAL	32.1%	31.3%
Range of Total	24% to 43%	11% to 54%
	*Representing 10 responses	**Representing 51 past projects (outliers removed)

S.5. Future Research Direction

This report and the accompanying Guidebook give transit agencies and other project sponsors a better understanding of what soft costs are, how they are estimated, and what has caused changes in soft costs in past projects. The Guidebook synthesizes the research and analysis from this technical report into a straightforward primer on soft costs and introduces a new methodology to estimate soft costs based on a review of historical drivers and costs.

More in-depth research into the documentation of one or more recent construction projects will enhance the understanding of the exact composition of soft costs and cost drivers. Future research might further examine the more-detailed elements of soft costs below the Standard Cost Category component level and document more of the estimation techniques used in later project phases. Given the specificity of this work, the research may need to be more closely tailored to a specific mode or operating environment (e.g., streetcar versus light rail on exclusive right-of-way). Moreover, a comprehensive industry outreach program will provide further insight on context-specific soft-cost estimation practices.

Finally, the methodology to estimate soft costs for public transportation infrastructure projects developed here is based on past heavy and light rail construction projects and is therefore not entirely applicable to other prevalent public transportation capital infrastructure projects such as bus rapid transit (BRT), commuter rail, streetcar, or state-of-good-repair projects to repair or replace aging infrastructure. Additional data and research would help estimate soft costs for these kinds of projects.

CHAPTER 1

Introduction

1.1. Purpose of This Report

This Final Report presents the research, data sources, and analysis underlying *Estimating Soft Costs for Major Public Transportation Fixed Guideway Projects, Part 1: Guidebook,* which came out of TCRP Project G-10. The purpose of TCRP Project G-10 was to research soft costs in major public transportation capital infrastructure projects, with the goal of producing a guide for project sponsors to learn more about these costs and better estimate them in the future.

This Final Report is one of two final products from the project and is intended to support the information summarized in the Guidebook in Part 1. Please refer to the Guidebook for a summary of how the results of the research presented here can be applied to practice, including an introduction to soft costs and a new methodology to estimate these soft costs based on historical projects.

1.2. Background

When a new rail transit project is proposed in the United States, its capital cost is one of the most visible and important characteristics in the public deliberation over whether to build the project. The capital cost of a rail project factors prominently when deciding alignment and mode during the alternatives analysis and preliminary engineering phases. It is reported in the press, debated by stakeholders, influences the public's perception of a sponsoring transit agency, and ultimately helps determine whether the project is ever constructed. The capital cost is also a crucial input to the cost-effectiveness indicator that helps determine the project's eligibility for federal funds. In addition, the transit industry has recently come under scrutiny for perceived persistent underestimating of capital costs and its ability to contain such costs. While research on the transit industry has focused primarily on hard construction costs and estimation techniques, relatively little literature exists on the composition and estimation of soft costs for transit projects.

Historically, soft costs have accounted for a significant portion of a capital project's total expenditures, yet many agencies know little about soft costs. As this report discusses, most rail transit projects' soft costs have ranged from as low as 11% to as high as 54% of hard construction costs. Given the importance and public scrutiny of transit capital costs and the relative inattention to a cost category that makes up a significant portion of expenditures, the transit industry may benefit from improved information on soft costs.

Therefore, the research team for TCRP Project G-10 hopes to help the transit industry better understand:

- The definition, importance, composition, and timing of soft costs;
- How the industry currently estimates soft costs, depending on project phase;

- What has driven soft cost expenditures in the past; and
- How soft costs can be estimated in the future.

Increasing the integrity, accuracy, and reliability of soft cost estimates will improve the industry's public perception and deliver public transportation infrastructure more cost-effectively. The ultimate objective of the researchers was a guidebook for estimating soft costs for major transit capital projects that walks a project sponsor through each step in building up a soft cost estimate.

1.3. Definition of Soft Costs

Generally, soft costs are the capital expenditures that are required to complete an operational transit project but which are not spent directly on activities related to brick-and-mortar construction, vehicle and equipment procurement, or land acquisition. Instead, these expenses are incurred on ancillary professional services that are necessary to complete the project. Soft costs are the expenditures necessary to develop and manage the project, whereas hard costs are the expenditures required for construction. Soft costs are a necessary part of a construction project because building or rehabilitating transit infrastructure requires more than the direct payments made to a general construction contractor or a vehicle vendor.

The Federal Transit Administration requires that all candidate and recipient projects of New Starts funds organize and report their project cost estimates in the same way, using the Standard Cost Category structure. This structure consists of ten major categories (as shown in Table 4), each of which is further broken down into components. For example, the SCC 50 Systems cost category includes separate components for Train Control, Traction Power, Communications, and Fare Collection.

Standard Cost Category 80, Professional Services, consists of eight separate components that together encompass all services and activities commonly associated with project soft costs (although some exceptions are discussed below).

In addition, a literature review on soft costs concludes that the existing engineering, technical and international professional literature on the definition of soft costs is consistent with the FTA's description of SCC 80, Professional Services, in the *Standard Cost Category Workbook* (U.S. FTA,

Table 4. FTA Standard Cost Categories and Category 80 components.

10	Guideway & Track Elements (route miles)
20	Stations, Stops, Terminals, Intermodal (number)
30	Support Facilities: Yards, Shops, Admin. Bldgs
40	Sitework & Special Conditions
50	Systems
60	ROW, Land, Existing Improvements
70	Vehicles (number)
80	Professional Services
90	Unallocated Contingency
100	Finance Charges
Total Project Cost (10–100)	

80.01	Preliminary Engineering
80.02	Final Design
80.03	Project Management for Design and Construction
80.04	Construction Administration and Management
80.05	Professional Liability and Other Non-Construction Insurance
80.06	Legal; Permits; Review Fees by Other Agencies, Cities, etc.
80.07	Surveys, Testing, Investigation, Inspection
80.08	Start Up

2008). Furthermore, using the SCC structure and the definition of SCC 80 is consistent with the historical analysis that underpins the new soft-cost estimation methodology discussed later.

For this reason, the researchers for this project adopted the definition and structure of FTA SCC 80, Professional Services, as being equivalent to the definition of soft costs. The FTA's characterization (U.S. FTA, 2008), restated below, is therefore a reasonable and consistent definition and has been used throughout the project:

> *[Soft costs include] all professional, technical and management services (and related professional liability insurance costs) related to the design and construction of fixed infrastructure during the preliminary engineering, final design, and construction phases of the project. This includes environmental work, design, engineering and architectural services; specialty services such as safety or security analyses; and value engineering, risk assessment, cost estimating, scheduling, before and after studies, ridership modeling and analyses, auditing, legal services, administration and management, etc. by agency staff or outside consultants.*

It is important to keep in mind institutional or contractual perspective when referring to soft costs. Although this research views soft costs from the perspective of the project sponsor or FTA, the classification of soft costs within the construction industry can take on somewhat different meanings, depending on institutional context.

As Figure 4 illustrates, the project sponsor will likely view soft costs as the non-construction professional services costs identified in Standard Cost Category 80. Expenditures in other cost categories reflect the sponsor's expenditures on direct activities, perhaps primarily composed of payments to the vehicle vendor or construction contractor.

The construction contractor, in turn, may view some portion of their total construction contract as indirect or soft costs for *their* organization, such as the cost of contract administration, home office overhead, and related expenses that are built into the contract amount. These indirect costs represent real costs of doing business to the construction contractor, but since they cannot be clearly attributable to a specific project, the construction contractor is likely to charge various projects in some proportional manner.

In addition, some costs that are clearly attributable a specific project cannot be attributed to physical components of the project (such as concrete or steel), and these may be referred to as "general conditions." While these activities sound similar to the types of services identified in SCC 80, they are the contractor's (not the sponsor's) costs and therefore considered hard costs outside of SCC 80. These multiple perspectives on indirect or soft costs are illustrated schematically in Figure 4.

To keep matters clear, this research assumes the perspective of a transit agency sponsoring major construction where at least some design and all construction work is to be performed by

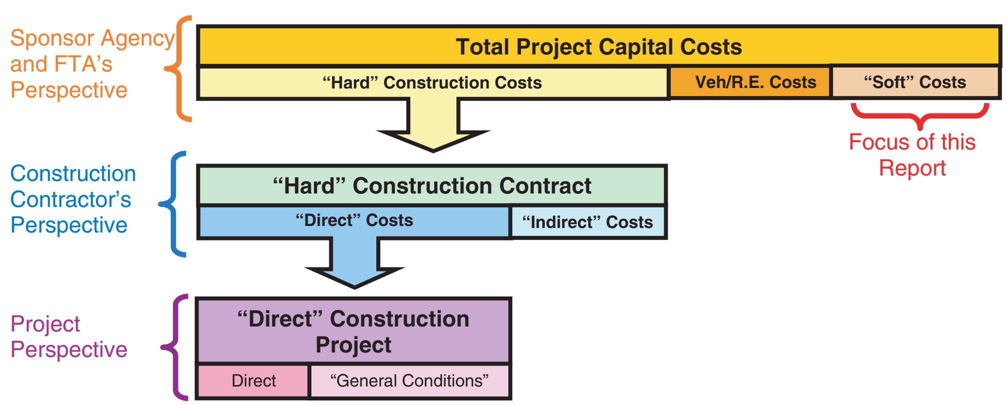


Figure 4. Capital costs from sponsor, contractor, and project perspectives.

outside contractor(s). For example, while a construction contractor might build their expected overhead costs into their bid, their total bid price from the transit agency's perspective, and according to the definition above, is a hard construction cost.

1.4. Organization of This Report

This report consists of five broad sections:

- A literature review on the definition and components of soft costs;
- Results from an industry questionnaire and interviews about how soft costs are estimated;
- Analysis of the relationship between project characteristics and actual as-built soft costs from 59 past rail projects, including univariate and multivariate analyses;
- A summary of the analysis underlying the Guidebook's new soft-cost estimation technique; and
- Concluding remarks and directions for future research.

CHAPTER 2

Literature Review on Soft Cost Definition and Components

The objective of this literature review is to find a consistent definition for the term "soft costs" in the context of capital construction projects and to decide what cost items fall under this term. The following general sources of information were reviewed:

- Technical and scholarly articles published in archival U.S. journals;
- Articles presented in various U.S. professional conferences and published as part of the proceedings;
- Internet sources;
- Books, and specifically, engineering textbooks;
- U.S. Army Corps of Engineers publications; and
- European cost estimation sources.

2.1. Papers and Websites

Many organizations and industry groups publish definitions of soft costs on the Internet or in readily available literature. It is important to note that the term "soft cost" is not used commonly in the technical literature. However, many of the cost items associated with soft costs are covered under the definition of indirect costs.

- The Association of Physical Plant Administrators (APPA, 2005) has the following definition:

> *Soft costs include such items as architecture, design, engineering, permits, inspections, consultants, environmental studies and regulatory demands needing approval before construction begins. Soft costs do not include construction, telecommunications, furnishings, fixed equipment and expenditures for any other permanent components of the project. . . . . These costs are related to those items in a project that are necessary to prepare and complete the non-construction needs of the project.*

While the main components are the same, there is a distinction in this terminology that limits the definition of soft costs to costs incurred *prior* to construction. In the FTA SCC definition, soft costs include professional and managerial services during the construction phase as well.

- KRG Insurance Group (2002) defines soft costs for building and entrepreneurial projects as follows:

> *"Soft Costs" may be defined as those indirect additional expenses that form part of the construction or repair of property. They not only impact on building cost but on business revenues. . . . In a typical accounting summary of construction costs on a new project it is normal for soft costs to comprise up to 30% of total expenses.*

> *Here is a partial listing of soft costs incurred in building construction: Architect and engineer fees, audit and bookkeeping charges, realty taxes/assessments, advertising and promotional expenses, real estate commissions, tenant inducement expense, premiums—Insurance/bonds, license and permit fees, increased mortgage costs, additional loan expenses, legal expenses, cost of vacancy, increased cost of labor, security expenses, and penalties.*

- Constructionplace.com (as of 10/5/2007) has the following definition for soft costs:

> *Soft Costs are cost items in addition to the direct Construction Cost. Soft Costs generally include architectural and engineering, legal, permits and fees, financing fees, construction interest and operating expenses, leasing and real estate commissions, advertising and promotion, and supervision.*

Further, this source contends that the terms indirect costs and soft costs are synonymous.

2.2. Indirect Costs

Few professional publications have used the term "soft costs," instead discussing many elements of soft costs at some length under indirect costs. However, extending the search to include the term "indirect costs" yielded more information regarding various elements of soft costs. In considering indirect costs it is important to identify the relevant perspective. As an example, a cost item that is considered an indirect cost for a *project* (general conditions) may be categorized as a direct cost from a *contractor's* perspective. In the same way, a cost that can be considered a direct cost for a *provider* of professional services (such as labor cost) could be considered an indirect cost from the *owner's* or *sponsor's* perspective.

- For example, the Association for the Advancement of Cost Engineering (AACE, 2007) offers the following definition for indirect costs:

> *Costs [that] are not directly attributable to the completion of an activity. Indirect costs are typically allocated or spread across all activities on a predetermined basis. In construction, all costs which do not become a final part of the installation, but which are required for the orderly completion of the installation and may include, but are not limited to, field administration, direct supervision, capital tools, startup costs, contractor's fees, insurance, taxes, etc.*

This definition is from the perspective of the *contractor.* For the sponsor of a capital project, such as a transit agency dealing with multiple contracts in the same project, the contractor's *general conditions* and *home office overhead* could be considered direct costs because they are clearly attributable to that specific contract. It is therefore conceivable that the whole construction contract could be considered a hard cost. Since the purpose of this guide is to help project sponsors estimate project soft costs with greater accuracy, this analysis takes the perspective of the project sponsor and treats the general conditions and home office overhead as construction costs.

2.3. Textbooks and Technical Books

Ten construction management textbooks were also selected for review because they have been commonly used in various universities and other academic settings for years. The term "soft costs" was only used in one of these textbooks (Bartholomew, 2000, p.252) as follows:

> *In development, as distinct from actual construction, direct costs are the hard costs, the total construction costs that include what we call in estimating both direct and indirect construction costs. The indirect, or soft, costs in development include the costs of financing, advertising and sales, fees, insurance, ground rent and taxes during construction, and the costs of land rights.*

2.4. U.S. Army Corps of Engineers Publications

U.S. Army Corps of Engineers publications on the Internet addressing the subject of construction costs included no reference to the term "soft costs." However, the Corps' estimating sources deal with non-construction costs, and these sources can be used in the current research.

As an example, the U.S. Army Corps of Engineers document *Engineering Instructions—Construction Cost Estimates* (1997) describes the process of cost estimating as prescribed by the Corps. This document does not use the term "soft costs"; however, costs are divided into construction costs and the non-construction activities costs for real estate; planning, engineering, and design; and construction management. This document also provides a work breakdown structure (WBS) for organizing the cost estimate; several categories of this WBS include soft cost items as defined in the FTA SCC description of Category 80. The document can be used for obtaining information on the Corps approach for estimating non-construction costs even though the main emphasis is on construction costs.

2.5. European Sources

Research was conducted to evaluate the European approach to cost classification and to see how European countries keep track of project soft costs. Sources were reviewed in places including Germany, the United Kingdom, and Switzerland. It appears that the term "soft costs" is not used to identify non-construction costs.

However, one useful source was the European Committee for Construction Economists (CEEC) *Code of Measurement for Cost Planning* (CEEC, 2004). The CEEC was established over 20 years ago as a European organization in the field of real estate economy. A working group of this committee focused on the problem of differences between national codes for the measurement of quantities and classification of construction costs (Stoy and Wright, 2006). This working group created the CEEC *Code of Measurement for Cost Planning* as a high-level standard summary for the classification of costs in construction and real estate. Table 5 provides general categories of costs (cost groups) according to the CEEC.

CEEC's *Code of Measurement for Cost Planning* applies the codes of Belgium, Switzerland, Germany, Netherlands, Ireland, and the United Kingdom to arrive at a uniform approach for categorizing construction costs. In this cost breakdown, general conditions costs (project overhead) can be found under cost group A (in Table 5). Items that may be classified as soft costs are found mainly under cost groups L, M, O, and X. As an example, cost group M, "ancillary costs and charges," is described as follows:

> General incidental costs to the client including the costs of models, documentation, copies of drawings, etc., laying of foundation stone, topping out, inauguration, competitions, permits, planning charges, connection charges for utilities, insurances, third party compensation, client's involvement, legal fees in association with construction, compensation payments due to statuary requirements.

The titles of cost groups can sometimes be misleading. As an example, project management and project administration costs are listed under cost group L, "design team fees." Insurance costs can be captured under items "779—general incidental building costs, other items" and "790—other incidental building costs" (cross-referenced from German DIN 276/1993).

Legal fees for land acquisition are under category U. Categories J and N are reserved for contingencies, and category V is reserved for finance.

There is a major effort in Europe to standardize construction cost categories across European nations. The general approach is not unlike the U.S. approach where the costs are divided into

Table 5. Breakdown of cost categories according to the CEEC.

CONSTRUCTION COSTS	
A	Preliminaries
B	Substructure
C	External superstructure/envelope structure
D	Internal superstructure
E	Internal finishings
F	Services installations
G	Special equipment
H	Furniture and fittings
I	Site and external works
J	Construction contingencies
K	Taxes on construction
DESIGN AND INCIDENTAL COSTS	
L	Design team fees
M	Ancillary costs and charges
N	Project budget contingencies
O	Taxes on design and incidental costs
COSTS IN USE	
P	Maintenance
Q	Operation
R	Disposal
S	Decommissioning
T	Taxes
LAND AND FINANCE	
U	Land costs
V	Finance
W	Grants and subsidies
X	Taxes on land

construction and non-construction costs, although the term “soft costs” is not used even in English speaking nations (the United Kingdom and Ireland).

2.6. Summary and Conclusion

In general, despite minor differences, the various definitions of soft costs in the professional publications are generally consistent. Methods of estimating or allocating these costs vary and change from organization to organization. From this literature review the researchers conclude that the definition provided by the FTA in Standard Cost Category 80 is a comprehensive definition consistent with most of the sources that were reviewed.

CHAPTER 3

Soft Cost Estimation: State of the Practice

Industry practices for developing soft cost budgets were assessed using a questionnaire completed by construction cost estimators at a variety of transit agencies, and in-depth interviews were conducted with experienced professional cost estimators in public transportation.

3.1. In-Depth Interviews with Professional Cost Estimators

To develop an initial picture of how the transit industry estimates soft costs, in-depth interviews were conducted with professional cost estimators. The following sections describe the findings of these interviews.

3.1.1. General Approach

From the interviews, it is clear that sponsors of major new transit projects approach estimating soft costs differently depending on how far along the project is in the planning process. Over time, as a project becomes better defined, the soft-cost estimate process increases in sophistication from a proportionate approximation to a more detailed or "bottom-up" estimation for each functional aspect of soft costs.

3.1.2. Soft Cost Estimation during Early Planning Phases

Early in the project development phase, such as during alternatives analysis or preliminary engineering, a transit project is only conceptually defined, as are the soft costs. At these early stages, transportation planners may identify a single corridor for construction but develop a range of options for more specific details such as mode, alignment, station locations, and, as a result, construction costs.

At this stage, capital cost estimates are very important, especially because they are a crucial input to the project's cost effectiveness, which can help determine eligibility for federal funding. However, despite the early importance of capital cost estimates, soft cost estimates are approximations at best in such early phases. Soft costs are generally approached as a percentage add-on to capital costs during alternatives analysis and are an approximation only. As a result, most attention focuses on hard costs, not soft costs, at this stage.

Because of the conceptual nature of the project and the emphasis on hard costs at this stage, soft costs are usually treated as percentage add-ons to estimates of hard construction costs. Estimators begin by estimating each soft cost component as a percentage of construction costs, choosing a percentage for each component within a range depending on a variety of factors. For instance, during conceptual design a sponsor might begin by estimating final design costs as 9% of construction costs, but then increase that estimate to 11% if they know the project is likely to require a more complex design due to special circumstances. Cost estimators interviewed for this study identified the following project characteristics as cost drivers:

- Mode (generally, soft cost percentages for highway projects are lower than for transit projects, which tend to be more complex with more unknowns);
- Vertical alignment (underground segments usually add to soft cost percentages);
- Traffic impacts and relocations around the construction site;
- Level of public support and acceptance of the project; and
- Local and regional politics that can complicate the project development process, including alignments, delays, local funding share and methods, and other concerns.

The project characteristics that were identified in the interviews as cost drivers, listed above, are very similar to those identified in the questionnaire (as shown in Table 8).

3.1.3. Soft Cost Estimation during Later Design and Construction Phases

If a project proceeds into preliminary engineering and final design and becomes better defined, the soft-cost estimation approach changes, and percentages are rarely used. Instead, percentage estimates are replaced with more closely tailored, bottom-up estimates relying on a more detailed understanding of the project than was available in earlier stages and relying on past experience with similar projects. For example, an estimator might forecast design costs using a standard number of drawings per station and drawings per linear foot of guideway and apply a standard per-drawing cost. Agency administration and management costs might be based on headcount, staff salaries, and project duration, in combination with the project's operational requirements. Third-party reimbursement and other costs in SCC 80.06 might be estimated based on construction duration per station as well as headcount. Right-of-way soft costs might apply assessed actual property values rather than a gross estimate of acquisition and real estate costs.

Importantly, the project faces external pressure to adhere to whatever soft cost estimate is assigned to the project during final design. The public, agency staff, FTA, and other oversight bodies tend to expect that the SCC budget line items as defined at final design will not change. In particular, FTA wants to avoid major budget revisions after final design and highly scrutinizes soft cost estimates at this stage. As a result, the cost estimator will typically approach each soft cost component with a conservative estimate.

During the construction phase, project management has little influence on the incurrence of soft costs. Due to the prior attention to the major SCC budget, the project sponsor might be reluctant to change the major SCC line items at the category level, although budget revisions within components are less difficult. To a great degree, the sponsor may be "stuck with the number" once construction begins. Some redesign may be necessary for differing or unexpected site conditions.

Once construction is underway, the management interface between agency and contractor is the most important determinant of soft cost expenditures; other potential factors have relatively little influence on soft costs at this point. The FTA's oversight, local regulations and building codes, and other potential complexities will have only minimal effect on soft cost expenditures. The effect of project delay (for whatever reason) can be mixed: some soft costs, such as manager salaries, are calendar-based and will continue regardless of progress, while other soft costs can be slowed or halted altogether as the project demands, such as when the design contractor temporarily reduces ongoing work on a project.

The market for construction management and design professional services itself can have an impact on construction costs and thereby the relative magnitude of soft costs. Contractors may bid lower if the market is weak, and vice versa.

3.2. Questionnaire of Transit Cost Estimators

To supplement the interviews, a questionnaire on soft cost estimation was completed by transit professionals and cost estimators at several consulting and engineering firms and transit agencies. The questionnaire was intended to build on the qualitative information gathered from the interviews by adding more quantitative information. The questionnaire had three objectives: to summarize the spectrum of soft cost percentages used in the industry by soft cost components, to identify the characteristics (or cost drivers) of a project that would change those percentages, and to measure how much the percentages might change within the range based on project characteristics. The questionnaire was transmitted to nine transit industry members of various sizes, from which 7 data points were collected—5 from transit agencies and 2 from agencies' planning consultants working on a specific capital project. Several respondents reported different estimation techniques and percentages at different project phases; this yielded a total of 10 data points for analysis.

3.3. Questionnaire Results: Magnitude of Estimated Soft Costs

Results from the first section of the questionnaire revealed that most agencies and contractors estimate soft costs as a percent of construction costs roughly consistent with the SCC structure; however, they use a fairly wide range of percentages, depending on context. These results are presented in Table 6.

The questionnaire asked respondents to report a midpoint as well as a high and low percentage for each cost component; however, some respondents supplied only a range or only an approximate midpoint. Where only a midpoint was noted, ranges are omitted, and where only high and low ranges were given, the mathematical average is shown. Some agencies provided percentage estimates that varied depending on project phase, resulting in multiple data points in the results presented in this document.

Several respondents noted other soft costs that are estimated on some basis other than a fixed percentage of construction costs. For example:

- Respondent 7 usually reserves around $1 million for a before-and-after study, regardless of relative project magnitude;
- Respondent 9 estimates resource needs for agency force account and flagging work on a project-specific basis, without using a percentage; and
- Similarly, respondent 10 estimates startup costs not as a percentage of construction costs but on a project-specific basis.

While most questionnaire respondents roughly followed the FTA SCC structure when estimating costs, there were some exceptions. For example, respondents 3, 4, and 5 use a single value to address both SCC 80.03, Project Management for Design and Construction, and 80.04, Construction Administration and Management. Respondents 1 and 2 estimate preliminary engineering and final design with a single value as well. Some respondents noted a percentage multiplier to estimate planning efforts in the early phases of project development, such as alternatives analysis, whereas many did not. This may be because these costs are already largely spent by the time

Table 6. Summary of soft cost percentages reported in questionnaire.

Questionnaire Respondent:		1	2	3	4	5	6	7	8	9	10
	Planning and Feasibility	---	---	---	---	---	---	---	2% for Environmental	---	---
80.01	Preliminary Engineering	*(included in Final Design below)*		1-2% (<1 to 2+%)	*(complete, same as at left)*	*(complete, same as at left)*	3% (2.3 to 3.8%)	3%	4% (3 to 6%)	(3 to 5%)	7.5% (7 to 8.5%)
80.02	Final Design	10% (6-15%)	11% (7-16%)	9-11% (<8 to 11+%)	9% (7% to 10%)	*(complete, same as at left)*	10% (7.5 to 12.5%)	7%	8% (7 to 12%)	(6 to 10%)	7.5% (7 to 8.5%)
80.03	Project Management for Design and Construction	8% (5-12%)	9% (6-12%)	8-10% (<8 to 10-12%)	18-20% (15 to 20+%)	17-19% (15 to 20%)	10% (7.5 to 12.5%)	12% of PE, then 12% of FD for PMC	8% (4 to 8%)	(4 to 6%)	9% (8.5 to 9.5%)
80.04	Construction Administration & Management	---	---	*(included in Project Management above)*			5% (3.8 to 6.3%)	12%	5% (2 to 5%)	(6 to 10%)	14.5% (14 to 15%)
80.05	Insurance	4% (2-6%)	4% (2-6%)	1.5-2% (<1 to 2.5+%)	1.5-2.5% (<1 to 2.5+%)	2% (1 to 3%)	0.1% (0.0 to 0.1%)	3% for Insurance and Legal	4% (3 to 6%)	(3 to 7%)	1%
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	---	---	0-2% (0 to 2+%)	---	0-2% (0 to 2+%)	0.7% (0.5 to 0.9%)		0.25%	(2 to 4%)	3%
80.07	Surveys, Testing, Investigation, Inspection	2% (1-4%)	2% (1-4%)	0-2% (0 to 2+%)	---	0-2% (0 to 2+%)	1% (0.8 to 1.3%)	---	2.5% (2 to 3%)	(2 to 3%)	0.5%
80.08	Start up	---	---	2% (0 to 2+%)	2% (0 to 2+%)	3% (2 to 4%)	0.6% (0.5 to 0.8%)	6%	3% for Start up and Artwork	---	Not estimated with %
	Other	---	---	---	---	---	---	$1m for Before/After Study	4% of SCC 60 for ROW Engineering; 7% of SCC 60 for Agency ROW Costs; 12% of SCC 70 for Vehicle Design and Agency Costs	Agency Force Account Work - Flagging Costs: As Needed	

Note: Midpoint reported first, figures in parentheses indicate upper and lower bound of range

Table 7. FTA Standard Cost Categories combined to report questionnaire results.

FTA SCC Category	Shown Here
80.01 Preliminary Engineering	Preliminary Engineering
80.02 Final Design	Final Design
80.03 Project Management for Design and Construction	Project Management and Construction Administration
80.04 Construction Administration and Management	
80.05 Professional Liability and other Non-Construction Insurance	Insurance and Legal
80.06 Legal; Permits; Review Fees by other agencies, cities, etc.	
80.07 Surveys, Testing, Investigation, Inspection	Surveys, etc.
80.08 Start Up	Start Up

an estimate is made or because the FTA directs agencies to exclude these costs in the SCC worksheet instructions (U.S. FTA, 2008).

This report combines several cost categories, as shown in Table 7 above:

The following section compares the questionnaire responses for each cost component, again with some FTA SCC components combined for reporting purposes.

Figure 5 shows the estimates for preliminary engineering provided by questionnaire respondents. Most agencies report a range of approximately 2–4%.

Questionnaire respondents reported using a fairly consistent range of between 7 and 11% of construction costs to estimate final design costs, as shown in Figure 6. However, these estimates go as high as 16%. Note that the percentages for respondents 1 and 2 include an estimate of preliminary engineering soft costs as well.

Responses were more varied as to the percentage of construction costs estimated for project management, construction management, and administration, as Figure 7 shows. Most estimates were in a range of around 7–19%, but some were as low as 5% and some were as high as 23%.

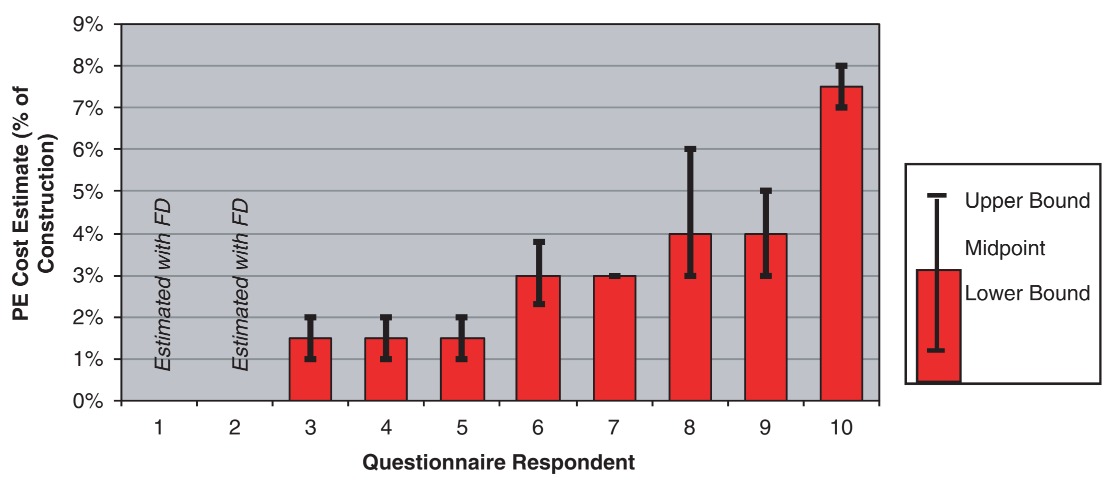


Figure 5. Preliminary engineering soft cost estimates.

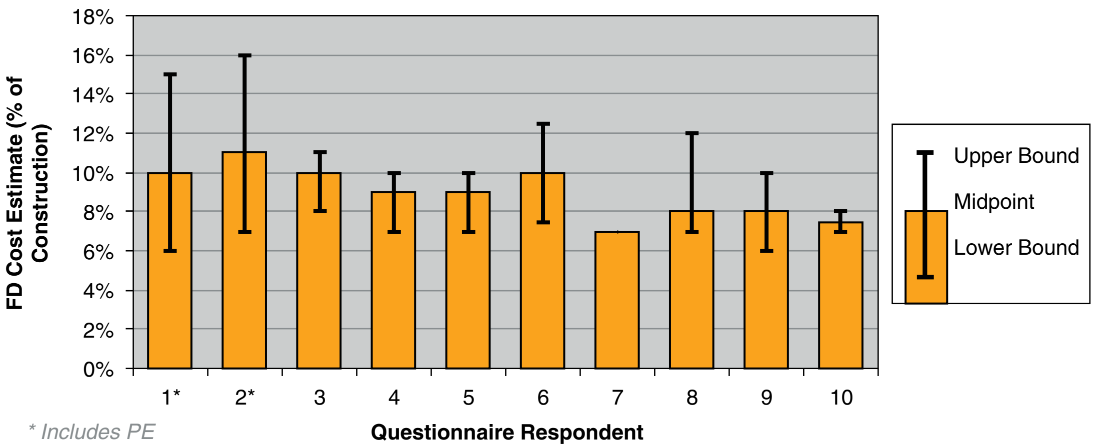


Figure 6. Final design soft cost estimates.

The relatively wider variance between respondents here may be due to the definition of management costs in major infrastructure projects involving a sponsoring public entity and multiple contractors, and the demarcation of where agency oversight ends and contractor oversight begins. As the literature review indicated, the definition of soft costs can often depend on institutional perspective or a project sponsors' decision regarding how much oversight and management to retain for agency staff and how much to contract out. If an agency expects a construction contractor to assume more management responsibility, these costs might appear to the agency as a higher construction bid. Alternatively, a transit agency might segment a large construction project into multiple contracts and hire a third-party construction manager to be responsible for their coordination and integration. The division of management labor between agency staff, management contractor, and construction contractor can differ depending on the sponsor agency.

Figure 8 and Figure 9 show that sponsors typically estimate around 2–4% of construction costs for insurance and legal soft costs, and another 1–2% for the cost of surveys, testing, and other costs. Similar to administration and management costs, however, these types of costs, particularly

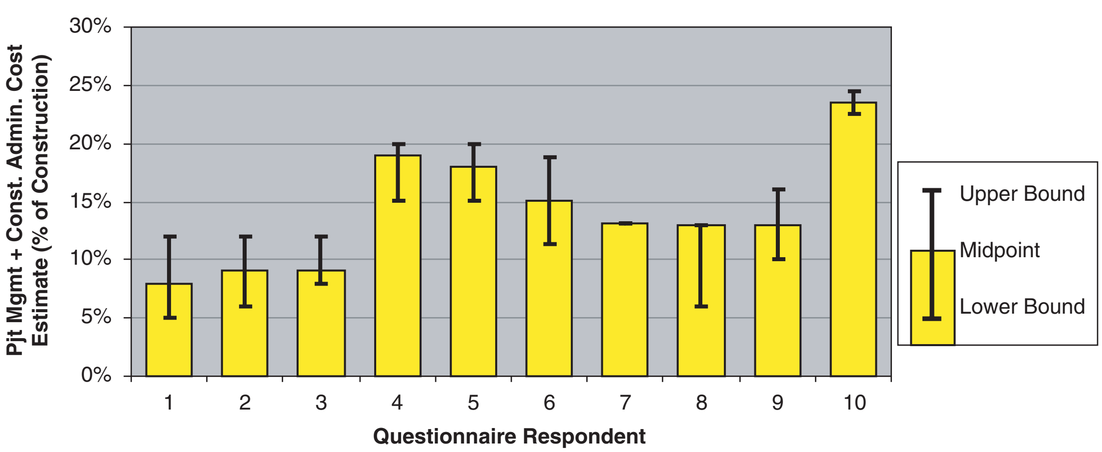


Figure 7. Project management and construction administration soft cost estimates.

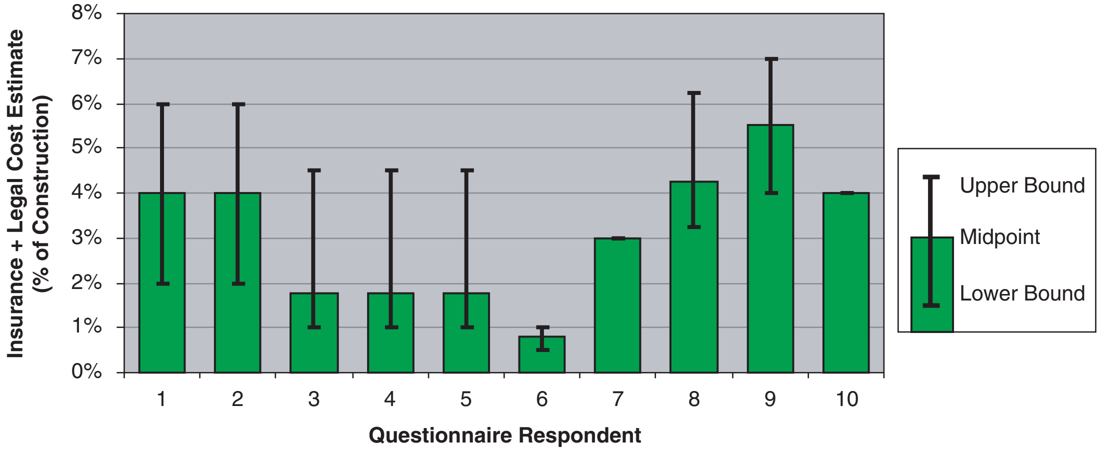


Figure 8. Insurance and legal soft cost estimates.

insurance, can depend on the practice of the agency and local circumstances, and it can be difficult to characterize industry-wide estimation patterns for these cost categories.

Sponsors appear to estimate startup costs quite differently, with estimates ranging from 0% to 7% for this category, as Figure 10 shows. Note the wide range given by respondents 1 and 3, further supporting this uncertainty.

When viewed as individual components or groups of components, as Figures 5 through 10 show, some estimators use fairly consistent soft cost percentages, while others vary more widely. However, some of the differences at the component level may be somewhat offset at the aggregate level. Figure 11, therefore, shows the sum of all soft cost components for each questionnaire response. The stacked bars represent midpoint estimates, while the error bars show the sum of the range of all elements. The midpoints of each soft cost component sum to approximately 25–35% of construction costs fairly consistently, even though the individual soft cost components may differ somewhat from respondent to respondent.

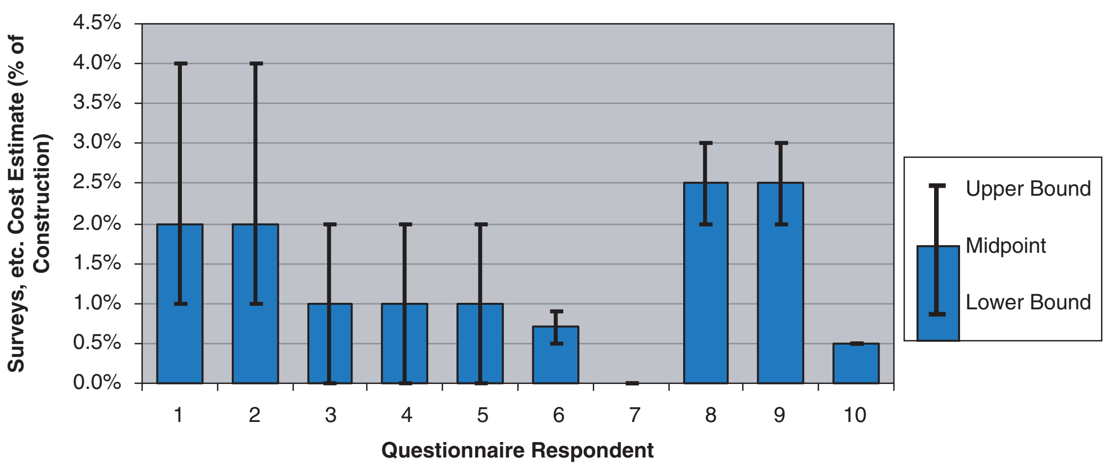


Figure 9. Surveys and other soft cost estimates.

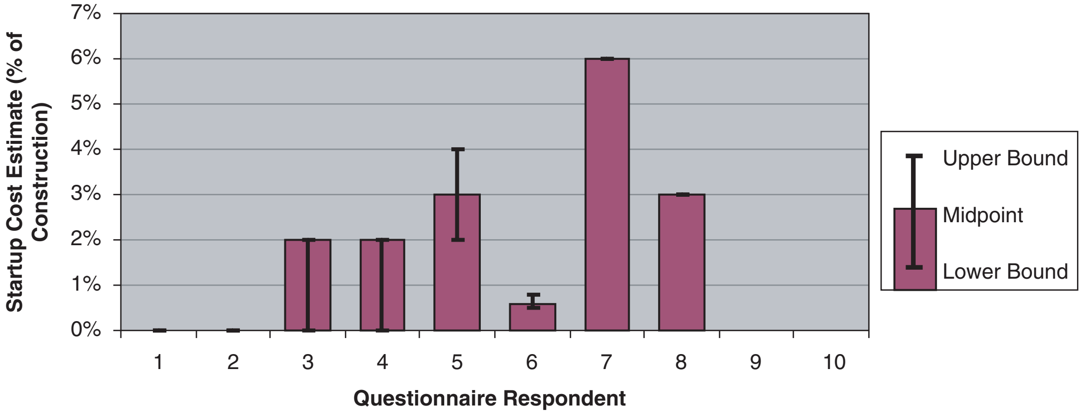


Figure 10. Startup soft cost estimates.

3.4. Questionnaire Results: Drivers Identified

Cost estimators were asked in an open-ended format to identify the kinds of project characteristics or circumstances that would ultimately impact their choice of percentages and that have impacted soft costs for past projects. The questionnaire suggested several attributes, but estimators were free to make their own responses as well. For each soft cost component (following the FTA SCC structure), estimators were requested to identify "cost drivers" that would have high, moderate, or minimal/no impact on soft costs in percentage terms. The results of this part of the questionnaire are presented in Table 8.

Respondents generally identified a wide variety of soft cost drivers, and this research uses these as a starting point for its historical analysis presented later. Some drivers relate to the physical

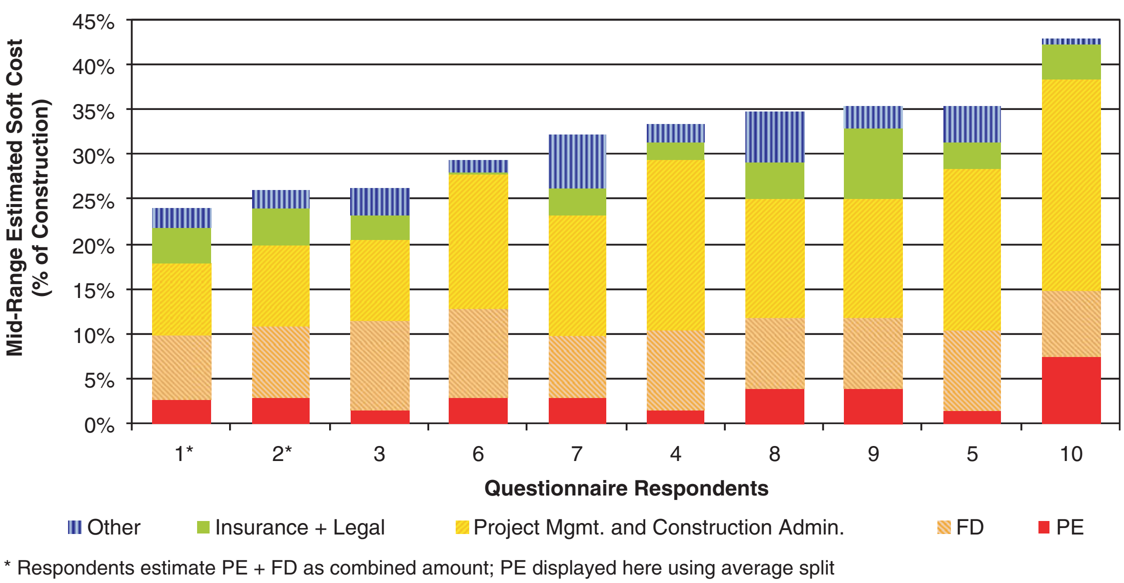


Figure 11. Midpoint soft cost estimates for all components.

Table 8. Soft cost drivers identified by questionnaire respondents.

SCC		Cost Impact	QUESTIONNAIRE RESPONDENT 1 and 2	3, 4, and 5	6	10
80.01	Preliminary Engineering	High	Alignment Grade; City v. Rural	Alignment Grade; City v. Rural	Alignment Profile	Alignment Grade, City v. Rural
		Moderate	Vehicle Quantity; Design Speed	Project Delivery; Mode	Quantity and Type of Stations	Vehicle Quantity, Design Speed
		None/ Minimal	Mode	Peak Throughput	Procurement Strategy	Mode
80.02	Final Design	High	Tunnel and Aerial Guideway; Quantity of Stations; Mode	Completeness of P.E.; City v. Rural	Community Outreach	Alignment Grade, City v. Rural
		Moderate	City v. Rural; Project Delivery Method; Mitigation	Deviation from P.E. Decisions; Alignment Grade	Value Engineering	Vehicle Quantity, Design Speed
		None/ Minimal	Design Speed; Grade; Peak Period Throughput	Peak Throughput	Budget	Mode
80.03	Project Management for Design and Construction	High	Tunnel and Aerial Guideway; Quantity of Stations; Mode	Ability and Experience of Contractor	City v. Rural	Vehicle Qty., Design Speed, Stations per LF; City v. Rural
		Moderate	City v. Rural; Project Delivery Method; Mitigation	Alignment Grade	Special Design Skills	Project Delivery Method
		None/ Minimal	Design Speed; Grade; Peak Period Throughput	Peak Throughput	Available Engineering Pool	---
80.04	Construction Administration & Management	High	Tunnel and Aerial Guideway; Quantity of Stations; Mode	Ability and Experience of Contractor	Available Resources	City v. Rural
		Moderate	City v. Rural; Project Delivery Method; Mitigation	Alignment Grade	Available Skills	Alignment Grade
		None/ Minimal	Design Speed; Grade; Peak Period Throughput	Peak Throughput	Avoid Owner / Contractor Duplication	---
80.05	Insurance	High	Tunnel and Aerial Guideway; Quantity of Stations; Mode	Market Forces	Risk Assessment	City v. Rural
		Moderate	City v. Rural; Project Delivery Method; Mitigation	Owner's experience; Brownfield v. Greenfield; City v. Rural	Risk Assessment	Alignment Grade
		None/ Minimal	Design Speed; Grade; Peak Period Throughput	Project Delivery Method	Safety Record	---
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	High	Tunnel and Aerial Guideway; Quantity of Stations; Mode	Brownfield v. Greenfield	Requirements Identification	City v. Rural
		Moderate	City v. Rural; Project Delivery Method; Mitigation	City v. Rural	Schedule	Station Density
		None/ Minimal	Design Speed; Grade; Peak Period Throughput	Vehicles; Design Speed	Agency Coordination	Brownfield v. Greenfield
80.07	Surveys, Testing, Investigation, Inspection	High	Tunnel and Aerial Guideway; Quantity of Stations; Mode	Elevated or Tunnel	Necessary Balance of Requirements	City v. Rural
		Moderate	City v. Rural; Project Delivery Method; Mitigation	Vehicles; Design Speed; Mode	Avoid Duplication	Brownfield v. Greenfield
		None/ Minimal	Design Speed; Grade; Peak Period Throughput	---	Share Historical Information	Alignment Grade
80.08	Start up	High	Tunnel and Aerial Guideway; Quantity of Stations; Mode	New Line v. Extension	Operation Coordination	Vehicle Quantity, Design Speed
		Moderate	City v. Rural; Project Delivery Method; Mitigation	Elevated or Tunnel; Design Speed	Skill Level Available	Station Density
		None/ Minimal	Design Speed; Grade; Peak Period Throughput	Vehicles	Schedule and Warranty Issues	---

characteristics of the project, the setting and circumstances in which the project is built, the skills and experience of the sponsor and its contractors, and mitigation and unexpected issues. Looking ahead to how these drivers might be used to estimate future soft costs, some of these drivers are relatively straightforward to predict (e.g., alignment grade), while others are much more difficult to foresee (e.g., agency coordination).

3.5. Questionnaire Results: Impact of Drivers

Finally, cost estimators were asked to quantify the impact of 11 project characteristics on soft costs within the following scenario:

- First, consider 7 project attributes that were designed to reflect increasing technical complexity;
- Second, consider 4 additional attributes highlighting different institutional arrangements between the public sponsor and private contractor;
- Third, consider a hypothetical base-case project: a simple light rail construction project, fully at grade, using an existing right-of-way, and delivered with a traditional design–bid–build method; and
- Fourth, consider changes from the base case and report whether the soft cost estimate for each soft cost element would go up or down in percentage terms, using a scale of from 1 to 5, 1 meaning "significant reduction," 3 meaning "no impact," and 5 meaning "significant increase."

To help visualize patterns in the data, the color scheme presented in Figure 12 was applied to the responses.

Table 9 shows the impact of mode on soft cost estimates, using light rail as the base case. Many respondents did not give information here or the response was not complete, perhaps because they lacked historical experience to respond. However, the table shows that, relative to light rail, estimators generally estimate higher soft costs for heavy rail projects, and only moderately higher for commuter rail projects. The results for BRT are mixed; one respondent predicted higher costs in some areas but lower in others, while another respondent predicted lower costs generally. However, these two questionnaire respondents should be interpreted within the context of their sample size.

Cost estimators generally reported that higher project complexity, as measured by a number of indicators in Table 10 below, will tend to increase soft cost expenditures. Most respondents noted that an elevated alignment increases soft costs only moderately compared to at grade, but that tunneling tends to increase soft costs more significantly. Respondent 10, however, noted that soft costs might decline in some categories when tunneling. Estimators at all agencies surveyed predicted rising costs, especially in design and construction management, when subsurface conditions differ from original plans. Results were mixed on the creation of a new right-of-way (versus the base-case existing ROW): some respondents foresaw no change, others predicted uneven increases, and others predicted significant increases.

The final three project attributes included in the questionnaire describe alternative project delivery methods, which generally intend to shift risk from the public agency to the private contractor. Table 11 shows that cost estimators generally estimate that soft costs to the transit agency will go down as more risk is borne by the constructor. However, it is unclear whether this pattern describes a real reduction in costs or merely a shifting of soft costs out of the transit agency's view and into a different cost category. Contractors bidding on a design–build contract, for example, might build soft costs into their bid.

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28 Estimating Soft Costs for Major Public Transportation Fixed Guideway Projects

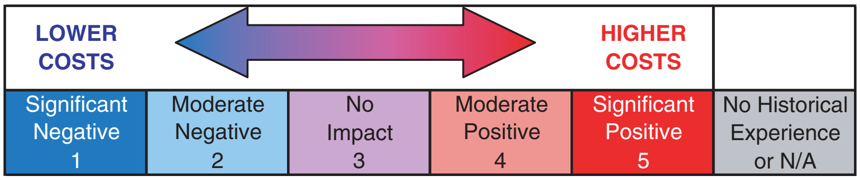

Figure 12. Questionnaire measurement system to quantify impact of cost drivers.

Table 9. Impact of mode on soft cost estimate.

Project Characteristic Change from Base Case	SCC	SCC Description	Questionnaire Respondent [1, 2] 1, 2	3, 4, 5	6	10
Mode: Heavy Rail	80.01	Preliminary Engineering	5	N/A	4	N/A
	80.02	Final Design	5	N/A	4	N/A
	80.03	Project Management for Design and Constructio	5	N/A	4	N/A
	80.04	Construction Administration & Management	5	N/A	4	N/A
	80.05	Insurance	5	N/A	5	N/A
	80.06	Legal; Permits; Review Fees by other agencies,	5	N/A	5	N/A
	80.07	Surveys, Testing, Investigation, Inspection	5	N/A	5	N/A
	80.08	Start up	5	N/A	3	N/A
Mode: Commuter Rail	80.01	Preliminary Engineering	4	N/A	4	N/A
	80.02	Final Design	4	N/A	3	N/A
	80.03	Project Management for Design and Constructio	4	N/A	3	N/A
	80.04	Construction Administration & Management	4	N/A	3	N/A
	80.05	Insurance	4	N/A	3	N/A
	80.06	Legal; Permits; Review Fees by other agencies,	4	N/A	3	N/A
	80.07	Surveys, Testing, Investigation, Inspection	4	N/A	3	N/A
	80.08	Start up	4	N/A	3	N/A
Mode: Bus Rapid Transit	80.01	Preliminary Engineering	2	N/A	4	N/A
	80.02	Final Design	2	N/A	5	N/A
	80.03	Project Management for Design and Constructio	2	N/A	4	N/A
	80.04	Construction Administration & Management	2	N/A	4	N/A
	80.05	Insurance	2	N/A	3	N/A
	80.06	Legal; Permits; Review Fees by other agencies,	2	N/A	5	N/A
	80.07	Surveys, Testing, Investigation, Inspection	2	N/A	4	N/A
	80.08	Start up	2	N/A	3	N/A

Notes:
Base case is light rail.
[1] Respondents 3, 4, 5, and 10 provided partial responses due to lack of experience; lack of response is noted as "N/A."
[2] Respondents 7, 8, and 9 did not provide responses and are omitted.

Table 10. Impact of project complexity on soft cost estimate.

Project Characteristic Change from Base Case	SCC	SCC Description	Questionnaire Respondent[1, 2]			
			1, 2	3, 4, 5	6	10
Alignment: Elevated	80.01	Preliminary Engineering	4	4	4	4
	80.02	Final Design	4	4	5	4
	80.03	Project Management for Design and Constructio	4	3	4	3
	80.04	Construction Administration & Management	4	3	4	4
	80.05	Insurance	4	4	3	3
	80.06	Legal; Permits; Review Fees by other agencies,	4	3	5	4
	80.07	Surveys, Testing, Investigation, Inspection	4	4	3	4
	80.08	Start up	4	3	3	3
Alignment: Tunnel	80.01	Preliminary Engineering	5	3	5	3
	80.02	Final Design	5	4	5	4
	80.03	Project Management for Design and Constructio	5	4	4	N/A
	80.04	Construction Administration & Management	5	4	4	N/A
	80.05	Insurance	5	4	5	4
	80.06	Legal; Permits; Review Fees by other agencies,	5	3	5	2
	80.07	Surveys, Testing, Investigation, Inspection	5	4	5	2
	80.08	Start up	5	4	5	3
Differing Subsurface Conditions	80.01	Preliminary Engineering	5	3	4	4
	80.02	Final Design	5	5	5	4
	80.03	Project Management for Design and Constructio	5	4	4	5
	80.04	Construction Administration & Management	5	4	4	5
	80.05	Insurance	5	4	4	3
	80.06	Legal; Permits; Review Fees by other agencies,	5	4	4	5
	80.07	Surveys, Testing, Investigation, Inspection	5	4	5	5
	80.08	Start up	5	3	3	3
New Right-of-Way	80.01	Preliminary Engineering	5	3	5	5
	80.02	Final Design	5	3	5	5
	80.03	Project Management for Design and Constructio	5	3	3	5
	80.04	Construction Administration & Management	5	3	3	5
	80.05	Insurance	5	3	3	4
	80.06	Legal; Permits; Review Fees by other agencies,	5	3	5	5
	80.07	Surveys, Testing, Investigation, Inspection	5	3	5	5
	80.08	Start up	5	3	3	5

Notes:
[1] Respondents 3, 4, 5, and 10 provided partial responses due to lack of experience; lack of response is noted as "N/A."
[2] Respondents 7, 8, and 9 did not provide responses and are omitted.

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Table 11. Impact of project delivery method on soft cost estimate.

Project Characteristic Change from Base Case	SCC	SCC Description	Questionnaire Respondent[1, 2]			
			1, 2	3, 4, 5	6	10
Procurement: Design-Bid-Build (DBB)	80.01	Preliminary Engineering	3	3	4	3
	80.02	Final Design	3	3	5	4
	80.03	Project Management for Design and Constructio	3	3	4	4
	80.04	Construction Administration & Management	3	3	5	4
	80.05	Insurance	3	3	3	3
	80.06	Legal; Permits; Review Fees by other agencies,	3	3	4	4
	80.07	Surveys, Testing, Investigation, Inspection	3	3	5	4
	80.08	Start up	3	3	3	3
Procurement: Design-Build (DB)	80.01	Preliminary Engineering	3	3	5	3
	80.02	Final Design	3	2	3	4
	80.03	Project Management for Design and Constructio	1	2	5	2
	80.04	Construction Administration & Management	2	2	3	2
	80.05	Insurance	2	3	3	3
	80.06	Legal; Permits; Review Fees by other agencies,	2	3	4	2
	80.07	Surveys, Testing, Investigation, Inspection	2	2	4	2
	80.08	Start up	3	3	4	3
Procurement: Design-Build-Operate-Maintain (DBOM)	80.01	Preliminary Engineering	3	N/A	N/A	3
	80.02	Final Design	3	N/A	N/A	4
	80.03	Project Management for Design and Constructio	1	N/A	N/A	2
	80.04	Construction Administration & Management	2	N/A	N/A	2
	80.05	Insurance	2	N/A	N/A	3
	80.06	Legal; Permits; Review Fees by other agencies,	2	N/A	N/A	2
	80.07	Surveys, Testing, Investigation, Inspection	2	N/A	N/A	2
	80.08	Start up	2	N/A	N/A	2
Procurement: Full Turnkey	80.01	Preliminary Engineering	3	N/A	N/A	N/A
	80.02	Final Design	3	N/A	N/A	N/A
	80.03	Project Management for Design and Constructio	1	N/A	N/A	N/A
	80.04	Construction Administration & Management	2	N/A	N/A	N/A
	80.05	Insurance	2	N/A	N/A	N/A
	80.06	Legal; Permits; Review Fees by other agencies,	2	N/A	N/A	N/A
	80.07	Surveys, Testing, Investigation, Inspection	2	N/A	N/A	N/A
	80.08	Start up	2	N/A	N/A	N/A

Notes:
[1] Respondents 3, 4, 5, and 10 provided partial responses due to lack of experience; lack of response is noted as "N/A."
[2] Respondents 7, 8, and 9 did not provide responses and are omitted.

CHAPTER 4

As-Built Soft Cost Analysis

This report has thus far summarized efforts to assess the practice of soft cost *estimation,* as revealed through interviews and a questionnaire of cost estimators. To complement this research, this section examines *actual soft cost expenditures* from past construction projects. This as-built analysis also assesses the relationship between characteristics of transit infrastructure projects and actual soft cost expenditures for as-built projects.

4.1. Approach

This analysis has three major objectives:

- Describe the magnitude and range of soft cost expenditures in previous projects;
- Analyze the relationship between these soft costs and other project characteristics as cost drivers, such as project complexity, mode, year, size, delivery method, and economic conditions; and
- Form the ultimate basis of a new historically based methodology to estimate soft costs for future rail transit construction.

4.2. Data Source: FTA Capital Cost Database

To examine historical costs, this analysis used as-built cost data and characteristics on 59 urban rail transit projects constructed over the past four decades in the United States. This cost data has been adapted from the capital cost databases developed for the FTA. In addition to this dataset, this study also relied on project schedule data adapted from the final report of TCRP Project G-07, *Managing Capital Costs of Major Federally Funded Public Transportation Projects* (Booz Allen Hamilton Inc., 2005), and developed some additional data on project characteristics such as public involvement, installation conditions, and sponsor agency capitalization policies.

4.2.1. About the Projects Included

The projects included in this database were constructed by transit agencies in major urban centers and distributed throughout the various geographic regions across the United States. Over the period of 1984 through 2008, 29 light rail projects were constructed, and 30 heavy rail projects date from 1974 through 2005. This project cost database includes the costs of 59 projects of various sizes, ranging from $100 million to over $2 billion, and represents new rail line segments, extensions of existing networks, and several rehabilitation and replacement projects. This wide range of rail projects provides a good distribution of projects to examine the soft cost requirements needed in their development and offers a reasonable representation of the requirements for professional services and soft costs for passenger rail construction in the United States.

4.2.2. About the Cost Data Format

All project expenditures are reported in standardized formats for individual light and heavy rail project segments. The light rail database reports as-built costs in the same format as the Federal Transit Administration's current SCCs, while the heavy rail data is reported using a prior SCC format. Both formats use common element definitions and consistent structures to document the as-built costs of these passenger rail projects. Costs were adjusted to an average of the 38 largest U.S. metropolitan areas and then escalated to a common base year of 2008 using *Means Construction Cost Index* (Murphy, 2008) for this consistent dollar value.

The cost categories for these two datasets are listed below in Table 12 using the present FTA SCC category format in order at left and the corresponding heavy rail categories at right.

Most capital cost categories examined in this section are comparable between the two data structures, with minor exceptions. In addition, this analysis took several steps to prepare and standardize the cost data:

1. All dollar costs were inflated to constant 2008 dollars;
2. All dollar costs were adjusted for local–national cost variations using the *Means Construction Cost Index* (Murphy, 2008); and
3. Outlier data points were eliminated.

The details of these adjustments can be found in Appendix C.

4.2.3. Project Development Schedule Database

The project development schedules used in this analysis have been adapted from the results of the contractor's final report from TCRP Project G-07 entitled *Managing Capital Costs of Major Federally Funded Public Transportation Projects* (Booz Allen Hamilton Inc., 2005). The G-07 report examined the various strategies, tools, and techniques available to better manage major transit capital projects and developed another separate project development schedule database to examine project schedule delays and their impacts on project costs. The evaluation of soft costs relies on Project G-07's schedule database to measure the relationship between project schedule and soft costs incurred.

4.2.4. Drivers Tested

Table 13 presents the non-financial data items that are tested here as potential cost drivers for actual soft cost expenditures. Some of these results are shown in Appendix C.

Table 12. Light and heavy rail capital cost categories correspondence table.

Light Rail	Heavy Rail
10 Guideway and Track Elements	1.00 Guideway Elements
20 Stations, Stops, Terminals, Intermodal	4.00 Stations
30 Support Facilities: Yards, Shops, Admin.	2.00 Yards and Shops
40 Sitework and Special Conditions	6.00 Special Conditions
50 Systems (Signals, Power, Communications)	3.00 Systems
60 ROW, Land, Existing Improvements	7.00 Right-olf-Way
70 Vehicles	5.00 Vehicles
80 Professional Services (Soft Costs)	8.00 Soft Costs
90 Unallocated Contingency	
100 Finance Charges	

Table 13. Project characteristics tested as cost drivers.

Mode
Guideway length (linear feet)
Percentage of guideway below grade
Percentage of guideway not at grade
Percentage of guideway at grade
Percentage of guideway at grade (incl. built-up fill and retained cut)
New line/extension of existing line/rehabilitation
Procurement or delivery method (design–build, etc.)
Midpoint of expenditures (year)
Planning/draft environmental impact statement (DEIS) midpoint (year)
Preliminary engineering/final environmental impact statement (FEIS) midpoint (year)
Final design midpoint (year)
Construction midpoint (year)
Revenue service begins (year)
Number of stations
Total project cost estimated at preliminary engineering
Total project cost – actual
Economic conditions at estimated bid date (U.S. GDP growth)
Experience level of sponsor
Installation conditions (active service, no active service, etc.)
Public or political involvement
Use of contractors in management or development
Unusual delays in project planning phases
Agency tendency to minimize capital charges

4.3. Potential Issues in Soft Cost Categorization

As described in Chapter 2, this project considers soft costs to be equivalent to professional services as defined in FTA's Standard Cost Category 80, Professional Services, in the *Standard Cost Category Workbook* (U.S. FTA, 2008). Refer to Section 1.3 for a definition of soft costs. According to the FTA definitions, however, other SCC categories besides Category 80 may contain expenditures that may be very similar to soft costs. This analysis has addressed these cases as follows:

- Construction costs (Categories 10 through 50) contain some indirect costs that could be considered soft costs, such as project and construction supervision, general conditions, contractor's general liability, insurance, overhead, and profit, plus comparable subcontractors' costs. Because these soft costs are more associated with direct construction functions, they are treated as hard construction costs.
- ROW, Land, Existing Improvements (Category 60) may include professional services associated with the real estate component of the project such as agency staff oversight and administration, real estate and relocation consultants, assessors, legal counsel, court expenses, and insurance. These costs have been considered separately in this analysis.
- The Vehicles category (Category 70) includes supporting services associated with the vehicle procurement aspect of the project. These costs may include agency staff oversight and administration, vehicle consultants, design and manufacturing contractors, legal counsel, and warranty and insurance costs that, like real estate soft costs, have been considered separately in this analysis.
- Unallocated Contingency (Category 90) includes some costs that could depend on other costs. These costs are essential to cost estimates in earlier project phases, but by the completion of the project, these costs are zero in the as-built cost. This cost category was therefore excluded from this soft cost analysis.
- Finance Charges (Category 100) contains costs that could be considered soft costs. These financing charges have been excluded from this analysis of soft costs because these costs are more project specific and depend on the availability of funding. They have more in common with the financing plan than the overall project development process.

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Table 14. Capital cost definitions of soft cost analysis terms.

Term Used Here	Light Rail Cost Categories Applied from Table 12	Heavy Rail Cost Categories Applied from Table 12
Soft costs as % of total costs	[80] ÷ ([10] + [20] + [30] + [40] + [50] + [60] + [70])	[8] ÷ ([1] + [2] + [3] + [4] + [5] + [6] + [7])
Soft costs as % of construction costs	[80] ÷ ([10] + [20] + [30] + [40] + [50])	[8] ÷ ([1] + [2] + [3] + [4] + [6])
Vehicle costs	[70]	[5]
ROW costs	[60]	[7]
Engineering soft costs	[80.010] + [80.020]	[8.02] + [8.03]
Management soft costs	[80.030] + [80.040]	[8.03] + [8.04] + [8.05] + [8.06]

This analysis uses terminology that implies certain groupings of cost categories from the two datasets for light and heavy rail. The numerical definition of these groupings is presented in Table 14. Project year in this analysis means the midpoint of expenditures, derived as the average year of expenditure for each individual cost element, weighted by expenditure amount. Other schedule years used in the analysis to denote project phases (e.g., preliminary engineering, design, construction and operations) mean the midpoint of that phase within the project schedule.

This analysis relies on FTA's prior categorization of costs for projects constructed prior to the current SCC structure and clarifying guidance. Therefore, users of this analysis must be mindful of potentially inconsistent classification of costs within the data. This is because of a number of possible reasons, including:

- Inconsistent reporting across agencies
  - At a basic level, some judgment is required to classify specific expenditures within the SCC structure, even with the available guidance from FTA. Broad categories such as the demarcation between vehicle and systems costs are likely to be more consistently comparable among the reporting agencies, while detailed cost items such as the difference between "Project Management for Design and Construction" and "Construction Administration and Management" are likely more susceptible to inconsistencies in reporting definitions. Since this dataset includes projects from across the country and across decades of construction, the data may be susceptible to some level of inconsistent definitions of cost categories.
  - Of particular relevance to this study is the reporting of professional service soft costs for vehicles and rights-of-way. These were initially reported into a database structure that was unclear about some of these related vehicle and right-of-way soft costs. More recent database structure and instructional guidance expressly defines the cost elements for vehicle and right-of-way soft costs. These more category-specific soft costs have been segmented from this analysis of construction-related soft cost.
- Refinements to the cost structure
  - The structure of FTA's SCC capital cost database has evolved over the past 20 years. This evolving framework for the cost data and varying levels of detail directly and indirectly affect some of the more detailed reporting and thereby the resulting relationships.
  - The FTA Standard Cost Categories have clarified the right-of-way and vehicle cost categories to include those categories related to soft costs. However, prior structures may not have been as clear and vehicle and right-of-way associated soft costs could be mixed into the general soft cost category.
- Agency capital program policies
  - The financial and administrative policies of the sponsoring agency can affect how soft costs are reported for a capital project, which could affect the amount and proportion of soft costs

when comparing projects across agencies. For example, staff and contractor soft cost charges can be funded through separate grants and are not always reported into the project budget.

- The salaries of some agency staff who support engineering, design, and/or construction may be treated as an operating expense rather than charged to the capital project.
- Early planning and preliminary engineering costs may be charged to a general planning grant rather than attributed directly to the capital project.
- Insurance may be carried by the construction contractor or the sponsor agency, and/or it may be embedded into individual cost elements as an overhead cost.

• Project delivery mechanism
  - The varying methods of project development and procurement present unique challenges to the breakdown and classification of project costs because cost classification can depend on institutional perspective. Sections 3.5 and 4.5.3 discuss this issue more thoroughly.

4.4. Historical Soft Costs

This first portion of the soft cost analysis presents the general breakdown of project soft cost attributes within the as-built project cost database. Total project costs are described using the following categories: Soft, Vehicle, and Construction costs. Soft costs are then examined as a proportion of the Construction Costs category and then further examined by individual soft cost components.

4.4.1. Describing the Data

As shown in Figure 13, construction costs made up the largest share of expenses for most projects, vehicle costs range from 0 to 25% of total project cost, ROW costs 0 to 20%, and soft costs 10 to 35%. While all projects incurred construction and soft costs, some projects had no ROW or vehicle procurement costs. For example, the extension of Bay Area Rapid Transit (BART) to San Francisco International Airport (SFO) required the purchase of no additional vehicles, while the extension of the CTA's Blue Line to O'Hare Airport did not entail right-of-way costs. Professional services for the many varied rail transit capital projects in this database usually accounted for around 10–35% of total project costs. This pattern forms the focus of the more detailed segmentation of these costs, presented briefly here and in more detail in Appendix C.

Figure 13 illustrates soft costs, with light bars at the top, expressed as a percentage of total costs. To measure soft costs in a more commonly used format, Figure 14 shows soft costs as a percentage

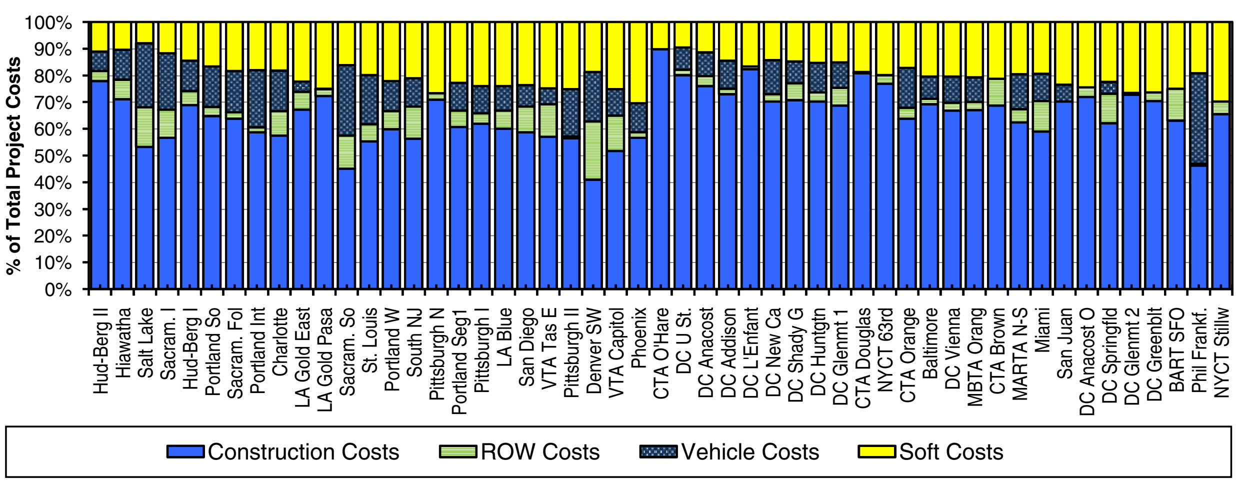

Figure 13. Project costs by category.

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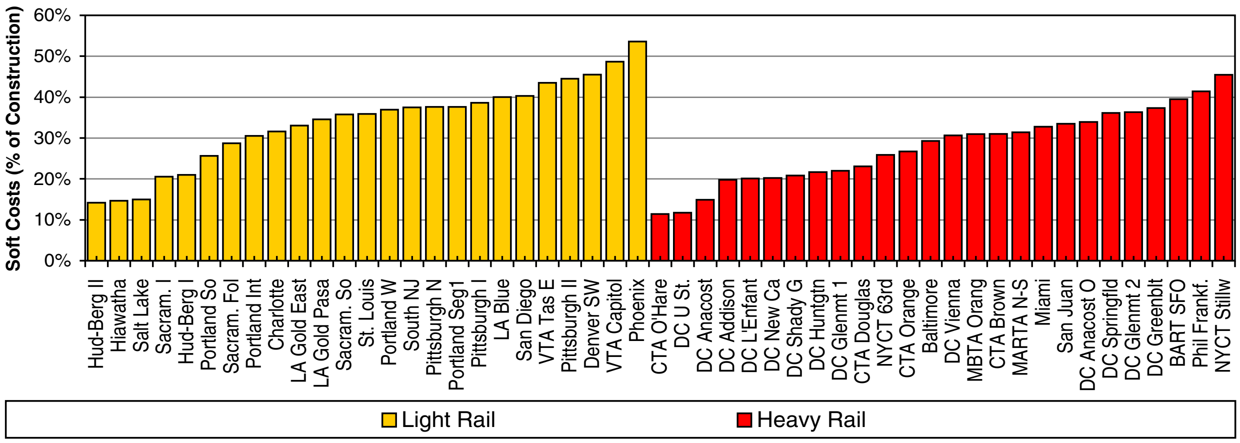


Figure 14. Soft costs percent of construction costs by project and mode.

of construction costs for these same projects. Construction costs include all of the guideway, trackwork, facility, station, systems, sitework, and special conditions costs (refer to Table 14). When expressed as a percentage of construction costs, soft costs vary considerably more across these same projects than when expressed as a percentage of the total cost—from 11% to a high of 54% of construction costs.

Expressing soft costs as a percentage of construction costs is pertinent to this analysis since soft costs associated with the vehicle and right-of-way costs are expressly defined as a separate cost element in each of those associated cost categories. This relatively wide range in soft costs as a percentage of construction costs merits further examination.

Note that in Figures 14 through 18, 20, and 22, the historical projects are ordered in terms of increasing soft costs as a percentage of construction costs, with separate ordering for light rail and heavy rail projects.

To explore the wide range in this soft cost measure, the individual cost components that compose total soft costs were analyzed. Total soft costs can be segmented into six major components, as defined in the FTA SCC structure:

- Preliminary Engineering,
- Final Design,
- Project Management for Design and Construction,
- Construction Administration and Management,
- Insurance, and
- All Other Soft Costs in SCC 80.

These six soft cost components are shown as a percentage of construction costs in the bar chart in Figure 15. The total percentages are consistent with those presented above in Figure 14. The six components are expressed as a percentage of overall soft costs in Figure 16, where the bar chart for each project totals 100%.

The components of soft costs appear to vary considerably across projects, especially as a proportion of overall soft costs. For example, preliminary engineering costs (bottom measure and dark aqua in Figure 15 and Figure 16) are a very small or near-zero proportion of soft costs for some projects, while for others (e.g., Hudson-Bergen Phase 1, Phoenix) these costs are significant expenditures. In projects with little or no reported preliminary engineering costs, there was likely either a missing expenditure or it was rolled into a combined grant with another soft cost component. Insurance can account for almost 10% of construction costs (e.g., CTA Douglas Branch) for some projects, or none at all for others. This may be due to different agencies'

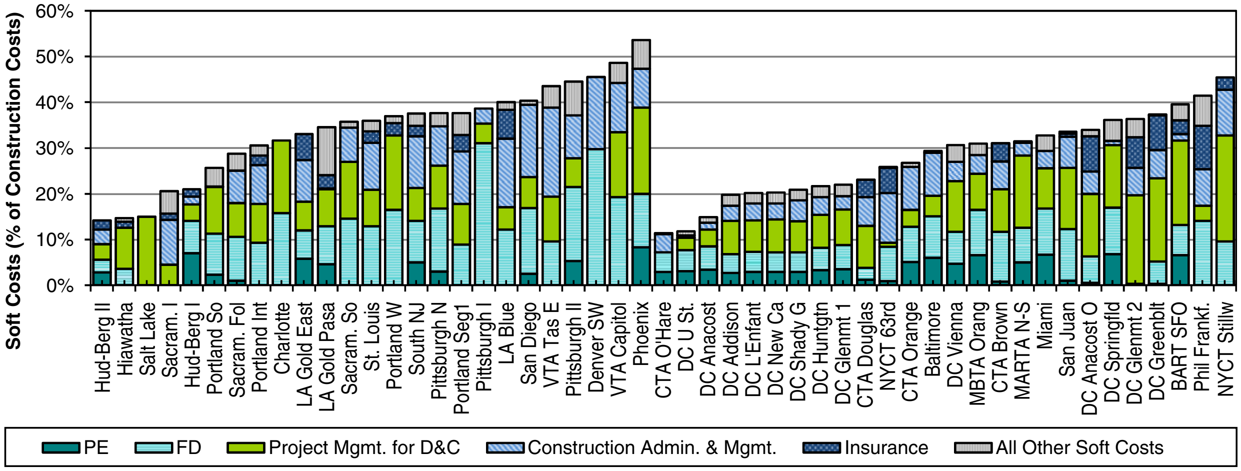


Figure 15. Soft cost components as a percentage of construction costs.

approaches to project development, where one agency may provide project-wide wrap-up insurance and others may require each contractor to provide their own insurance, or some combination of these. In general, individual variances may be due to real differences in expenses incurred as a result of project characteristics, while some variation is probably due to the way in which costs are reported or categorized. The more consistent soft cost components were final design, project management, and construction management.

Some projects appear to have inconsistencies in the reported soft cost experience that may indicate questionable data. For example, some projects show zero engineering or design costs, which is unlikely given the complexity of constructing major transit capital projects. In these cases, expenditures may have been classified elsewhere in the SCC structure or charged to a separate, off-project funding source and not reported into the project budget.

In subsequent analysis in this report, certain outliers were omitted from the more detailed analyses to eliminate the effect of these uncertain data. The decision to remove an outlier was based on analyzing the distribution of projects' soft costs, and is more fully described in Section C.4 in Appendix C.

Figure 17 shows the average soft cost percentages by component for all projects in the dataset (outliers excluded) and the range of percentages encountered. The bars represent average soft-cost

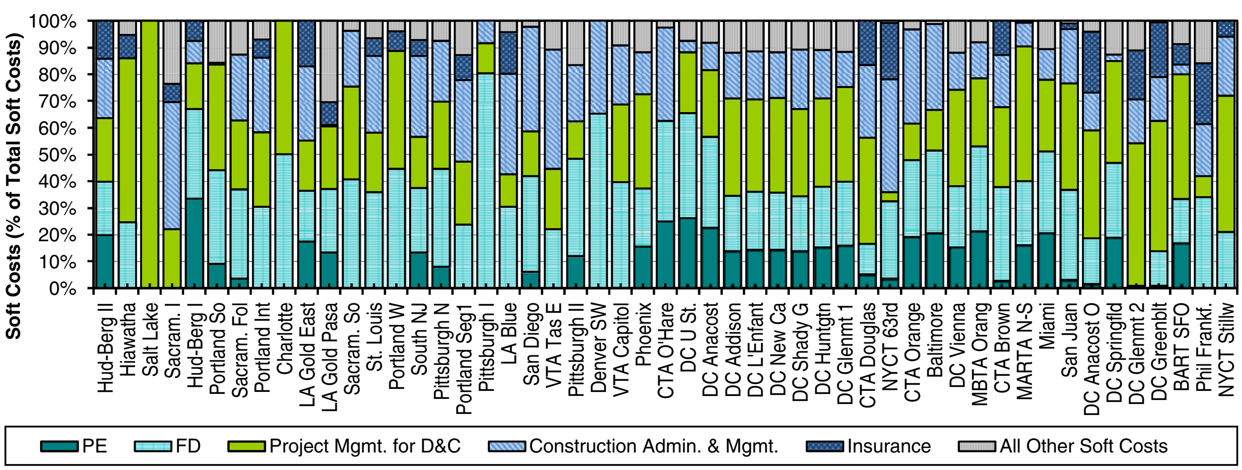
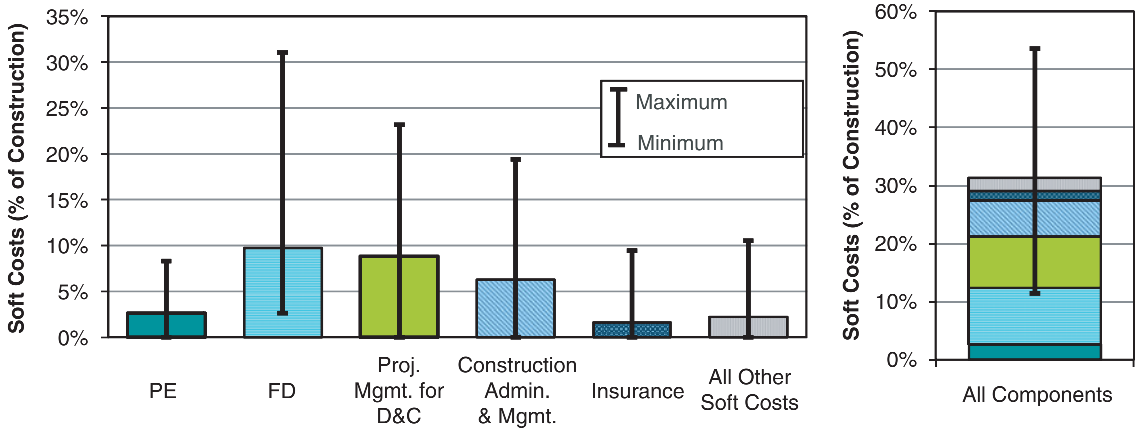


Figure 16. Soft cost components as percentage of total soft costs.



Soft Costs as % of Construction

	PE	FD	Proj. Mgmt. for D&C	Construction Admin. & Mgmt.	Insurance	All Other Soft Costs		All Components
Average	2.7%	9.7%	8.8%	6.3%	1.6%	2.2%		31.3%
Minimum	0.0%	2.6%	0.0%	0.0%	0.0%	0.0%		11.4%
Maximum	8.3%	31.0%	23.2%	19.4%	9.4%	10.5%		53.6%

Figure 17. Average and range of soft cost components as percent of construction.

component expenditures, and the lines indicate the maximum and minimum values in the dataset. For instance, the average project incurred final design expenses of 9.7% of construction costs, but this percentage ranged as low as 2.6% for one project and as high as 31.0% for another. Most categories contained projects with zero expenditures for that category, resulting in the minimum of the range being zero.

Figure 17 also shows that when all components are combined, projects show average soft costs of around 31% of construction costs. However, the range of total soft costs has been as low as 11.4% for one project and as high as 53.6% for another project, after excluding outliers.

To test the hypothesis that soft-cost component costs may have been inadvertently assigned and reported to a related soft cost component, the analysis grouped some related soft cost components and subtotaled them into the following three soft-cost component categories:

- Pre-construction costs (design and engineering),
- Construction expenditures (construction management, administration, etc.), and
- Other costs (insurance, others).

Although an approximation of these project development phases, this broad categorization produces the results displayed in Figure 18 (as a percentage of construction costs) and Figure 20 (as a percentage of total soft costs).

A more consistent soft cost basis appears to emerge from the analysis when soft cost components are grouped by these categories, which approximates the project development phase in which the expenditures were incurred. Figure 19 shows the averages and ranges of these three groups of soft cost components, expressed as a percentage of construction costs. This figure indicates that a typical project incurs preliminary engineering and final design costs of 12.4% of construction, and construction management and project administration soft costs of 15.1% of construction, but that these percentages can range from around 3% to 33% for some projects.

When expressed as a percentage of total soft costs as shown in Figure 20, the resulting cost proportions are more consistent. About 40–50% of soft costs are generally related to engineering and final design, another 40–50% of soft costs are related to construction management and administration, and about 10% are other costs. The first two of these three categories (engineering and final design, and construction management and administration) are sometimes used in subsequent analysis in this report.

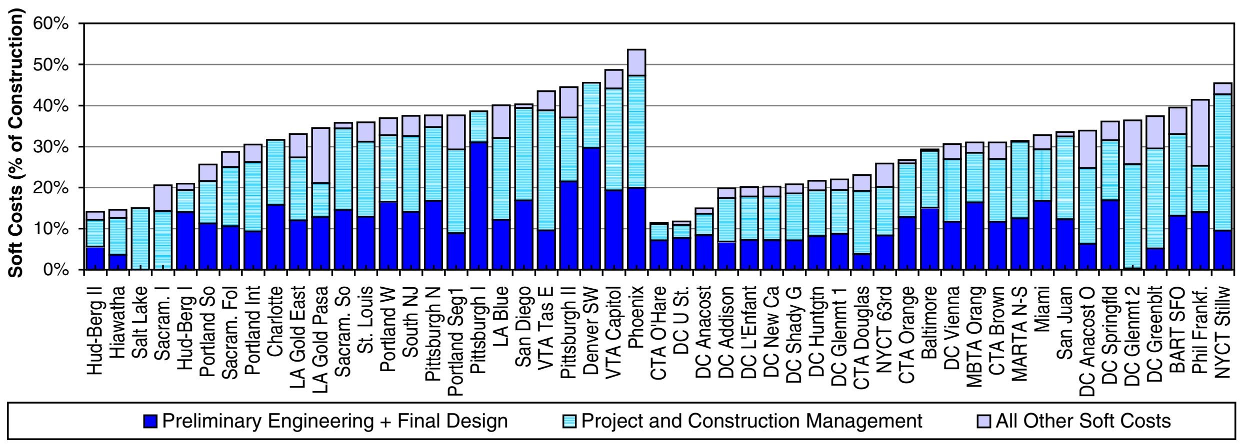
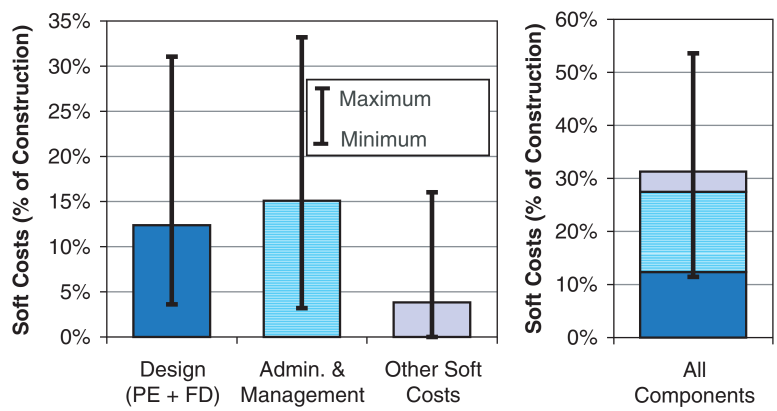


Figure 18. Subtotaled soft cost components as a percentage of construction costs.



Soft Costs as % of Construction

Average	12.4%	15.1%	3.8%		31.3%
Minimum	3.6%	3.2%	0.0%		11.4%
Maximum	31.0%	33.2%	16.0%		53.6%

Figure 19. Average and range of subtotaled soft cost components as a percentage of construction.

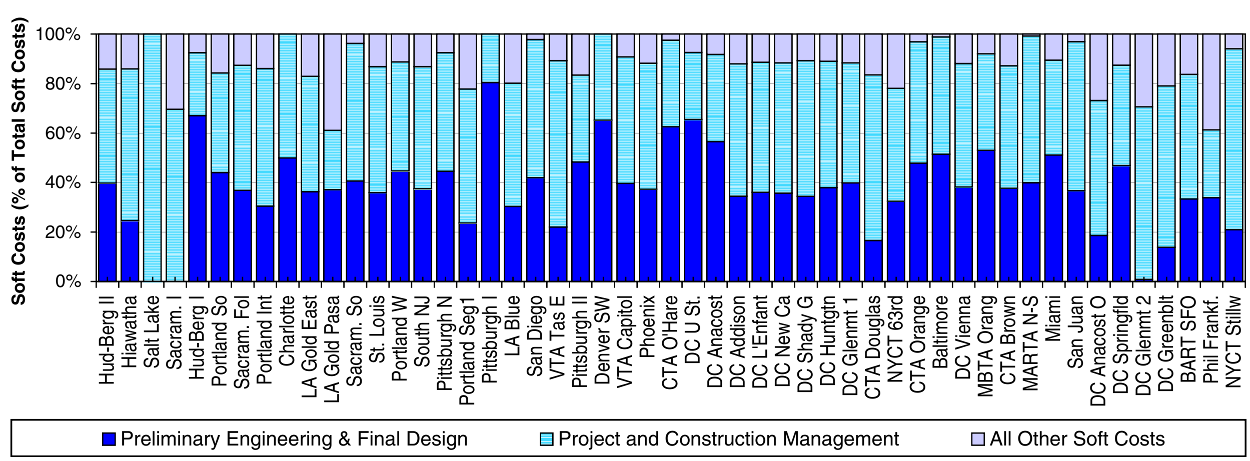


Figure 20. Subtotaled soft cost components as a percentage of total soft costs.

4.4.2. Measuring Soft Costs

Developing a guidebook on the estimation of soft costs requires the identification of specific measures. This section tests a number of different ways to measure soft costs and explores how each may be used in a guidebook context. Soft costs of as-built projects can be measured in the following ways:

- As a percentage of total project cost;
- As a percentage of all other costs, excluding only soft costs;
- As a percentage of construction costs;
- In constant dollar value terms; or
- In constant dollars per linear foot of constructed guideway.

This analysis does not rely on the first and fourth measurements on this list. Figure 13 above showed soft costs as a percentage of total project cost, and this measurement is sometimes used to describe soft costs. However, measuring soft costs as a percentage of total project cost is not an appropriate metric for a cost estimator since the estimator does not know total project cost until the soft cost estimate is complete. Soft costs may also be expressed in dollar value terms, but this measure would fail to account for differences in project size across the dataset. Therefore this analysis focuses on measuring soft costs as a percentage of all other costs, as a percentage of construction costs, and in dollars per linear foot of guideway.

Figure 21 compares measuring soft costs as a percentage of all other total costs (i.e., all other costs besides soft costs themselves) and as a percentage of construction costs (i.e., excluding vehicle and right-of-way costs) and shows that these two percentage-based methods of measurement are highly correlated. This applies to both light and heavy rail modes and the combined analysis of projects of both modes. These results suggest that ROW and Vehicle category costs (those that are excluded when measuring construction costs only) have a relatively small effect on soft costs. This may indicate that their related soft costs (ROW and Vehicle category costs) have been accurately accounted for within each of these categories.

Measuring soft costs per linear foot is another way to measure soft costs. To test the quality of this measure, all project costs were normalized by applying the national average metropolitan area *Means Construction Cost Index* (Murphy, 2008) and then inflating to 2008 dollars. Significant project outliers were excluded from this analysis to focus on the more consistent results. Figure 22 shows this measurement for all included projects.

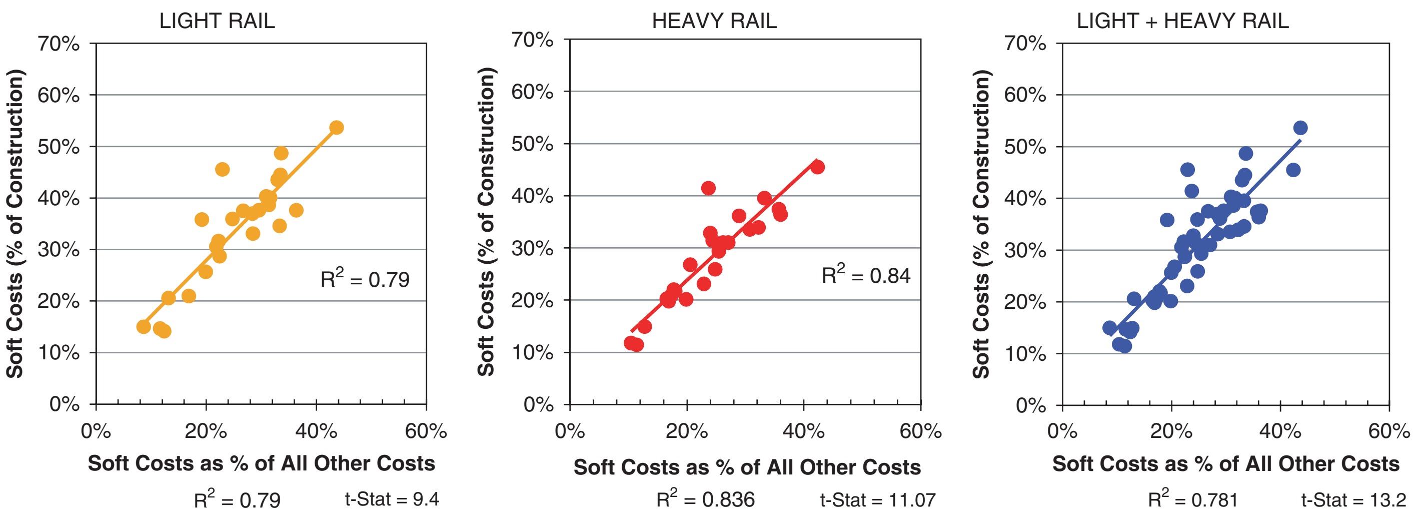


Figure 21. Soft cost percentage of construction costs versus soft cost percentage of total other costs.

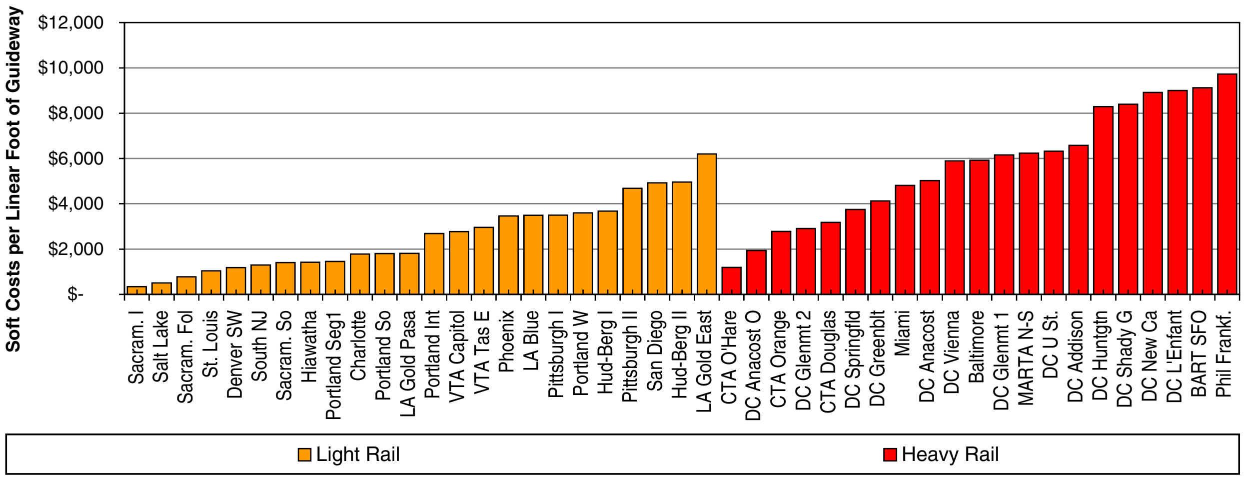
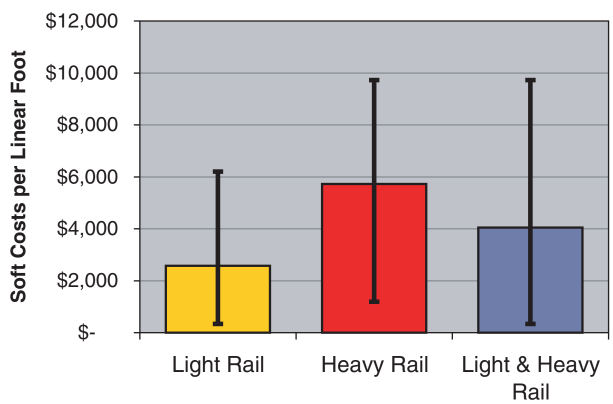


Figure 22. Soft costs per linear foot of constructed guideway by project and mode.

Soft costs on a per-linear-foot basis vary considerably, even with the removal of outliers, from less than $1,000 to nearly $10,000 per linear foot (all costs in 2008 dollars). Specifically, light rail projects averaged $2,572 per linear foot, heavy rail $5,726, and all projects combined $4,044 per linear foot, as shown in Figure 23. The range for soft costs in light rail is somewhat less than for heavy rail projects.

In general, soft costs tend to be higher for heavy rail, consistent with the generally higher cost of heavy rail overall. The soft cost per linear foot measure appeared to offer some consistency with the range estimates noted above. The next step in the analysis was to see if there was any relationship with the soft cost percentage of construction. Figure 24 compares the measurement of soft costs as a percentage of construction cost and as a dollar value cost per linear foot.

As Figure 24 indicates, measuring soft costs as a dollar-value cost per linear foot versus a percentage of construction cost would not yield similar results. The heavy rail projects have a somewhat better relationship that may indicate a greater relationship of increasing complexity of the heavy rail projects with greater soft cost requirements.



Soft Costs per Linear Foot

	Light Rail	Heavy Rail	Light & Heavy Rail
Average	$ 2,572	$ 5,726	$ 4,044
Minimum	$ 335	$ 1,191	$ 335
Maximum	$ 6,201	$ 9,728	$ 9,728

Figure 23. Average and range of soft costs per linear foot of constructed guideway.

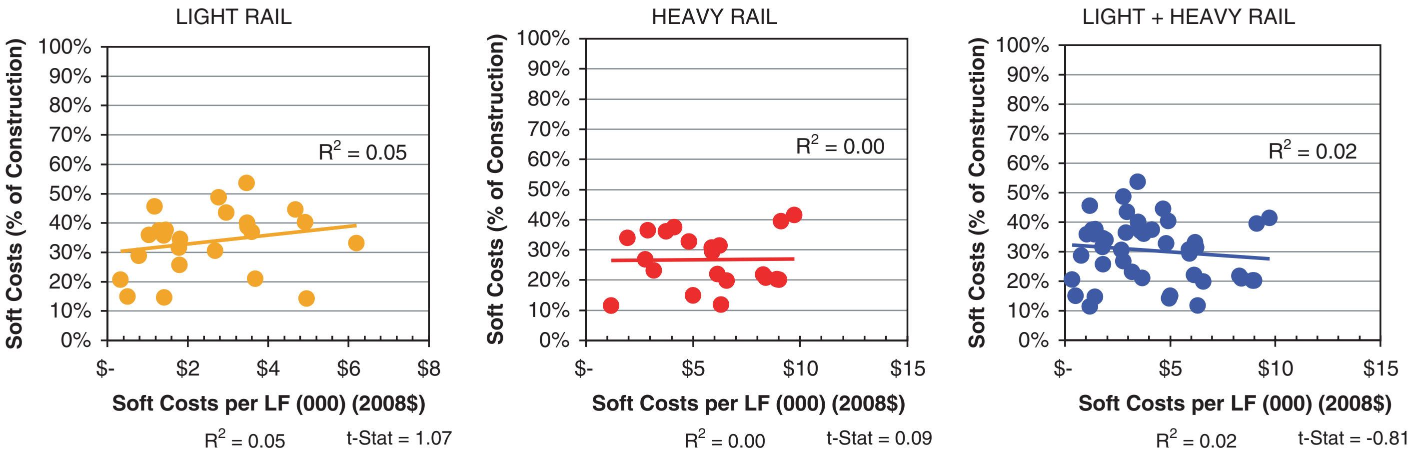


Figure 24. Soft costs as a percentage of construction versus soft cost per linear foot of constructed guideway.

It is unclear from these initial analyses which basic measurement of soft costs (percentage or dollar value terms) is most appropriate. Therefore this analysis shows results with both unless one measure appears more appropriate given the circumstances.

4.5. Relationships between Cost Drivers and Historical Soft Costs

This section tests the relationship between various project characteristics such as mode, alignment, and year (detailed above in Table 13) and actual soft cost expenditures. This research took two approaches to measuring how soft cost drivers have impacted actual soft costs:

- **Univariate testing of soft cost drivers suggested in interviews and the questionnaire.** First, this research began by creating a series of scatter diagrams comparing soft costs with the kinds of project characteristics that estimators currently use to choose higher or lower soft cost percentages. This kind of analysis tests only whether one project characteristic alone influences soft costs. As the results below demonstrate, some of these tests showed that soft costs are correlated with certain project characteristics, while other tests yielded less conclusive results. Many of the less conclusive results are presented in Appendix C. These single-variable results served to guide the research into the next phase described in Section 4.5.7.
- **Multivariate testing of combinations of soft cost drivers.** Second, this research tested a multitude of combinations of soft cost drivers and their effect on soft costs in a multivariate regression. Project characteristics were the independent variables, and soft costs as percent of construction costs acted as the dependent variable. After several hundred tests, a single multivariate regression was developed that can explain approximately 60% of the differences in soft cost percentages by variations in project characteristics ($R^2 = 0.58$), as will be described later. This kind of analysis tests the cumulative effect of how changes in a variety of project attributes have affected resulting soft costs.

4.5.1. Assembling Data on Soft Cost Drivers

A set of characteristics was gathered for the projects to help identify cost relationships, including the following:

- Physical attributes, such as alignment length, profile (e.g., below grade, at grade, aerial), number of stations, or whether the project initiated new service or extended an existing line.

- Installation conditions, such as whether the project interacted with other active rail transit lines.
- Schedule information, including major milestones in the project lifecycle for a subset of projects in the dataset. While each project had a midyear of expenditure, only some projects had full schedule data available.
- Characteristics of the project sponsor, such as experience level, internal policies on capital costs, and use of outside contractors.
- The context of the project development process, such as the level of public involvement, delivery method, or whether a significant redesign was necessary.

For these last two types of characteristics, the definition and determination of values required some judgment based on knowledge of those projects' development process.

Many measures were derived from this primary dataset that were intended to act as a proxy to capture other project characteristics, such as project magnitude (e.g., construction costs per linear foot), complexity (e.g., percent of alignment below grade), unique circumstances (e.g., real estate acquisition costs, project occurred prior to certain federal requirements), and many others.

4.5.2. Soft Costs by Mode and Year

Figure 25 shows the average soft costs as percentage of construction costs across modes and by decade. The amount spent on soft costs appears to vary little depending on mode, as indicated in the left pane. Light rail projects averaged 33.8%, heavy rail projects averaged 28.0%, and the combined database projects averaged 30.9% of soft cost percentage of construction.

Soft costs have been rising over time since the 1970s. The right pane of Figure 25 shows that on average, soft costs for both heavy and light rail have recently amounted to approximately 34.6% of construction costs, and this figure is an increase from about 21.4% three decades ago.

4.5.3. Soft Costs by Project Delivery Method

Project delivery method or procurement strategy also appears to affect expenditures on soft costs. Although most projects in the dataset were delivered via a DBB methodology, evidence for light rail projects indicates that DB projects have lower soft costs, as shown in Figure 26. With only nine design–build projects and one construction management/general contractor (CM/GC) project out of all database projects, these findings need to be considered within the limitations caused by the small sample size.

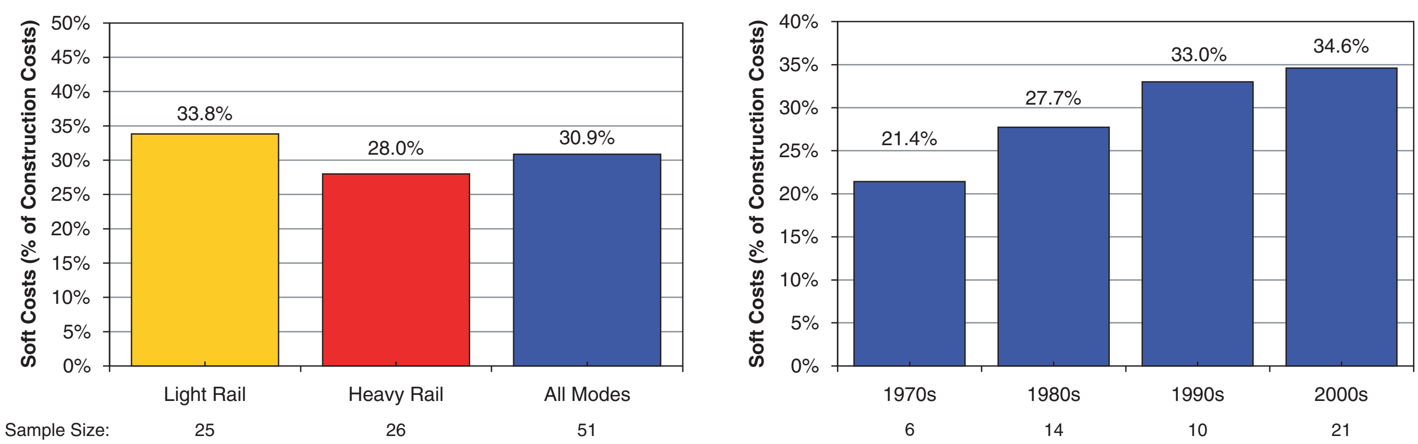


Figure 25. Average soft costs by mode and by decade.

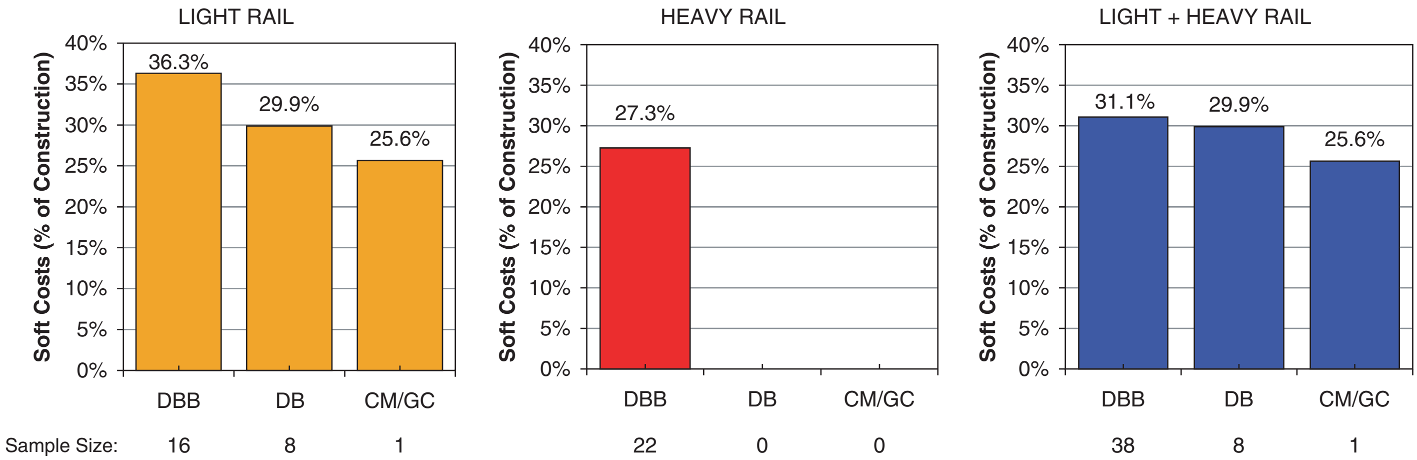


Figure 26. Soft costs as a percentage of construction versus project delivery method.

Projects selected for design–build delivery method may be chosen for their simplicity, however, so care should be exercised when considering the above chart. An agency may choose to advertise for design–build projects that would incur low soft costs regardless of delivery method. The Hudson-Bergen project, for example, was delivered with a design–build contract, which may have contributed to lower soft costs. Alternatively, design–build contractors may classify soft costs in different ways than a public agency (e.g., in the construction line item), which might make soft costs appear lower.

One of the problems with these delivery methods is that they are not yet very common in the United States, and transit agencies may not fully understand them. Some transit agencies may award a design–build or other alternative delivery contract but then continue to perform engineering work in a more traditional project delivery mode, unknowingly duplicating soft costs.

4.5.4. Soft Costs by Project Development Schedule

Figure 27 shows the effect of pre-construction duration (from planning/DEIS to construction phases) on soft costs in dollar terms. Total soft costs are presented in the left pane, and engineer-

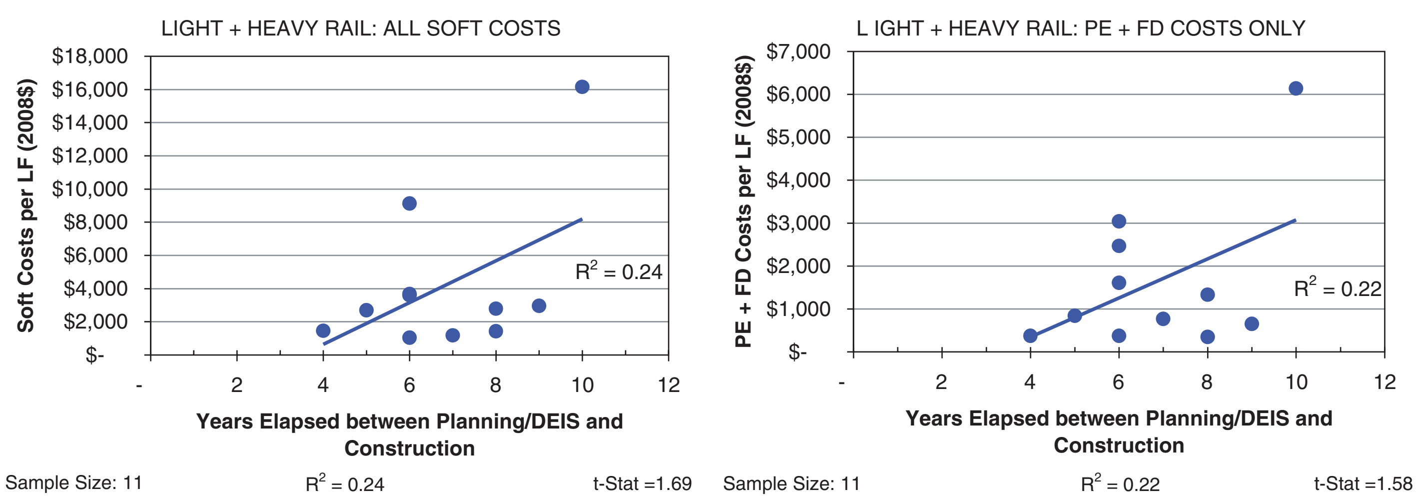


Figure 27. Soft costs per linear foot versus years elapsed between completion of the draft environmental impact statement and construction.

ing costs (preliminary engineering and final design) are presented in the right pane. In the left pane the results are pronounced, from zero soft cost at 4 years to a maximum of about $16,000 per linear foot at about 15 years between the DEIS completion and construction. This relationship holds for engineering soft costs as well, as shown in the right pane.

This finding seems to suggest that the duration of pre-construction phases should be considered within the estimate of soft costs. However, the findings in Figure 27 may simply show that costly projects take longer to plan and design. The relatively small sample size (11) and the role of one relatively costly project in this chart should be recognized in a careful consideration of these findings.

4.5.5. Soft Costs by Project Complexity

The remainder of the univariate analysis focuses on project characteristics that address complexity (such as percentage of guideway not at grade), number of stations, and other factors and the impact of these characteristics on soft costs. In general, indicators of complexity tend to correlate well with soft costs when measured in dollar terms per linear foot. Many of these relationships where soft costs are measured as a percentage of construction costs are presented in the appendices. The following figures compare soft cost percentages to the project's alignment profile and typify many of the other results addressing project complexity.

The alignment profile of new rail construction can substantially influence the technical complexity of the project. In the proposed hypothesis, as the proportion of guideway that is not at grade (in tunnels, on aerial structures, etc.) increases, complexity increases, and soft costs may increase likewise. In the first part of this analysis, "not at grade" is defined as an aerial structure, built-up fill, underground cut and cover, underground tunnel, or retained cut or fill guideway. Figure 28 shows little correlation between the proportion of alignment not at grade and soft costs as a percentage of construction costs. The light rail soft cost percentage is flat at about 40%, while heavy rail shows an increasing trend in the soft cost percentage from 25% to about 35%. The combined project database is flat at about 38%. The statistical trend line for all three relationships shows a very weak correlation (R^2 less than 0.04), and all relationships are statistically insignificant.

The issue of project complexity can be examined in another way, by measuring soft costs in terms of dollar per linear foot. Figure 29 expresses soft costs in dollars per linear foot and shows that soft costs indeed rise as greater portions of the alignment are not at grade.

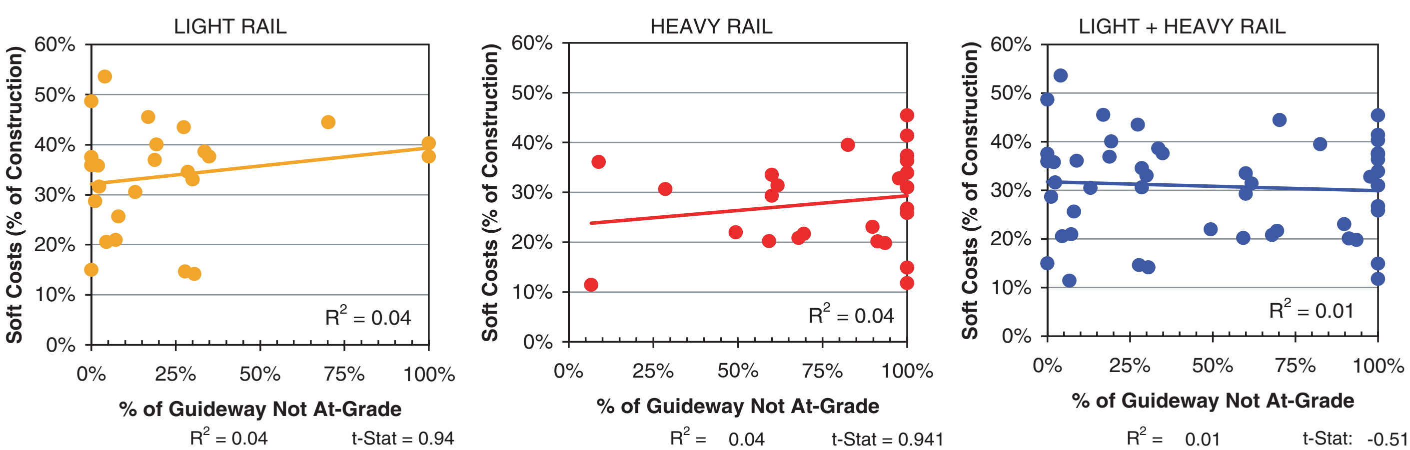


Figure 28. Soft costs as a percentage of construction versus percentage of guideway not at grade.

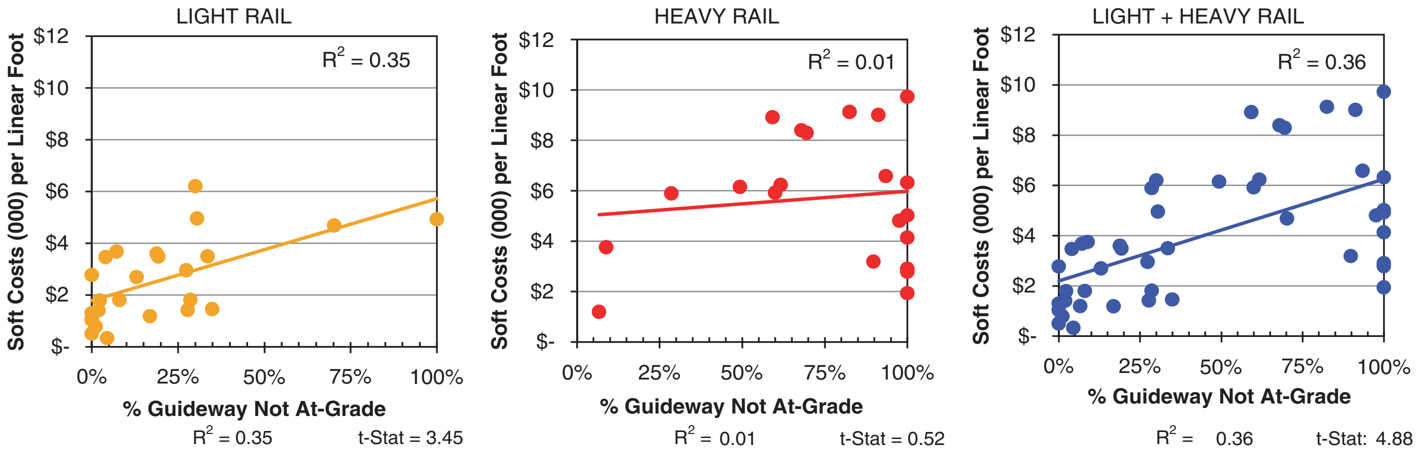


Figure 29. Soft costs per linear foot versus percentage of guideway not at grade.

As Figure 29 shows, the relationship between the percent of guideway not at grade and soft costs per linear foot is statistically significant for light rail, and for both modes combined, but not for heavy rail alone. Indeed, the R^2 value for light rail indicates that the proportion of guideway not at grade can explain about half of the variation in soft costs per linear foot for heavy rail projects. As the not-at-grade percentage of the projects increase, the soft costs as measured in dollar value terms per linear foot increase.

So while the dollar value of soft costs does measurably increase with project complexity as shown in Figure 29, the pattern is not significant enough to increase soft costs in percentage terms, as demonstrated in Figure 28.

Although it is tempting to measure soft costs in dollar value terms because this measure produces more correlation with complexity variables, it is worth exploring the measure further. One benefit of measuring soft costs in percentage terms is that the measure controls for variations in unit costs. Soft cost requirements of more expensive projects can be consistently compared to inexpensive projects in percentage terms. Measuring soft costs in dollars-per-linear-foot terms risks autocorrelation between unit costs—high soft costs could be correlated with higher other costs. In general, Figure 30 tends to confirm this hypothesis: in dollar terms, soft costs increase proportionately to construction costs. The correlations shown are strong and statistically signif-

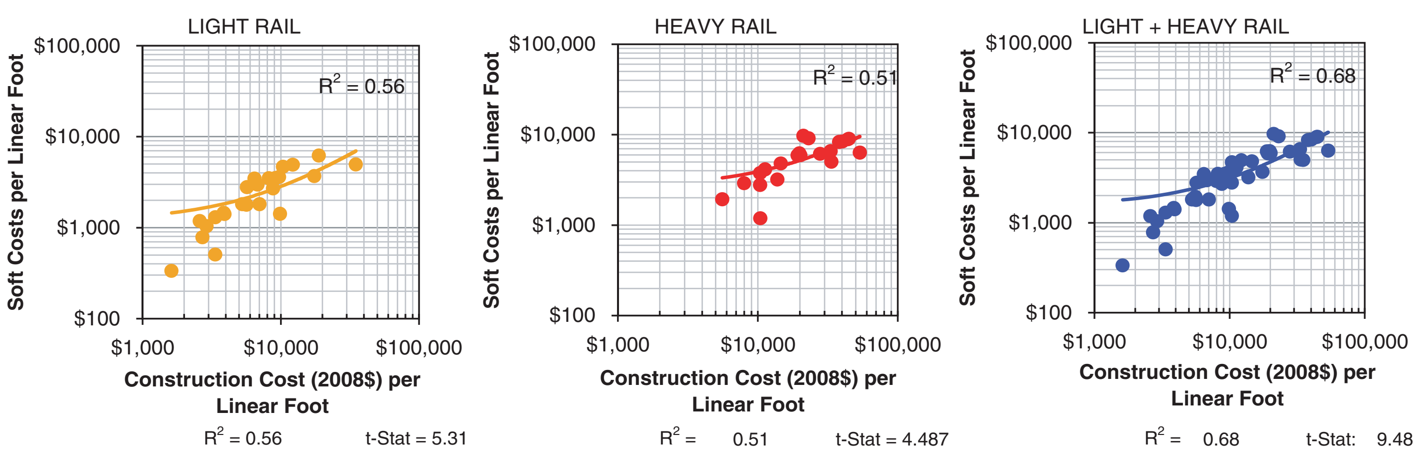


Figure 30. Soft costs per linear foot versus construction costs per linear foot on a logarithmic scale.

icant for both modes and the combined database. This trend may help explain why soft costs measured in percentage terms appear unrelated to many other variables like alignment profile—these other variables may simply drive up construction costs at the same rate.

4.5.6. Soft Costs by Other Characteristics

As the questionnaire responses and interviews with cost estimators indicated, other important determinants of soft costs are the characteristics of the sponsor agency, and the political, operational, or other circumstances under which the project is being developed.

Figure 31 shows the correlation between soft costs and the experience level of the sponsor agency (in the left pane), and the installation conditions of the project (in the right pane). The left pane shows a rough spectrum of experience levels across the x-axis, from inexperienced on the left to fairly experienced with both mode and delivery/procurement method at right. The experience level of the project sponsor has a mixed correlation with soft costs.

The right pane of figure 31 shows how the level of a project's interaction with existing transit service can affect soft costs. Specifically, the more a project must coordinate with and work around other services, the more soft costs tend to increase in percentage terms. A project to construct a new, stand-alone transit line that is not adjacent to any previous service seems to require less design costs than projects to extend or expand an existing rail line. When a construction project interacts with existing transit service in any way, more engineering and design work has typically been required in the final design phase. Working on or near an active rail right-of-way poses additional logistical challenges that must be planned for, and may also trigger additional safety requirements. Extending a rail line will mean integrating the new track and station(s) into the older infrastructure, and additional work is usually required to ensure that signal, power, safety, and other systems operate compatibly.

Figure 32 summarizes the relationship between soft costs and three other project characteristics: whether the project required a direct interface with existing service, whether political or public influence was unusually high, and whether public involvement or opposition was significant.

As Figure 32 shows, a project that requires a direct connection or interface with existing revenue service, such as a line extension, a new branch intersecting an existing line, or the rehabilitation of an existing line, tends to show somewhat higher soft costs. Projects where political influence

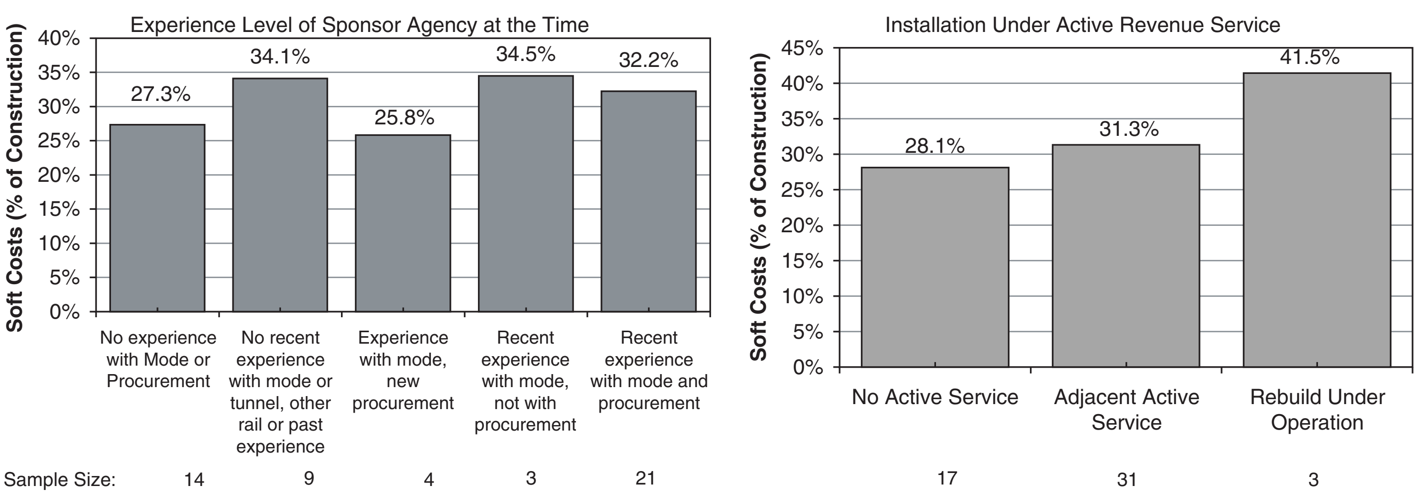


Figure 31. Soft costs versus sponsor experience level and installation conditions.

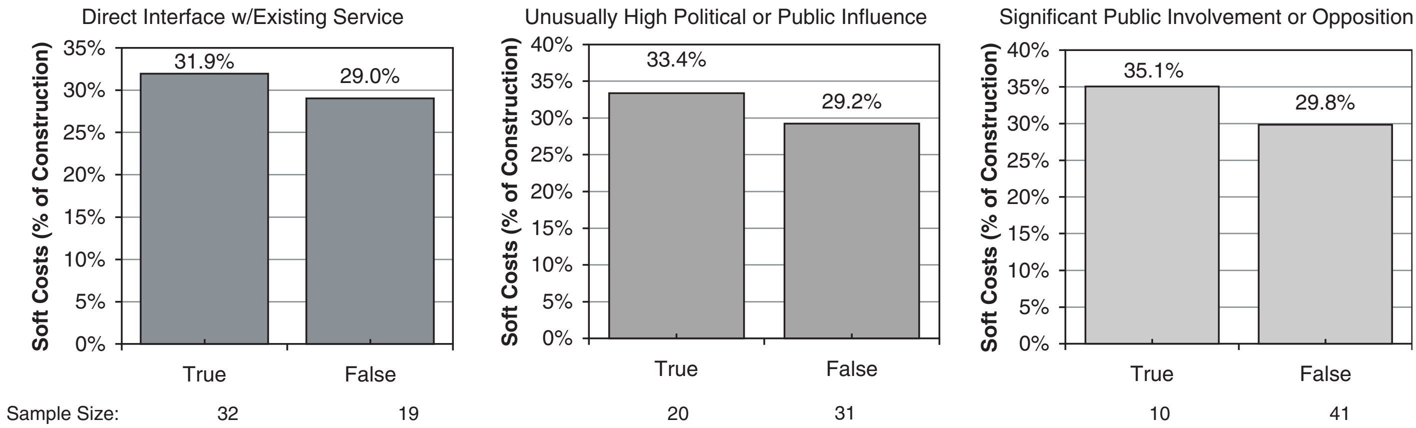


Figure 32. ***Soft costs versus installation conditions, political influence, and public involvement.***

is unusually high or where public involvement or opposition is significant also tend to be correlated with higher soft cost percentages.

Figure 33 compares soft cost percentages to the sponsor agency's tendency to use outside contractors to varying degrees, to whether the project was ever required to be redesigned for any reason, and to whether the project's planning phase was unusually long. As the left pane shows, sponsors that make more extensive use of outside contractors in early project development phases to design and plan tend to incur somewhat higher soft cost expenditures. However, sponsors who use contractors in both the development and construction phases do not typically see significant differences in soft cost percentages.

The middle pane of Figure 33 shows that the two projects in the dataset that had to undergo significant redesign do not show significantly different soft cost percentages.

The right pane of Figure 33 demonstrates that when projects remain in development stages for an unusually long period of time (beyond approximately five to seven years), their soft cost percentages tend to increase. A significant component of engineering and design soft cost is simply the salary and benefit costs of planners working on the project. When the planning phases for a project take an unusually long time, these costs tend to continue to be charged to the project, increasing

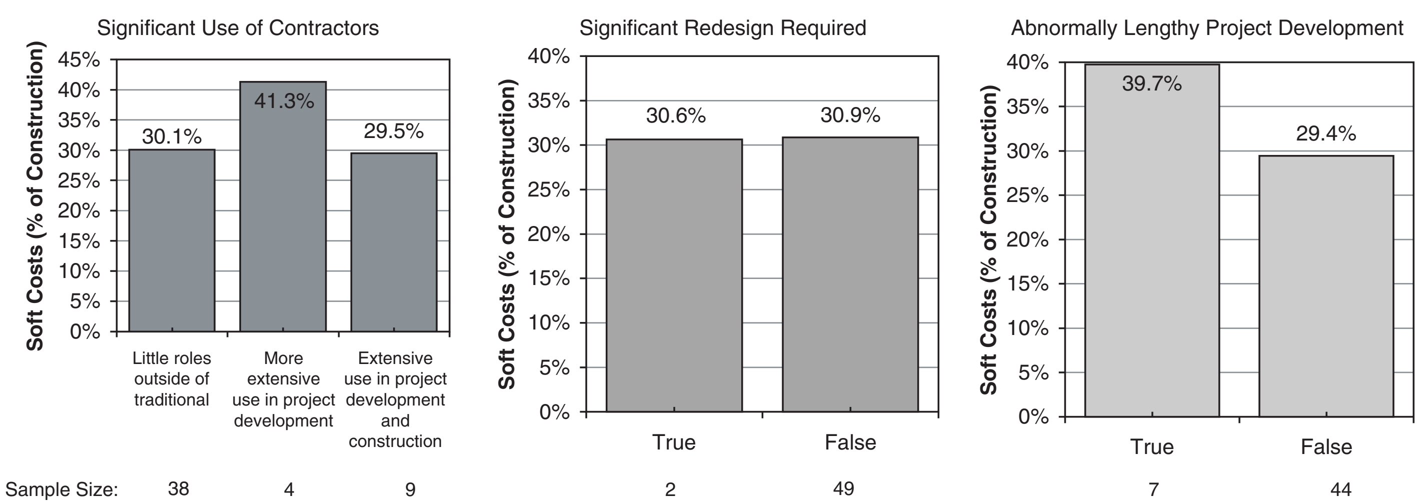


Figure 33. ***Soft costs versus use of contractors, redesign required, and lengthy project development phase.***

overall soft costs. When a significant amount of time elapses between entering preliminary engineering and the beginning of construction, projects incur higher soft cost percentages.

4.5.7. Soft Costs by Multiple Project Characteristics

So far, this analysis has focused on testing the cost relationship between soft cost percentages and a project's characteristics one variable at a time. The next step of this analysis tests the ability of a number of variables in combination to predict the variability in soft costs between projects using multivariate regression techniques.

To do this, various combinations of variables were tested, including those variables that did not show particularly strong correlations in the univariate analysis. Soft costs as a percentage of construction costs was the dependent variable, and different combinations of project characteristics were the independent variables. Variables that described broadly similar project characteristics were grouped, and the relative contribution of each variable to the overall predictive power (R^2) of the regression was measured. In an iterative fashion, one or several variables for each broad facet of the project were retained while many other indicators were left out. The following describes the variables tested and the resulting decision.

Project Magnitude

The variables with the best ability to predict soft cost percentages were *alignment length* (in linear feet) and *construction costs,* adjusted to 2008 dollars.

It may seem counterintuitive that alignment length and construction cost in combination produced opposite signs since both measures broadly describe the magnitude of the project. However, these two measures in tandem are good predictors of soft costs and produce better statistical results together than either of them alone, one divided by another, or other measures of project magnitude such as number of stations or station density. The two variables together capture the special cases where short, expensive projects (such as a tunnel project) or long, less-expensive projects (such as service on existing right-of-way or in less developed areas) may tend to demonstrate differing soft costs.

Several other variables describing the magnitude of a project were tested but were eliminated since they contributed relatively less to the regression analysis:

- Construction costs per linear foot,
- ROW costs as a percentage of construction,
- Vehicle costs as a percentage of construction, and
- Number of stations.

Project Complexity

Of many measures of project complexity, its mode, an indicator of installation conditions (i.e., whether the project is a new standalone line with no active adjacent service or not), and an indicator of an unusually lengthy project development phase were the best predictors of soft cost percentages.

Heavy rail projects tend to incur somewhat higher soft costs than light rail, other things being equal, perhaps due to their relative complexity. This finding contrasts somewhat with that of Figure 25 because this multivariate regression controls for other factors influencing soft costs. Heavy rail projects can typically involve constructing guideway and systems that have been designed to more rigorous engineering standards that support more complex systems, move higher passenger volumes, and operate at higher speeds relative to light rail. This finding in the multivariate analysis confirms the results of the industry questionnaire and the interviews with cost estimators.

A project to construct a new, stand-alone transit line that is not adjacent to any previous service will usually require less design costs than projects to extend or expand an existing rail line. When a construction project interacts with existing transit service in any way, more engineering and design work has typically been required in the final design phase. Working on or near an active rail right-of-way poses additional logistical challenges that must be planned for and may also trigger additional safety requirements. Extending a rail line will mean integrating the new track and station(s) into the older infrastructure, and additional work is usually required to ensure that signal, power, safety, and other systems operate compatibly. Note that this variable is not statistically significant to a high degree of certainty (t-statistic of −1.25).

A significant component of engineering and design cost is simply the salary and benefit costs of planners working on the project. When the planning phases for a project take an unusually long time, beyond approximately five to seven years, these costs tend to continue to be charged to the project, increasing overall soft costs.

Other variables were eliminated due to their relatively low contribution to the regression analysis' predictive power:

- Station density (number of stations per mile of guideway constructed),
- Percentage of guideway below grade,
- Percentage of guideway not at grade,
- Rebuild or rehabilitation under operation (dummy variable),
- Project type (new service, extension of existing service, or rehabilitation of existing service), and
- Direct interface with existing revenue service required.

Delivery Method

A dummy variable indicating whether the project sponsor chose an alternative project delivery method (i.e., a method that is not the traditional design–bid–build) contributed the most to the regression analysis in a statistically significant way. Including the specific effects of a certain kind of alternative delivery method did not strengthen the regression analysis, primarily due to the small sample size of such projects.

When sponsors choose to procure their project through an alternative delivery mechanism such as design–build, design–build–own–maintain, or construction manager/general contractor, these projects have historically incurred lower soft costs. In addition, these alternative delivery methods tend to frontload more design and planning costs in preliminary engineering.

However, the lower soft costs of projects implemented with alternative delivery methods may be partially the result of differences in measurement rather than a real reduction in cost. Contractors may simply categorize their costs in different ways than transit agencies (in the construction line item, for example), which makes that project's soft costs as a percent of construction appear low.

Sponsor Agency Characteristics

An indicator of whether the sponsor agency tended to minimize capital charges contributed the most to the regression. A dummy variable indicating if the sponsor agency tended to rely heavily on outside contractors during project development phases did not demonstrate significant power to predict soft cost percentages, and was excluded.

When a transit agency sponsors a construction project, it usually contributes some of its own labor and even materials. Agency employees often inspect construction activities, monitor safety, administer the contract, acquire property, manage the project, and perform many other tasks. As opening day approaches, agency staff contribute time coordinating testing, training, safety inspections, and shared tasks with other agencies. The agency chooses whether to charge these expenditures to the capital project (either directly or as an overhead-type allocation) or to absorb them into the operating budget, and project sponsors each have different internal policies for this.

External Factors

Of many indicators of the broader circumstances in which a project is developed, two variables stood out: economic conditions and unusual political influence.

The overall health of the economy, as well as the level of construction activity, can affect the construction bids a transit project sponsor can expect to receive. If the construction sector or economy at large is in a downturn when a project sponsor accepts bids, contractors may reduce their bids due to economic forces. In this case, soft costs computed as a percentage of the engineered construction cost estimate might look relatively higher simply because the bid construction cost is lower. Historically, some change in soft costs can be attributed to the rate of gross domestic product (GDP) growth when construction contracts are bid, after accounting for other variables. Although GDP growth rises and falls with the economy, it has historically risen an average of 2.5% to 3.0% per year. However, it is difficult to use this driver to estimate soft costs for a project years away from construction since future GDP growth is difficult to predict. The Guidebook therefore recommends using this cost relationship only when a cost estimator can be reasonably sure the project is to be bid within one year.

When public involvement or political pressures are high, such as in a contentious design and planning process, soft costs tend to rise relative to construction costs. When, for example, multiple planning boards, citizen advisory councils, and officials must approve the design and could even call for a redesign, these external factors were shown to increase soft costs.

Other measures of project context and external circumstances contributed less to the regression analysis and were excluded:

- Unusually high public involvement and/or opposition (dummy variable),
- Major project redesign required (dummy variable), and
- Decade.

The multivariate regression also used midyear of expenditures as an independent variable. As Figure 25 showed earlier, soft costs have been rising over time, so including this variable controls for the effect of the historic rise in soft costs. However, in estimating soft costs for a given project, the Guidebook does not recommend increasing soft cost percentages for future projects.

Extension regression analysis yielded a 10-variable equation that can explain approximately 60% of the difference in soft cost percentages by variations in the projects' characteristics ($R^2 = 0.58$). Table 15 shows the resulting coefficients from this regression, whose dependent variable is total soft costs as percent of construction costs.

Table 15. Multivariate regression results on soft costs as a percentage of construction costs.

Variable Name	Unit	Coefficient	t-Stat
Guideway alignment length	10,000 linear feet	1.4%	2.69
Construction costs	Billions, 2008$	-5.9%	-2.49
Mode	Dummy, heavy rail = 1	6.0%	1.64
Installation conditions	Dummy, no active service = 1	-3.8%	-1.25
Delivery method	Dummy, non-DBB = 1	-7.2%	-2.10
Economic conditions	GDP % annual growth	-1.4%	-2.34
Unusually long project development phase	Dummy, yes = 1	7.1%	2.08
Unusual political influence	Dummy, yes = 1	6.6%	2.22
Agency tendency to minimize capital charges	Dummy, yes = 1	-6.0%	-1.65
Years from 2008	Years	-0.4%	2.22

Using the projects contained in this FTA capital cost database, the strongest correlation that could be produced is the regression described above. After testing many combinations of explanatory independent variables, these 10 could best predict the relationship between soft and hard costs. Although the strength of this correlation is not ideal (the R^2 and t-statistics are relatively small), the relationship does highlight the importance of judgment in cost estimation. In addition, as more projects are included in this cost database, it may be possible to perform analysis with stronger cost relationships.

4.5.8. Preparing Multivariate Results for Use in Guidebook

Alternative multivariate regressions were examined using different actual soft cost components (rather than total soft costs) as the dependent variable. The coefficient from the overall soft cost analysis was distributed to the soft cost components that correlated to the project characteristics in a statistically significant way. For example, alignment length showed an overall coefficient of around 1.4% per 10,000 linear feet regressed against overall soft costs, and this relationship was strongest when regressed against project management and other soft costs, so the Guidebook recommends adjusting the percentage estimate for those two components to a total of 1.4% per 10,000 linear feet.

Finally, the starting points and recommended percentage adjustments were validated against the original projects to gauge the potential error in the Guidebook methodology. Some minor adjustments to the coefficients were made to minimize the sum of each component's root mean square error for all projects.

CHAPTER 5

Conclusion

This Final Report presents the research, data sources, and analysis underlying *Estimating Soft Costs for Major Public Transportation Fixed Guideway Projects, Part 1: Guidebook*, which came out of TCRP Project G-10. This Final Report is intended to support the information summarized in the Guidebook in Part 1. Please refer to the Guidebook in Part 1 for a summary of how the results of the research presented here can be applied to practice, including an introduction to soft costs and a new methodology to estimate these soft costs based on historical projects.

This conclusion section summarizes the key points from previous sections, and presents objectives for future research.

5.1. Literature Review

While the term "soft costs" is often similar to "indirect costs" or other terminology, the FTA's definition of Standard Cost Category 80, Professional Services, is an operational definition considered equivalent to soft costs for this report and consistent with the financial, construction, and related literature.

5.2. Soft Cost Estimation: State of the Practice

Cost estimators for transit construction projects follow different approaches to estimating soft costs depending on the phase of the project.

During alternative analysis through preliminary engineering, soft costs are estimated for each cost component as a percentage of hard construction costs. Estimators begin with a range of percentages for each soft cost component and apply a value within that range to a specific project based on knowledge about the project and its sponsor. Figure 34 shows the percentages used for each cost component by each cost estimator questioned for this research.

For each cost component, estimators choose one percentage from within that range based on historical experience and their knowledge of the specific project characteristics.

During the final design and construction phases, estimates of soft costs based on a percentage of construction cost are replaced with more closely tailored, bottom-up estimates relying heavily on past experience with similar projects, as indicated earlier. Estimators usually perform a resource-driven analysis for each cost element. For instance, administration costs may be estimated based on headcount and construction schedules.

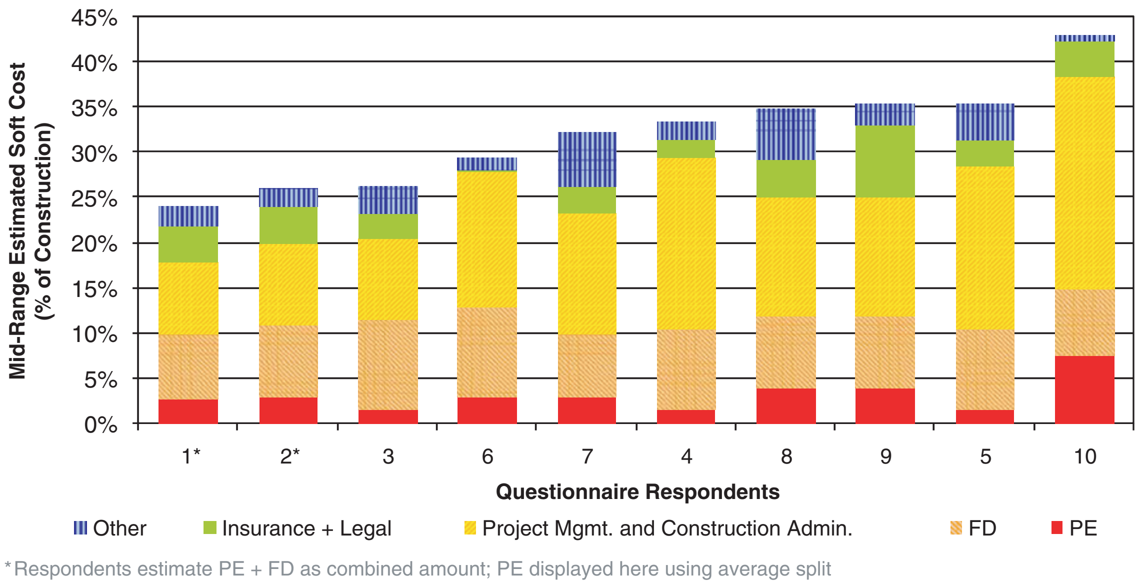


Figure 34. Midpoint soft cost estimates for all components reported by surveyed cost estimators.

5.3. As-Built Cost Analysis

Analyzing the database of actual as-built soft cost expenditures provided the following insights into soft costs:

- Soft costs have historically averaged 31% of construction costs, a value that is consistent with how the industry currently estimates soft costs both in total and at the component level.
- However, the range of variability in past projects has been wider than the range estimators report. While estimators report an uncertainty range of ±10%, actual soft costs have been as low as 11% of hard costs and as high as 54% of hard costs, or an uncertainty range of around ±20%.
- Soft costs have averaged around $2,600 per linear foot for light rail, and around $5,700 per linear foot for heavy rail, with a range between $300 and $10,000 per linear foot of guideway for both modes (2008$, outliers removed).

The as-built analysis also revealed relationships between project characteristics and soft costs:

- Soft costs have been increasing over the past four decades, particularly for heavy rail projects.
- Project complexity, mode, delivery method, magnitude, and context all appear to drive soft costs. Univariate analysis reveals some relationships between these considerations and soft costs, but a more complete and consistent picture emerges through a multivariate regression analysis. A multivariate analysis of 10 variables captured the cumulative effect of a number of variables on soft cost percentages and was able to explain approximately 60% of variability in soft costs.
- Projects where alignments stretch longer distances tend to incur somewhat higher soft costs as a percentage of construction cost.
- More expensive construction projects tend to display somewhat smaller soft cost percentages, other things being equal.
- Heavy rail projects tend to incur somewhat higher soft costs than light rail, perhaps due to their relative complexity and higher engineering standards.
- A project to construct a new stand-alone transit line will usually require less design costs than a project to extend, expand, or interface with existing transit services.

- Projects procured with alternative delivery methods such as design–build appear to have incurred less soft costs.
- The health of the national economy and the level of construction activity can affect the relationships between soft and hard costs.
- Longer project planning phases, unusual political influence, and a sponsor agency's capitalization policies may increase soft cost requirements.
- In the end, cost relationships based in historical evidence cannot explain 100% of the variability in soft costs. Therefore, soft cost estimation must blend the art of human judgment with the science of cost relationships.

5.4. Future Research Directions

More in-depth research into the documentation of one or several recent construction projects will enhance the understanding of soft cost drivers. Moreover, a comprehensive industry outreach will provide further insight on context-specific soft cost estimation practices. Finally, the methodology to estimate soft costs for public transportation infrastructure projects developed here is based on past heavy and light rail construction projects and is therefore not entirely applicable to other prevalent public transportation capital infrastructure projects such as BRT, commuter rail, streetcar, or other state-of-good-repair projects to repair or replace aging infrastructure. Additional data and research would help estimate soft costs for these kinds of projects.

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APPENDIX A

Cost Estimators Interviewed

The following section presents the experience and qualifications of the professional cost estimators interviewed for this research.

Cesare DeRose, a vice president with AECOM Transportation, has over 25 years of experience in the field of heavy construction. Projects Mr. DeRose has worked on have been in the $1 to $200 million range. Typical duties have included cost estimating, scheduling, engineering, design, constructability, project management, site supervision, and project planning in all types of involved engineering tasks. Mr. DeRose has worked on many large projects, including the Lincoln Center Development Corporation, preliminary and final design of the Second Avenue Subway, the New York City Water Tunnel project, the Queensboro Bridge, the Charles River Bridge crossing in Boston, the Amawalk and Titicus dams, rehabilitation of the Brooklyn Battery Tunnel, the Tappan Zee fender replacement, and the Hillview Reservoir wall extension and sediment removal. In addition to this, his involvement has been with bridge, highway, and other heavy construction; sewer and utility work; foundation supports; marine construction; and commercial rehabilitation.

James T. Czarnecky, AICP, a senior project manager with AECOM Transportation, is a nationally certified professional planner (AICP) and Master of Community Planning (MCP), and has 19 years of transportation planning and civil engineering experience. He has managed and participated in all phases of project development, including systems planning, major investment studies (MIS), alternatives analysis, environmental impact statements, preliminary engineering, and final design and construction support. He specializes in the development and analysis of multimodal transportation networks, inclusive of transit and highway components designed to complement the foreseeable socioeconomic conditions and related planning initiatives unique to each community. Mr. Czarnecky is focused on a realistic approach to solving transportation problems with respect to the balancing of costs and benefits.

Raul V. Bravo, president of Raul V. Bravo & Associates Inc., has over 40 years of experience in the design, development, construction, and implementation of transportation vehicles and systems. Since 1974 Mr. Bravo has been primarily involved with guided transportation; first as engineering manager for Rohr Industries and later as Amtrak's director of equipment design and operations planning; since 1979, Mr. Bravo has been managing director of Raul V. Bravo & Associates Inc., transportation planners and engineers, located in the Washington, DC, metropolitan area. Mr. Bravo is a member of the Railroad Safety Advisory Committee (RSAC) assisting the Federal Railroad Administrator in developing new rules and regulations. Mr. Bravo is also a member of TRB committees examining the future of intercity passenger rail in the United States and management structures, and standardization of rail systems and vehicles.

Petitioner's Attachment No. JCK-3R

APPENDIX B

Project Names and Descriptions in As-Built Analysis

This appendix provides a key of the abbreviated names for the projects identified in this analysis and offers a short description of each project. The project descriptions and graphics below provide a brief snapshot of the variety of projects contained in the capital cost databases used in this analysis.

B.1. Data Sources for Project Descriptions

While the detailed capital costs are from FTA cost databases, the following descriptions were developed from the following data sources:

- FTA's *Light Rail Transit Capital Cost Study Update,* 2003 (3–6)
- FTA's *Annual Report on New Starts,* various years (2006–2009), Alphabetical List of Projects by Development Phase and State, Full Funding Grant Agreements, Appendix A: New Starts Project Profiles
- Project information and fact sheets from project sponsors
- Transit agency/project sponsor websites
- Internet sources

Table 16. Data on projects included in as-built cost analysis.

Abbreviated Name	Full Project Name	Approx. Length (mi)	Midyear of Expend.	Mode	Delivery Method
Sacram. I	Sacramento Stage I	20.6	1985	Light	DBB
Pittsburgh I	Pittsburgh Light Rail Stage I	24.5	1984	Light	DBB
Portland Seg1	Portland MAX Segment I	15.0	1984	Light	DBB
LA Blue	Los Angeles – Long Beach Blue Line	22.6	1987	Light	DBB
San Jose N	San Jose North Corridor	20.8	1985	Light	DBB
Hud-Berg I	Hudson-Bergen MOS-I	8.7	1999	Light	DB
Hud-Berg II	Hudson-Bergen MOS-II	6.1	2000	Light	DB
Hiawatha	Hiawatha Corridor	11.6	2001	Light	DB
Portland Int	Portland Interstate MAX	5.8	2002	Light	DB
San Diego	San Diego Mission Valley East	5.5	2003	Light	DBB
St. Louis	St. Louis St. Clair County Extension	17.4	1999	Light	DBB
Salt Lake	Salt Lake North-South Corridor	15.0	1998	Light	DBB
South NJ	Southern New Jersey Light Rail Transit System	34.0	2002	Light	DB
Portland W	Portland Westside/Hillsboro MAX	18.0	1996	Light	DBB
Sacram. So	Sacramento South Corridor	6.3	2002	Light	DBB
Sacram. Fol	Sacramento Folsom Corridor	11.4	2002	Light	DBB
LA Gold Pasa	Pasadena Gold Line	13.7	2002	Light	DB
Denver SW	Denver Southwest Corridor	8.5	1999	Light	DBB
Pittsburgh II	Pittsburgh Light Rail Stage II	5.5	2002	Light	DBB
LA Gold East	Los Angeles Eastside Gold Line	5.9	2006	Light	DB
Phoenix	Phoenix Central/East Valley Light Rail Line	19.6	2008	Light	DB
Portland So	Portland South Corridor	6.5	2005	Light	CM/GC
Seattle Cen	Seattle Central Link Light Rail Project	13.9	2006	Light	DBB
Pittsburgh N	Pittsburgh Northshore Light Rail Connector	1.2	2008	Light	DBB

Table 16. (Continued).

Abbreviated Name	Full Project Name	Approx. Length (mi)	Midyear of Expend.	Mode	Delivery Method
Charlotte	Charlotte South Corridor	9.6	2005	Light	DBB
VTA Tas W	VTA Tasman West	7.6	1999	Light	DBB
VTA Tas E	VTA Tasman East	4.9	2004	Light	DBB
VTA Capitol	VTA Capitol Segment – Connected to Tasman East	3.3	2004	Light	DBB
VTA Vasona	VTA Vasona Segment	5.3	2005	Light	DBB
MARTA N-S	Atlanta MARTA North-South Line	22.2	1984	Heavy	DBB
MARTA Dun	Atlanta MARTA North Line Dunwoody Extension	7.0	1998	Heavy	DBB
MBTA Orang	Boston MBTA Orange Line	4.7	1983	Heavy	DBB
Baltimore	Baltimore MDMTA Metro Sections A and B	15.0	1982	Heavy	DBB
CTA Orange	Chicago CTA – Southwest Orange Line	9.0	1990	Heavy	DBB
CTA O'Hare	Chicago CTA – O'Hare Extension Blue Line	7.1	1981	Heavy	DBB
CTA Brown	Chicago CTA Brown Line (Ravenswood) Rehabilitation	9.1	2006	Heavy	DBB
CTA Douglas	Chicago CTA Blue Line (Douglas) Rehabilitation	5.6	2002	Heavy	DBB
LA Red 1	Los Angeles Red Line Segment I	3.4	1988	Heavy	DBB
LA Red 2	Los Angeles Red Line Segments 2A & 2B	6.7	1994	Heavy	DBB
LA Red 3	Los Angeles Red Line Segment III	6.5	1998	Heavy	DBB
Miami	Miami Dade Metrorail	21.0	1982	Heavy	DBB
San Juan	San Juan Tren Urbano	10.7	2002	Heavy	DBB
BART SFO	San Francisco, CA BART SFO Extension	8.7	2002	Heavy	DBB
DC Shady G	Washington, DC – Shady Grove (A Route)	18.0	1977	Heavy	DBB
DC Glenmt 1	Washington, DC – Glenmont (B Route)	5.7	1980	Heavy	N/A
DC Glenmt 2	Washington, DC – Glenmont Outer (B Route)	6.2	1996	Heavy	N/A
DC Huntgtn	Washington, DC – Huntington (C Route)	12.1	1977	Heavy	DBB
DC New Ca	Washington, DC – New Carrollton (D Route)	11.8	1974	Heavy	DBB
DC U St.	Washington, DC – U Street (E Route)	1.7	1988	Heavy	DBB
DC Greenblt	Washington, DC – Greenbelt Mid (E Route)	2.3	1997	Heavy	DBB
DC Anacost	Washington, DC – Anacostia (F Route)	4.3	1988	Heavy	DBB
DC Anacost O	Washington, DC – Anacostia Outer (F Route)	6.7	1999	Heavy	DBB
DC Addison	Washington, DC – Addison (G Route)	3.5	1978	Heavy	DBB
DC Springfld	Washington, DC – Springfield (J,H Route)	3.5	1988	Heavy	DBB
DC Vienna	Washington, DC – Vienna (K Route)	12.0	1980	Heavy	DBB
DC L'Enfant	Washington, DC – L'Enfant (L Route)	1.7	1974	Heavy	DBB
Phil Frankf.	Philadelphia SEPTA Frankford Rehabilitation	5.3	1997	Heavy	DBB
NYCT 63rd	New York NYCT 63rd Street Tunnel	0.4	1977	Heavy	N/A
NYCT Stillw	New York NYCT Stillwell Terminal Rehabilitation	0.3	2000	Heavy	N/A

B.2. Project Descriptions

Sacramento Stage I — Sacramento, CA

Label: Sacram. 1

The Sacramento Stage I project included a 20.6-mile light rail system with two lines, the Northeast (Blue) and Folsom (Gold) lines, which connect the eastern and northeastern suburbs to downtown Sacramento. The segment is mostly single-track, with double-tracking in passing sections for about 40% of its length. The alignment is largely at grade and is located on existing rights-of-way in freeway medians and abandoned railroad corridors.

Pittsburgh Light Rail Stage I — Pittsburgh, PA

Label: Pittsburgh 1

The Stage I Light Rail Transit Program in 1980 to restore light rail transit service on the old trolley routes connecting the South Hills suburbs with downtown Pittsburgh. Stage I consisted of 12.5 miles of new alignment construction and 12 miles of right-of-way rehabilitation. In 1985 the first segment started operating for 1.6 miles underground in the downtown business district and at grade south of the Monongahela River to the South Hills Village.

Portland MAX Segment I — Portland, OR

Label: Portland Seg1

The Portland MAX Segment I construction project resulted in the opening of the first modern light rail line in Portland in 1986. A 15-mile east-west alignment, named the Banfield Corridor, was built mostly at grade with some elevated portions along joint highway alignments. It extended from the Cleveland Avenue station in Gresham to downtown Portland. The Segment I alignment permits trains to operate in reserved rights-of-way in city streets, arterials, and highway medians. Of the 30 stations built, 25 are at grade, less than a mile apart, and have easy access for pedestrians. Stations generally lack park-and-ride facilities but have bus transfer facilities with good intermodal coordination. MAX Segment I was the first segment to open on the present day Hillsboro-Gresham (Blue) line that was extended in 1998 with the opening of the Portland Westside/Hillsboro MAX segment.

Los Angeles—Long Beach Blue Line — Los Angeles, CA

Label: LA Blue

The Blue Line is a modern light rail transit line in Los Angeles and primarily uses the original Pacific Electric right-of-way. It provides riders from the communities of Vernon, Huntington Park, South Gate, Watts, Compton, Carson, and Long Beach with access to downtown Los Angeles and the greater Metro system. The 22.6-mile line required 22 stations and connects at its downtown terminus to the Metro heavy rail lines at the 7th Street/Metro Center station. Its southern termini stations are in the 4-station loop in downtown Long Beach. Approximately 80% of the line is a dedicated alignment, mostly at grade or elevated with an underground portion. Construction began in October 1987 and revenue service commenced in July 1990. This project encountered some complications in planning and design due to unexpected environmental review, state environmental laws, and an active political and stakeholder environment.

San Jose North Corridor — San Jose, CA

Label: San Jose N

Revenue service commenced in December 1987 in a small segment of the San Jose North Corridor that would become the first section built of a longer San Jose Guadalupe Corridor that would require two phases to reach completion. The full 20.8-mile North Corridor was completed and servicing passengers in April 1991. This project's alignment is mainly located along the median area of major roadways and a transitway through downtown San Jose. The alignment is at grade for nearly the full length and required only one bridge, two overpasses, and a short underpass to be built in the new guideway. The guideway is double-tracked for its entirety except for two small sections of single-track operation.

Hudson-Bergen MOS-I — Newark, NJ

Label: Hud-Berg I

The first two lines of the Hudson-Bergen Light Rail began full revenue operations in 2002. (Service had opened in three phases between 2000 and 2002.) The project included 8.7 miles of double-tracking and 14 stations (including intermodal transfer stations). The fully built segment starts at the Hoboken Terminal and runs south towards the Liberty State Park station after which the 22nd Street-Hoboken (Blue) and West Side Avenue-Tonnelle Avenue (Orange) lines separate with the latter running a 3-station spur line to western Jersey City. The alignment of the 22nd Street-Hoboken Terminal line continues south from the Liberty State Park junction parallel with the I-78 and Garfield Avenue corridors and then along Avenue E, terminating at the 22nd Street station.

This project encountered some soft cost complexities when the project underwent an engineering redesign after the sponsor had executed design–build contracts and had begun utility relocation.

Hudson-Bergen MOS-II — Newark, NJ

Label: Hud-Berg II

This project included a new light rail line from the Hoboken Terminal station to North Bergen County (the green-colored Tonnelle Avenue-Hoboken Terminal Line). In addition, a station was added to the Blue Line, moving the southern terminus from the 34th Street station to the 22nd Street station. The completed project required 6.1 miles of track and 7 new stations. The MOS-2 segment opened for revenue service in increments from 2003 to 2006.

Hiawatha Corridor — Minneapolis, MN

Label: Hiawatha

The Hiawatha Corridor LRT project included an 11.6-mile light rail transit line with 17 stations that operates primarily in the Hiawatha Avenue/Trunk Highway 55 Corridor linking downtown Minneapolis to the Mall of America in Bloomington and also servicing the Minneapolis-St. Paul International Airport. The alignment includes a 1.5-mile tunnel under the airport runways. Revenue operations began in December 2004.

Portland Interstate MAX — Portland, OR

Label: Portland Int

The Portland Interstate MAX Light Rail Project included a 5.8-mile, 10-station light rail transit line (Yellow) that extends north from downtown Portland parallel to the I-5 Corridor. The line branches from the existing Blue Line in the Rose Quarter District, follows the median of Interstate Avenue for 4.5 miles, between the Albina and Overlook Park stations, to Kenton, and then is on a separate alignment to the Portland Exposition Center terminus, which is just south of the Columbia River. The original design called for the line to extend across the river to Vancouver, Washington, but Tri-Met scaled back alignment options after Portland voters rejected a bond measure. This project's alignment near an active highway also raised design complexities. The project opened to revenue service in May 2004.

San Diego Mission Valley East — San Diego, CA

Label: San Diego

The Mission Valley East (MVE) project included in a new double-track light rail line that runs from the Mission San Diego Trolley station east of I-15 to the Grossmont Center Trolley station. The new line provides important connectivity between the pre-existing Blue and Orange Lines, as well as San Diego State University, which was an active stakeholder in the design process. The 5.9-mile project required 4 new stations and the renovation of an existing station. The project opened for revenue service in July 2005.

St. Louis St. Clair County Extension — St. Louis, MO

Label: St. Louis

The St. Clair County Metrolink Extension Project is a three-phase light rail construction project that will eventually extend service over 26 miles from East St. Louis, IL, to the MidAmerica

Airport in St. Clair County. The Phase 1 segment opened for revenue service in May 2001. It is a 17.4-mile Minimum Operable Segment (MOS) light rail extension of the existing Red Line from the prior terminus at the 5th & Missouri station in East St. Louis to the College Station. The project required 8 new stations, 7 park-and-ride lots, 20 new LRT vehicles, and a new vehicle maintenance facility.

Salt Lake North-South Corridor — Salt Lake City, UT

Label: Salt Lake

The North-South Corridor included construction of the SLC-Sandy line, which opened for revenue service in 1999 from the Arena Station to the Sandy Civic Center Station. The original 15-mile light rail alignment starts on South Temple, turns right onto Main Street, right at 700 South, left at 200 West, and then follows the Union Pacific (UP) corridor. The remainder of the alignment goes south within the UP corridor to the 10000 South (Sandy Civic Center) station. The original line was mainly built with double-tracking, with two single track sections at the I-215 overpass and the State Street Bridge (U.S. Highway 89), and had 16 stations.

Southern New Jersey Light Rail Transit System — Trenton, NJ

Label: South NJ

The Southern New Jersey Light Rail Transit System, known as the "River Line," was built for intercity travel in the southwestern part of the state. The line has 20 stations between Trenton and Camden, near Philadelphia. The 34-mile light rail system runs roughly parallel to New Jersey Highway Route 130 in the former Conrail right-of-way adjacent to the Delaware River. The line's construction required upgrading 50 at-grade crossings on local streets and the reconstruction of 20 bridges. Stations connect to other public transport services offered by NJ TRANSIT, PATCO, SEPTA, and Amtrak to provide passengers with easy connections to New York City, Philadelphia, Trenton, and Atlantic City. Construction began in May 2000, and revenue operations began in 2004.

Portland Westside/Hillsboro MAX — Portland, OR

Label: Portland W

The Westside/Hillsboro extension is an 18-mile light rail extension to the TriMet MAX Blue line from downtown Portland to Beaverton and Hillsboro. While TriMet, the sponsor agency, initially considered designing an alignment that runs at 6% grade to cross the West Hills, which rise 700 feet higher than the downtown area, this plan was eventually changed in favor of a 3-mile twin tube tunnel. The alignment emerges from the twin tube tunnel, which includes the Washington Park Station at 260 feet below ground, to follow Highway 26 to the Sunset Transit Center before turning onto Highway 217. The alignment approach at the Beaverton Transit Center required newly constructed right-of-way. The line eventually ends on 12th Avenue in Hillsboro before terminating on Washington Street. Revenue operation began in 1998.

Sacramento South Corridor — Sacramento, CA

Label: Sacram. So

The Sacramento South Corridor includes a 6.3-mile light rail line with 7 stations that spurs southward at the 16th Street station from the original Sacramento Light Rail alignment. The constructed section originates in downtown Sacramento at the intersection of 16th and Q streets and follows the Union Pacific freight corridor until it terminates at the Meadowview Road station. The extension opened for revenue operation in 2003.

Sacramento Folsom Corridor — Sacramento, CA

Label: Sacram. Fol

The Sacramento Folsom Corridor light rail project was built to extend transit service within a corridor following Highway 50 to downtown Folsom. The 10.7-mile suburban extension required 9 stations between the Mather Field/Mills station and downtown Folsom. In addition, the Sacramento Valley station (adjacent to the Amtrak station) was built and connected via a new 0.7-mile double-track extension to the existing 8th & K station. The connection to Amtrak service required additional boarding platforms to be constructed at existing stations.

Pasadena Gold Line — Los Angeles, CA

Label: LA Gold Pasa

The Pasadena Gold Line runs 13.7 miles, stopping at 13 stations, to connect Chinatown, Highland Park, South Pasadena, and Pasadena to downtown Los Angeles via Union Station (its western terminus). At Union Station this light rail line provides walking connections to the Red and Purple heavy rail lines. Construction commenced in 1994 and revenue operations were scheduled to begin in May 2001. Unfortunately, a lack of funding and other complications resulted in construction stoppage. The state of California authorized the creation of the Metro Gold Line Construction Authority in 1998 with the sole purpose of immediately instituting tighter cost controls and resuming design, contracting, and construction of the Los Angeles to Pasadena Metro Gold Line. The newly formed construction authority completed construction in three years and the line opened for revenue service in 2003.

Denver Southwest Corridor — Denver, CO

Label: Denver SW

The Southwest Corridor line was built to connect the southern portion of Denver with its downtown via the already operational Central Corridor at the I-25 & Broadway station. The extension added 8.5 miles and 5 stations of service to the growing Denver light rail system. The extension is entirely grade-separated from the I-25/Broadway station to the Mineral Avenue station in Littleton, Colorado. This project planning phase spent some time addressing complexities arising from the need to accommodate through-routing of trains. Revenue service on the extension began in 2000.

Pittsburgh Light Rail Stage II — Pittsburgh, PA

Label: Pittsburgh II

The Stage II LRT Priority Project included the reconstruction of the Overbrook line, a 5.5-mile existing rail line, which had closed in 1993 because of the deterioration of old bridges. This included rebuilding the existing light rail track bed, new bridges, and retaining walls through its entire length. The first segment connected with the existing operating light rail system at the South Hills Junction on its northern end and with the Castle Shannon Junction at its southern end. These operational challenges resulted in some design complexities. The service opened in June 2004.

Los Angeles Eastside Gold Line — Los Angeles, CA

Label: LA Gold East

The eastside extension will provide transit access from the east side of Los Angeles to the regional Metro system. The 5.9-mile eastside extension of the Gold Line will be primarily at grade, with a 1.8-mile mid-section tunnel. It will originate at Union Station in downtown Los Angeles, where it connects to the Pasadena extension of the line and the heavy rail lines. The project alignment runs eastward along Alameda Street, 1st Street, and 3rd Street before terminating just before the intersection of Pomona and Atlantic Boulevards. This project was originally designed as a heavy rail line, but was altered to light rail because of funding constraints. Construction began in 2004 and revenue operation is scheduled to begin in late 2009.

Phoenix Central/East Valley Light Rail Line — Phoenix, AZ

Label: Phoenix

After some initial complications in the early planning phases, the City of Phoenix and Valley Metro Rail, Inc., a nonprofit public corporation in charge of the design, construction, and operation of the regional light rail system, partnered to construct a 19.6-mile, 27 station light rail system. The system's alignment, located primarily in the street median from 19th Avenue and Bethany Home Road, starts in north central Phoenix and runs through the City of Tempe to the intersection of Main Street and Longmore in Mesa. The City of Phoenix entered into a Full Funding Grant Agreement (FFGA) in January 2005, construction started the same month, and revenue operations began in December 2008.

Portland South Corridor — Portland, OR

Label: Portland So

The Tri-County Metropolitan Transportation District (TriMet) and Portland Metro, the region's metropolitan planning organization, are constructing 8.3 miles of new light rail transit consisting of two segments connecting to the existing "MAX" LRT system along Interstate 84. The South Corridor Extension will provide a new rail line, "the Green Line," from Clackamas Town Center to Portland State University (PSU). A portion of the Green Line will merge with and share 6.2 miles of the existing Blue Line along I-84 before continuing in the right-of-way of I-205 from the Gateway/NE 99th Avenue Transit Center to a new rail transit center at the Clackamas Town Center. The I-205 alignment is 6.5 miles of double-tracked and at-grade line with several grade-separated roadway crossings. The alignment in downtown Portland will run along the North-South Transit Mall Portland Union Station to the PSU campus while providing connectivity to the Red Line. The project includes 8 bi-directional stations for the I-205 segment and 14 unidirectional stations along the downtown Portland Mall alignment, with 7 on each leg of the one-way loop. Revenue operation is scheduled to begin in September 2009.

Seattle Central Link Light Rail Project — Seattle, WA

Label: Seattle Cen

Central Puget Sound Regional Transit Authority (Sound Transit) is constructing a 13.9-mile double-track light rail system for the initial segment of the Central Link Light Rail transit project. This segment is scheduled to open for revenue operations in July 2009. Its alignment runs from Westlake Center station through downtown Seattle to the Tukwila International Boulevard station. The system will use the existing 1.3-mile Downtown Seattle Transit Tunnel (DSTT), a new 1-mile long Beacon Hill tunnel, and a new 0.1-mile tunnel used for crossover and turnback operations. The scope of work includes 7 new stations, the renovation of 4 stations in the DSTT, a maintenance and operations facility, and a park-and-ride lot at the Tukwila International Blvd. station. A 1.7-mile extension to the Seattle-Tacoma Airport is scheduled to open in late 2009.

Pittsburgh Northshore Light Rail Connector — Pittsburgh, PA

Label: Pittsburgh N

The Port Authority of Allegheny County (Port Authority) is constructing a 1.2-mile double-tracked light rail transit extension from the existing Gateway terminus station in the Golden Triangle area of downtown Pittsburgh across the Allegheny River to the rapidly developing North Shore area. While remaining underground along the North Shore, the alignment travels adjacent to Bill Mazeroski Way accessing a station near the PNC Park stadium. The alignment continues below grade adjacent to Reedsdale Street and transitions to an elevated alignment near Art Rooney Avenue to a station along Allegheny Avenue, near the Heinz Field stadium, before terminating near the West End Bridge. The project includes two bored tunnels below the Allegheny River and 3 newly constructed stations, and includes a new Gateway Station that will be constructed adjacent to the current Gateway Station to facilitate the tie-in to the existing system. The first North Shore station (North Side Station) will be located underground, and the terminus at Allegheny Station will be aerial.

Charlotte South Corridor — Charlotte, NC

Label: Charlotte

The Charlotte Area Transit System (CATS) and the City of Charlotte managed the construction of a 9.6-mile and 15-station light rail transit line from the city's central business district (CBD) to I-485 in south Mecklenburg County. A 3.7-mile portion of the system—between the CBD and the Scaleybark Road station—operates in an abandoned Norfolk Southern Railroad right-of-way owned by the City of Charlotte. The remainder of the operating service (5.9 miles) runs on separate tracks parallel to this right-of-way. The single-line system opened for revenue service in 2007.

This project's planning process encountered some difficulties when a redesign was required to meet FTA's cost-effectiveness threshold and other requirements. Construction was stalled because CATS had to remove from the railroad right-of-way a species of flower listed as endangered under the provisions of the Endangered Species Act.

VTA Tasman West — San Jose, CA

Label: VTA Tas W

The VTA Tasman West construction project was the first leg of the Tasman Light Rail Project. The entire project was originally planned as a 12.4-mile expansion of an existing line; however, funding constraints forced the VTA to scale back immediate construction to a 7.6-mile Tasman West segment that opened for revenue service in December 1999. This project had an extensive public outreach and involvement process.

VTA Tasman East — San Jose, CA

Label: VTA Tas E

The Tasman East Project was a 4.9-mile light rail extension from the existing San Jose Guadalupe corridor Baypointe station to the Hostetter station. The alignment runs along Tasman Drive from North First Street to I-880 and then follows the Great Mall Parkway and

Capitol Avenue. Phase I construction from the Baypointe Transfer station to the I-880/Milpitas station aligned the track for 1.9 miles in the median of Tasman Drive between the Baypointe Parkway and Alder Drive to the I-880 in Malpitas. It includes 3 new stations and opened for revenue service in May 2001. The second segment was a 3-mile extension in the median of Capitol Avenue between Alder Drive to just south of Hostetter Road. Both 4 new stations and a 7,200-ft bridge for grade separation were completed in June 2004. This project had an extensive public outreach and involvement process.

VTA Capitol Segment — San Jose, CA

Label: VTA Capitol

The Capitol Light Rail Project was a 3.3-mile light rail extension of the Tasman East Project that continued the alignment in the median of Capitol Avenue to extend service to the present terminus just south of Alum Rock Avenue. It opened simultaneously with Tasman East II for revenue operations in June 2004. This project had an extensive public outreach and involvement process.

VTA Vasona Segment — San Jose, CA

Label: VTA Vasona

The Vasona Light Rail Project is a 5.3-mile light rail extension from downtown San Jose to the Winchester Transit Center. The project added 8 new stations between Woz Way in downtown San Jose and Winchester Station in Campbell. The Vasona Light Rail operates primarily on the existing Union Pacific Railroad right-of-way between the San Jose Diridon Station and Winchester Station. Additionally, the segment between the San Fernando and San Jose Diridon Stations is in a tunnel, and the segment between Bascom Avenue and Route 17 bridges over Hamilton Avenue. This project had an extensive public outreach and involvement process and opened for revenue operations in October 2005.

Atlanta MARTA North-South Line — Atlanta, GA

Label: MARTA N-S

The MARTA North-South Line project included a 22.2-mile heavy rail line from the Hartsfield-Jackson Atlanta International Airport to the Doraville station south of the I-285 Beltway in northeast Atlanta. The alignment runs up Main Street to the Arthur Langford Parkway where it continues on Lee Street SW. The alignment veers east onto W. Whitehall Street SW just south of downtown Atlanta. In downtown the line runs underneath Peachtree Street and follows a railroad right-of-way after the Arts Center station to its northeastern terminus. The complete 18-station heavy rail line became operational in 1992.

Atlanta MARTA North Line Dunwoody Extension — Atlanta, GA

Label: MARTA Dun

The Dunwoody extension project created a spur line off the North-South line's alignment. It opened for revenue service in 1996. This line and the North-South line are co-aligned from the Airport to the Lindbergh Center station. Its alignment is a 7-mile spur line off of the North-South alignment splitting off north of the Lindbergh Center station and runs to the Dunwoody station north of the I-285 Beltway. The alignment parallels Georgia State Route 400 between the Buckhead and Medical Center stations and ends at Dunwoody between Route 400 and I-295.

Boston MBTA Orange Line — Boston, MA

Label: MBTA Orang

After anti-highway protests stalled the construction of a freeway into downtown Boston through the Southwest Corridor, the Massachusetts Bay Transportation Authority (MBTA) constructed a heavy rail line through the corridor. This double-tracked 4.7-mile line extended and rerouted the Orange Line south of the Chinatown station from the former Washington Street Elevated to the Southwest Corridor right-of-way. The Southwest Corridor alignment runs primarily below grade, with some portions in open-cut and other portions in subway, and primarily serves Boston's South End, Roxbury, and Jamaica Plain neighborhoods.

Baltimore MTA Metro Sections A and B — Baltimore, MD

Label: Baltimore

The Maryland Transit Administration (MTA) built a 15-mile, 12-station heavy rail line in two phases. The first phase of construction built the line from the Charles Center station in downtown Baltimore to the Reisterstown Plaza station in the northwest section of the city along Eutaw Street, Pennsylvania Avenue and briefly on Reisterstown Road before re-emerging at grade in the Western Maryland Railroad (WMR) right-of-way adjacent to Wabash Avenue. Revenue service began in 1983 along this 9-station line. A 3-station extension, which continues in the WMR right-of-way and the I-795 median to the current western terminus at Owings Mills in Baltimore County, opened for revenue service in 1987.

Chicago CTA—Southwest Orange Line — Chicago, IL

Label: CTA Orange

The CTA Orange Line, the first rapid transit line to operate in southwest Chicago, runs 9.0 miles (double-tracked) from the downtown loop to its terminus at Midway Airport (eight stations) along freight rights-of-way. Approximately 2.7 miles of the fixed guideway is aerial structure, and the remaining 6.3 miles is on embankment. It connects the neighborhoods of Burbank, Bedford Park, Bridgeview, Hometown, Justice, Merrionette Park, Oak Lawn, and Summit to the downtown Chicago loop and connections with the other five heavy rail lines. The line opened for revenue service in 1993.

Chicago CTA—O'Hare Extension Blue Line — Chicago, IL

Label: CTA O'Hare

The O'Hare project extended the Blue Line (formerly called the Milwaukee Line) within the median of the Kennedy Expressway in northwest Chicago. Construction began in the early 1980s to extend the line 7.1 miles with 4 new stations from the previous terminus at the Jefferson Park station to the present terminus at the O'Hare Airport station. Revenue service to the Rosemont station began in 1983 and to O'Hare in September 1984.

Chicago CTA—Ravenswood Brown Line Rehabilitation — Chicago, IL

Label: CTA Brown

Persistent crowding on the Brown Line platforms prompted the Chicago Transit Authority (CTA) to begin reconstructing existing platforms and stations to accommodate eight-car trains, along with other related capital improvements

The Ravenswood (Brown) Line extends approximately 9.1 miles with 18 stations from the Kimball Terminal on the north side of Chicago through the "Loop Elevated" section in downtown Chicago. The majority of the heavy rail line operates on an elevated structure (8.0 miles), except for a portion near the northern end of the line that operates at grade (1.1 miles). The project began in late 2004 and is under construction. As of March 2009, 16 of 18 station project renovations have been completed.

Chicago CTA—Douglas Blue Line Rehabilitation — Chicago, IL

Label: CTA Douglas

The Chicago Transit Authority reconstructed 5.6 miles of the Douglas Branch, then a portion of the Blue Line (now operated as the Pink Line). The heavy rail line extends from the Clinton station, to the west of downtown Chicago, to its terminus at the 54th St./Cermak Avenue station. The project required the reconstruction and rehabilitation of 11 stations, aerial structures, upgrading power distribution and signal systems, and the reconstruction of the 54th Street maintenance yard. The rehabilitation project was completed on schedule and the line opened to revenue operation in January 2005.

Los Angeles Red Line — Los Angeles, CA

Labels: LA Red 1, LA Red 2, LA Red 3

The Red Line is a heavy rail line in Los Angeles between Union Station and North Hollywood. This line opened for revenue service in three phases between 1993 and 2000. The line includes a 3.4-mile segment of underground guideway from Union station to Westlake/MacArthur Park station.

Miami-Dade Transit Metrorail — Miami, FL

Label: Miami

Miami-Dade Metrorail built a 21-mile elevated rapid transit line with 21 stations in the early 1980s. Most of the heavy rail line operates on an aerial structure. This rapid transit line opened for revenue service in May 1984.

San Juan Tren Urbano — San Juan, PR

Label: San Juan

The Puerto Rico Highway and Transportation Authority, a division of the Puerto Rico Department of Transportation and Public Works, constructed a 10.7-mile (17.2-km) double-track heavy rail system between Bayamón Centro and the Sagrado Corazon area of Santurce in San Juan. The entire project includes 5.7 miles (9.3 km) of aerial structures and a 0.8-mile (1.4-km) tunnel. When the existing *publico* service was incorporated into the project during planning phases, ridership requirements increased and the design sequence changed, which impacted the project's budget. Approximately 40% of the alignment is at grade or near at grade. Aside from a short below-grade segment in the Centro Medico area, and an underground segment through Rio Piedras, the remainder is elevated track. The project includes 16 stations, 74 vehicles, and a maintenance/storage facility. The project opened for revenue service in June 2005.

Bay Area Rapid Transit San Francisco Airport Extension — San Francisco, CA

Label: BART SFO

After an extended planning process (the project's original EIS occurred in 1985), BART and San Mateo County Transit District (SamTrans) completed a rail extension in 2003. BART and

SamTrans completed this 8.7-mile double track, 4-station, heavy rail extension that runs from the Colma station through the cities of Colma, South San Francisco, and San Bruno along the Caltrain right-of-way to Millbrae. Approximately 1.5 miles north of the Millbrae Avenue intermodal terminal, an east-west aerial "Y" stub branches to the east to service the San Francisco International Airport (SFO). Because this project extended BART service beyond the existing five counties in BART's service area, the project involved coordination with San Mateo County, including the execution of an agreement for the county to fund East Bay projects and to share the operating subsidy. With the support of the airport, the project sponsor was BART and the principal funding sources were San Mateo County and FTA. The extension opened for service in June 2003.

WMATA—Shady Grove Extension (A Route) — Washington, DC

Label: DC Shady G

The Shady Grove (A Route) construction project added 15 stations along 18 miles of heavy rail alignment in the District of Columbia and Montgomery County, MD. This segment of the Red Line extends from the Farragut North station to the present terminus at the Shady Grove station.

Revenue service on the Shady Grove extension began in January 1977 with the opening of the Dupont Circle station. Revenue operations to the Van Ness-UDC station began in December 1981 and the full extension opened in December 1984.

WMATA—Glenmont Extension (B Route) — Washington, DC

Labels: DC Glenmt 1, DC Glenmt 2

The Glenmont and Glenmont Outer (B Route) project was an 11.9-mile extension of WMATA's heavy rail Red Line in northeastern Washington, DC, and eastern Montgomery County, MD. This extension starts in the B&O Railroad right-of-way with an above-grade crossing of U.S. Route 50 (Rhode Island Ave.) right after the Rhode Island Ave-Brentwood station. It continues at grade in the railroad right-of-way through Washington, DC, with grade-elevated crossings through the downtown of the Silver Spring, MD, suburb. It submerges south of the intersection of 16th and Georgia Avenue and continues underground beneath Georgia Avenue to the terminus at the Glenmont station. The extension first opened for revenue service to the Silver Spring station in February 1978 followed by the opening of service to Wheaton in 1990. The full extension began revenue operations in January 1998.

WMATA—Huntington (C Route) — Washington, DC

Label: DC Huntgtn

WMATA's Huntington project included a 12.1-mile new heavy rail line (present-day Yellow Line) that opened for revenue in two phases. In the first phase, which opened in 1983, Yellow Line trains began operating across the Fenwick bridge over the Potomac River, and the Archives-Navy Memorial-Penn Quarter station opened. Later in 1983, the Yellow Line was extended south of Washington National Airport to its current terminus at Huntington.

WMATA—New Carrollton (D Route) and Vienna (K Route) — Washington, DC

Labels: DC New Ca, DC Vienna

The New Carrollton project included 11.8 miles of heavy rail and 14 stations, including a 5-station extension from the Stadium-Armory station in Southeast Washington to New Carrollton, MD. When it opened for revenue service in November 1978, the line originated in suburban Maryland, ran through downtown Washington via Pennsylvania Avenue, D Street, 12th Street and I Street before passing under the Potomac River to the Rosslyn station in Arlington County, Virginia. The original service alignment terminated on the Virginia side at Washington National Airport. The Maryland portion of the alignment proceeds underground from the Stadium-Armory station. It continues above ground after crossing the Anacostia River and follows the Anacostia Freeway (DC 295) and US 50 corridors at grade and on elevated structure before terminating at the New Carrollton station, a major intermodal transfer center.

The Vienna project opened eight new stations on the Orange Line in two phases. In 1979, underground stations on the Wilson Boulevard corridor in Arlington County opened between Rosslyn and Ballston stations. An extension to the Vienna station, which runs primarily at grade in the median of I-66, opened for revenue service in 1986.

WMATA—Green Line (E, F Routes) Washington, DC

Labels: DC U St., DC Greenblt, DC Anacost, DC Anacost O

The Green Line opened for revenue service in several phases between May 1991 and January 2001. The initial Anacostia alignment to be built ran north and south of downtown Washington. The DC U St. Project included a 3-station, 1.65-mile northern section (the "Mid-City line") that runs north underneath 7th Street NW from the Gallery Pl.-Chinatown station before turning west to the U Street/African-American Civil War Memorial/Cardozo station at 13th and U Streets NW. The 3-station, 4.3-mile southern section runs from L'Enfant Plaza along M Street before crossing underneath the Anacostia River to reach the Anacostia station adjacent to Suitland Parkway. The northern section opened for revenue service in May 1991 with the full 6-station line opening for service in December 1991. In September 1999, with two additional stations, the full line was operational.

The Outer Anacostia project extended the line 5 stations and 6.7 miles into southeast Washington, DC, and Prince George's County, MD. The alignment runs underground equidistant between Martin Luther King Jr. Avenue SE and Suitland Parkway to Southern Avenue. It runs at grade parallel with Southern Avenue in a northeastward direction, briefly submerges, and reappears above-grade at Branch Avenue and Naylor Road in Temple Hills, MD. It continues parallel to the Suitland Parkway before terminating east of Branch Avenue in Suitland, MD. Revenue operations on this extension commenced in January 2001.

The 2-station, 2.3-mile Greenbelt extension from the Prince George's Plaza station opened for revenue service in December 1993.

WMATA—Addison (G Route) and Springfield Extensions (J, H Routes) Washington, DC

Labels: DC Addison, DC Springfld

The Addison project extended the Blue Line for 3.5 miles, adding 3 stations, from the previous terminus at the Stadium-Armory station to the Addison Road-Seat Pleasant station in Prince George's County, MD. It continues east under E. Capitol St. NE and follows that major thoroughfare underground until that corridor becomes Central Avenue in Capitol Heights, MD. Revenue service commenced on this extension in November 1980. The 2-station extension to the present terminus at Largo Town Center opened up for revenue service in December 2004. The database costs do not reflect the latest extension to Largo Town Center.

The Springfield project extended Blue Line service 3.5 miles from the King Street station to the present terminus at the Franconia-Springfield station. Service with the Yellow Line south of the National Airport station is shared to the King Street station. Blue Line revenue operations south of the National Airport began in June 1991 with the opening of the Van Dorn Street station. The full extension was opened for revenue service in June 1997.

WMATA—L'Enfant Plaza (L Route) Washington, DC

Label: DC L'Enfant

The L'Enfant Plaza project included 1.71 miles connecting the L'Enfant Plaza station and the Pentagon Station via the 14th Street Bridge. This addition enabled service underground in Washington, DC, in what is today the Yellow Line via 7th Street NW.

Philadelphia SEPTA Frankford Rehabilitation Philadelphia, PA

Label: Phil Frankf.

SEPTA began rebuilding the entire Frankford Elevated Line in 1986 with new track, signal systems, and stations along a 5.25-mile span between Girard Avenue and Bridge Street. In addition to renovating 10 smaller stations, the project transformed the prior terminus into the larger modern intermodal Frankford Transportation Center (FTC) in northeast Philadelphia. The new FTC terminal building was opened on August 4, 2003. This project had an extensive public outreach process.

New York NYCT 63rd Street Tunnel New York, NY

Label: NYCT 63rd

The project included a two-level tunnel. The NYCT F rail service uses the upper level, connecting the IND Queens Boulevard Line in Queens to the IND Sixth Avenue Line in Manhattan via the IND 63rd Street Line. The lower level will be used by the Long Island Rail Road East Side Access project, which will bring LIRR commuter trains to Grand Central Terminal. The tunnel is constructed with immersed tubes in trenches at the bottom of the East River bed. Beyond the river, the tunnel was built using cut-and-cover construction. The tunnel opened in October 1989.

New York NYCT Stillwell Terminal Rehabilitation New York, NY

Label: NYCT Stillw

The New York Metropolitan Transportation Authority (MTA) completed the rehabilitation of its eight-track Stillwell Avenue Terminal station in Brooklyn, NY, in May of 2004. In addition to rehabilitating 90-year-old platforms, the project included a new triple-vaulted glass and steel structure with solar panels on the roof. This project had an extensive public outreach process, including the existing ridership on NYCT service as a significant stakeholder.

APPENDIX C

Supplementary As-Built Cost Analysis

This appendix summarizes additional analysis of historical capital costs performed to support TCRP Project G-10. This appendix describes how the historical data was prepared and analyzed for cost relationships between soft costs and other project characteristics.

C.1. Data Preparation and Standardization

This analysis used actual historical capital cost data from two FTA Capital Cost Databases for light and heavy rail, respectively. This analysis took several steps to standardize and prepare the data in both databases for an accurate comparison. Most capital cost categories in the two data structures are similar, with minor exceptions. For example, vehicle costs are separated as their own category in both systems, although presented in a different numbering category sequence. Otherwise, the full capital costs to complete each project are represented in each dataset and these results are reflected in the analysis.

C.2. Adjustments Addressing Different Cost Categorization

This analysis combines light and heavy rail transit project capital cost databases using slightly different categorization structures for each mode. To correct for small variations in reporting protocols, the following modifications were made.

- **Project Initiation:** Cost category 8.07 in the heavy rail database, Project Initiation, contains two sub-items for Mobilization and Maintenance of Traffic which are reported under 8.00 Soft Costs. The light rail dataset includes these items as SCC 40.073 and 40.074 under 40.000 Sitework and Special Conditions. To ensure comparability, the two heavy rail cost components were reclassified as an element of 40.073 and 40.074 of the Special Conditions category.
- **Planning and Feasibility Costs:** Only a few projects reported these costs. This is for work that is typically carried out early in the initial phase of a transit project's development lifecycle. These efforts are conducted prior to entry into the FTA New Starts Program and have been inconsistently documented at the project level. Therefore, FTA has eliminated these early efforts from the SCC structure. Transit agencies might assign these costs to general planning activities or other grants rather than a specific project budget, and FTA's current SCC worksheet excludes planning costs incurred prior to FTA approval to enter preliminary engineering. To ensure comparability, this cost category (8.01 for heavy rail and 80.090 for light rail) was omitted entirely.
- **Unallocated Contingency:** The light rail dataset reports Category 90, Unallocated Contingency. However, since costs are final as-built expenditures, unallocated contingency is zero

for all projects. The heavy rail dataset does not report contingencies. Therefore, this cost category has no impact on the analysis and was omitted.

- **Finance Charges:** A small number of light rail projects report finance charges. However, these costs are largely a function of the financial structure and policies of the sponsor agency, and do not affect the relationship between project characteristics and construction-related soft costs. To ensure comparability, finance charges (8.08 for heavy rail and 100.00 for light rail) were omitted entirely from the analysis.

These steps help to ensure that this technical analysis is based on a uniformly reported dataset for both light and heavy rail construction projects.

C.3. Adjustment for Inflation and Nationalization

The soft cost analysis adjusted all costs for inflation and local price differentials, and expresses nominal costs in U.S. 2008 dollars. The historical cost index from *Means Construction Cost Index* (Murphy, 2008) was applied to inflate all costs to the study base year of 2008. Differences in local metropolitan area labor, equipment, and material costs were adjusted to U.S. average 2008 dollars based on the *Means Construction Cost Index* (Murphy, 2008) for the 38 largest U.S. metropolitan areas. For example, cost of labor was less expensive in Charlotte than New York, so this analysis factors base-year dollars up in Charlotte and down in New York to the average nationwide value. Each cost amount is also associated with a year of expenditure corresponding to the midpoint of the individual element expenditure.

C.4. Outliers Omitted

Some inconsistencies in the data appear to be a result of conflicting cost reporting or interpretation of the cost element definitions. These projects were omitted because they were considered as non-representative outliers or as reflecting incomplete data. For example, the Chicago Transit Authority Brown Line/Ravenswood Rehabilitation project overhauled an existing rapid transit line and built only minimal new guideway; therefore this project does not offer a consistent cost basis to express the project costs on a per-linear-foot basis and compare that with the other projects in the database.

In other project cases, while the overall soft costs total was in the reasonable range and could be used, the breakdown by individual soft cost element was not and that project was withdrawn from the more detailed analyses. For example, some projects reported zero costs for an individual soft cost component such as preliminary engineering or final design, but the overall soft cost value was in the reasonable range. Therefore, the total soft cost was used, but the cost analysis at the component level was not used. Finally, not all detailed information on project schedule was always available. Wherever data was considered incomplete, questionable, or incomparable to other projects, these projects were omitted from the analysis in situations where appropriate. Table 17 below shows the resulting sample size from removing outliers or incomplete data points.

C.5. Vehicle Soft Costs

This analysis sought to determine if any soft costs were reported in a category outside of SCC 80. FTA instructions for reporting project costs within the Standard Cost Categories guide grantees to report professional services related to vehicle procurement under SCC 70 Vehicles, not the general soft cost category (SCC 80 Professional Services). However, the strict separation

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Table 17. Resulting sample sizes for each project characteristic.

Data Analysis Type	Sample Size
All projects in dataset	59
All projects used for analysis	51
Soft costs per linear foot	45
Soft cost subcomponents (engineering, management, etc.)	48
Duration from planning/DEIS to construction	13
Duration from preliminary engineering to construction	13
Duration from construction to operations	12
Duration from preliminary engineering to operations	13
Project delay	15

of soft costs for vehicles from other soft costs may not hold consistently across the dataset. (Section C.1 discusses this potential shortfall.) Therefore, several figures below test for the possibility that vehicle soft costs are included in the directed vehicle-specific category and not the overall soft costs category.

Establishing the clear use of these related terms (soft costs generally and vehicle soft costs) is an important step in evaluating soft costs and developing a soft cost guidebook. Figure 35 shows the effect of vehicle costs on soft costs as percent of construction.

If vehicle soft costs are included mistakenly in overall soft costs, one would expect to see that bigger vehicle purchases cause soft costs as percentage of construction to rise if the underlying guideway construction remains the same. Many of these project cost summaries were collected before there was federal guidance for classifying capital costs into a consistent set of cost categories. Indeed, the data included 59 projects sponsored by numerous different agencies across nearly 35 years of experience. Instead, however, Figure 35 shows that soft costs appeared mostly immune to changing levels of vehicle procurements—the trend was slightly downward in light rail, upward in heavy rail, and zero for both modes, and all correlations were statistically insignificant. This is a good indication that vehicle soft costs are not included or reflected within the general soft costs category (SCC 80).

C.6. Soft Costs by Mode and Year

Figure 36 expands on the analysis of soft costs by decade in Figure 25 by analyzing average soft costs by mode and decade. The pattern shown in Figure 25 of increasing soft costs over time may in part be the result of no light rail projects from the 1970s being included in the dataset.

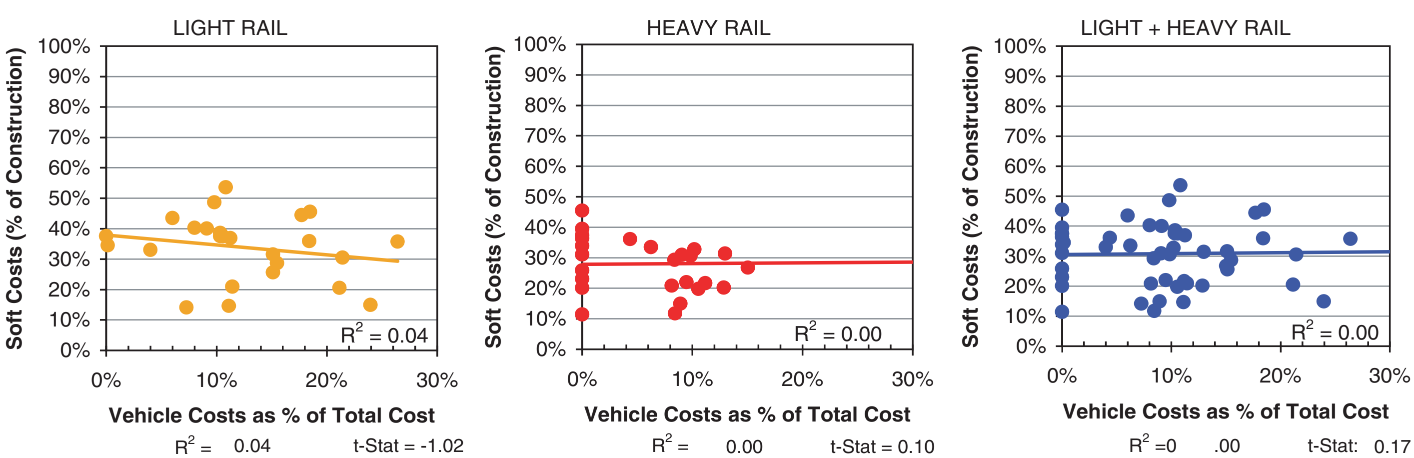

Figure 35. Soft costs as a percentage of construction versus vehicle costs as a percentage of total other costs.

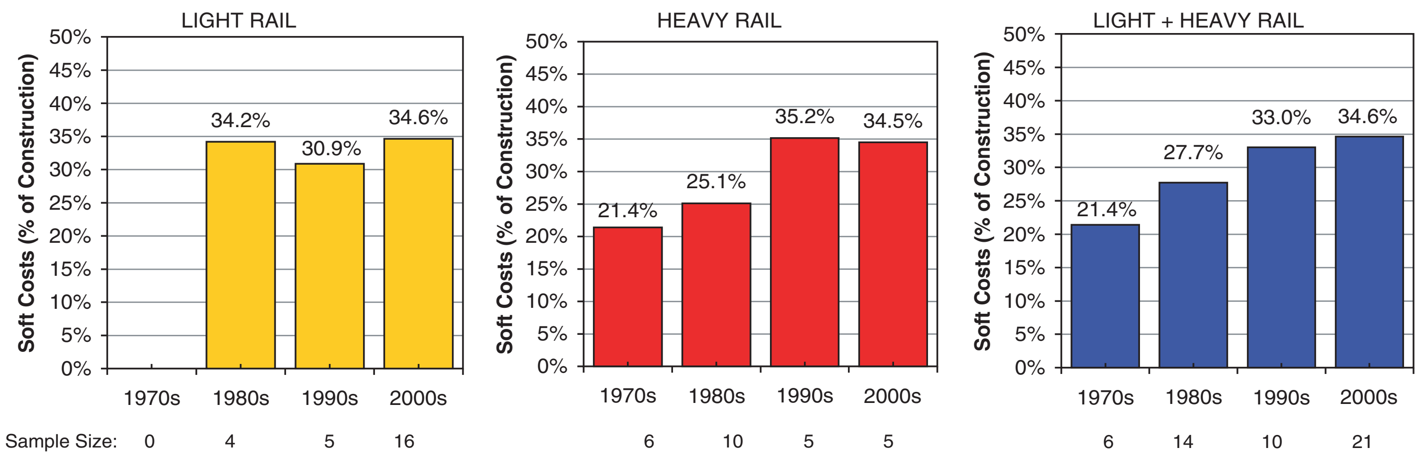

Figure 36. Soft costs as a percentage of construction by decade and mode.

Figure 36 confirms that heavy rail projects are primarily responsible for the pattern of rising soft costs over time. Soft costs for light rail projects have been stable over this same period. However, the higher soft cost percentages are related to light rail projects constructed in the 1980s, possibly by agencies developing their initial segments.

Figure 37 disaggregates the data in Figure 36 further from decade to actual year of construction. This analysis confirms that the overall correlation for all modes combined is statistically significant, but that heavy rail projects are primarily responsible for the pattern of rising soft costs over time.

Although light rail projects show a limited correlation in the increasing relationship, heavy rail projects exhibit a stronger relationship in increasing soft costs over time. *Note that midyear of expenditure represents the midpoint of all project expenditures, which is similar to, but not necessarily the midpoint of, physical construction.*

Figure 38, Figure 39, and Figure 40 present the same analysis as the two previous figures but further disaggregate the soft cost category into several groups of components: PE+FD, FD alone, and construction management and administration. The same overall relationship of rising soft cost percentage of construction costs holds true, but the relationship is weak. The final design soft costs show a stronger relationship and the same increasing relationship over time for both modes combined. The soft costs incurred in construction phases (measured as a percentage of construction

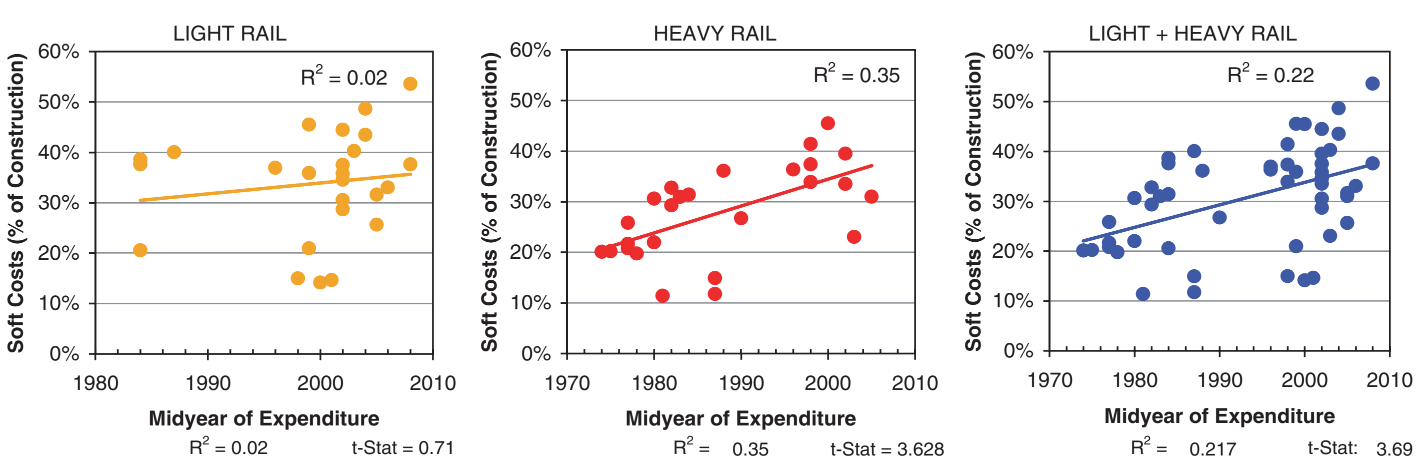

Figure 37. Soft costs as a percentage of construction versus midyear of expenditure.

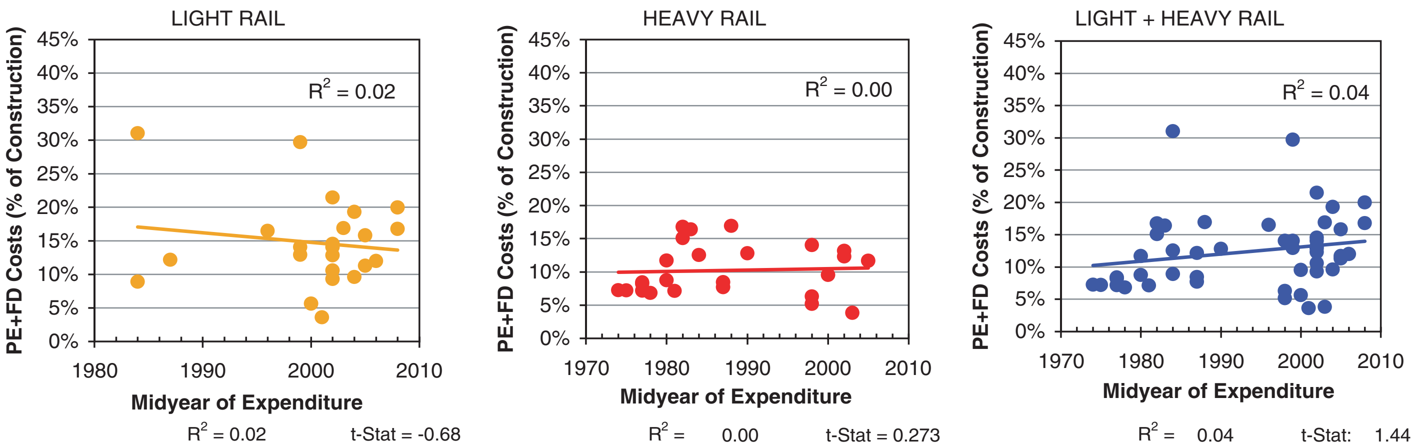

Figure 38. Preliminary engineering and final design costs as a percentage of construction versus midyear of expenditure.

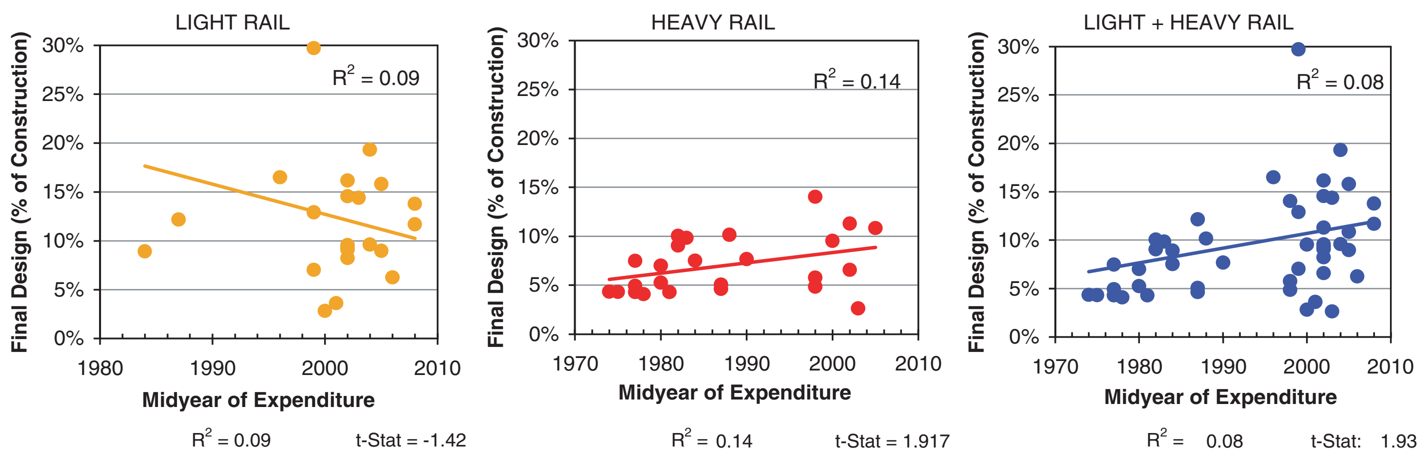

Figure 39. Final design costs as a percentage of construction versus midyear of expenditure.

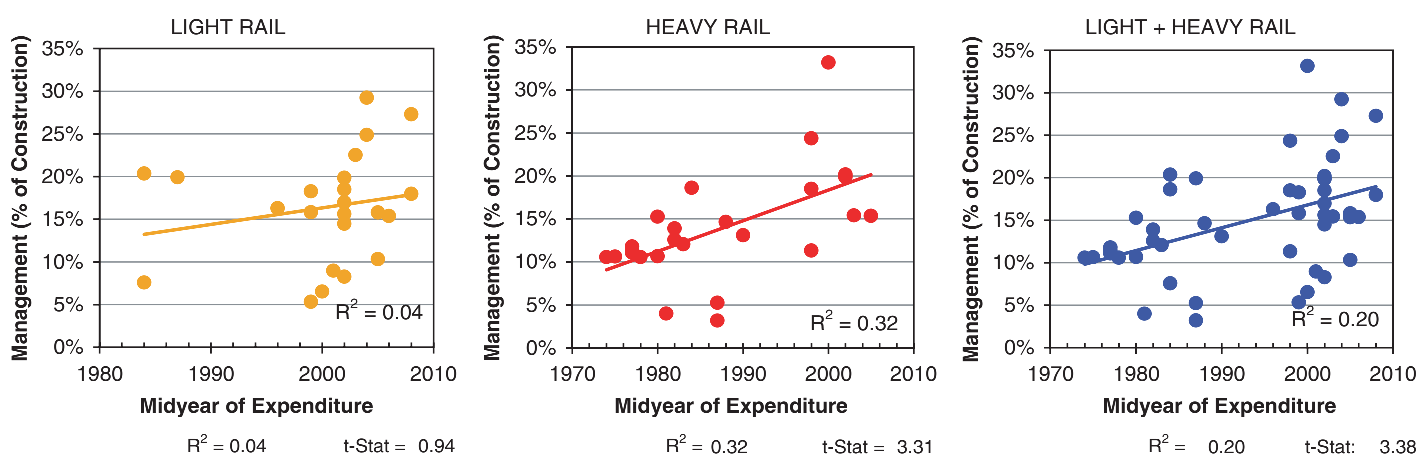

Figure 40. Management and administration costs as a percentage of construction versus midyear of expenditure.

costs) illustrates a higher increasing trend over this time period. This pattern is more prevalent and statistically significant for the heavy rail projects than for the light rail projects.

These soft cost percentages of construction costs by project development phase figures are consistent with the findings of Figure 37. Soft costs of all kinds have risen since the 1970s, but the pattern is strongest in heavy rail projects. Causes of this trend may include increasingly stringent environmental or mitigation requirements, the trend from new construction toward extending existing rail lines, or changing institutional roles or construction management techniques.

The opposite logic is also likely true and may have a greater impact on these results, although in the same direction. Many of the heavy rail projects started in the 1970s were extension projects along already well-established networks and constructed by sponsoring organizations with significant engineering and design capability. Light rail projects, by contrast, were constructed at emerging agencies that had to contract and develop their engineering and design capabilities. The project development demands may have increased for all of the projects; the actual percentage increase was relatively larger for the heavy rail agencies since they started from a lower soft cost percentage due to more limited learning curve effects.

C.7. Soft Costs by Complexity: Overall Project Size

Soft costs can generally be expected to rise with the technical complexity of the project. However, there are myriad ways to quantify complexity, and the choice of soft cost measurement may be important since construction costs can also generally be expected to rise with technical complexity.

Figure 41 shows that soft cost percentage is not dependent on the total cost of the overall project. There is virtually no relationship or correlation of the soft cost percent of construction to the total project expense. This is consistent for each of the light and heavy rail modes and the total project database.

In a similar vein, Figure 42 shows that soft costs do not depend on the total cost for the construction portion of the project either. As noted above, there was no soft cost percentage relationship with total project cost and also here with project construction costs. If anything, soft costs appear to decline as construction costs decline, suggesting some economies of scale in engineering and management. The correlations, however, are not statistically significant.

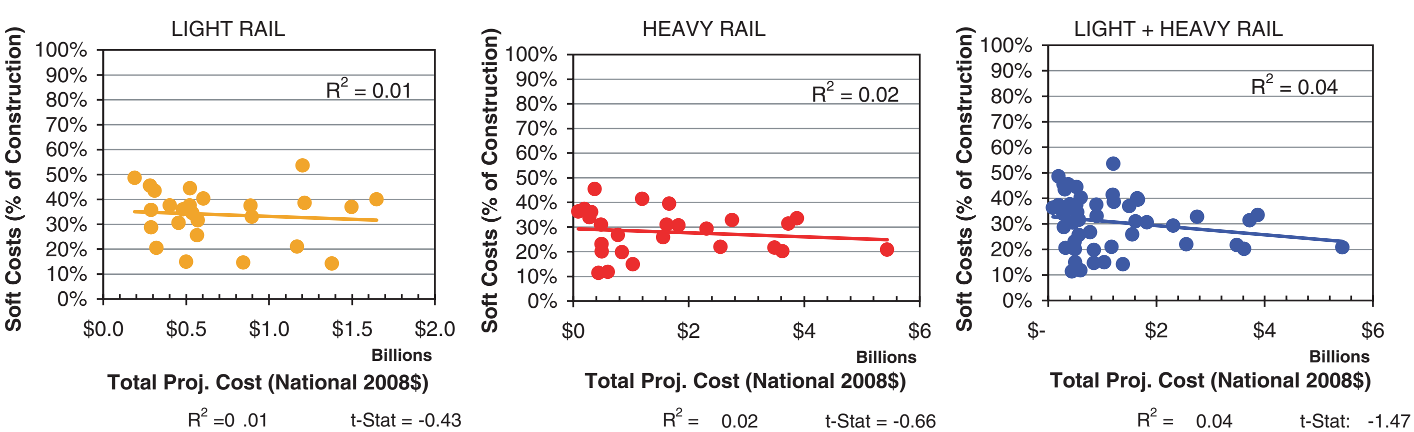

Figure 41. Soft costs as a percentage of construction versus overall project cost.

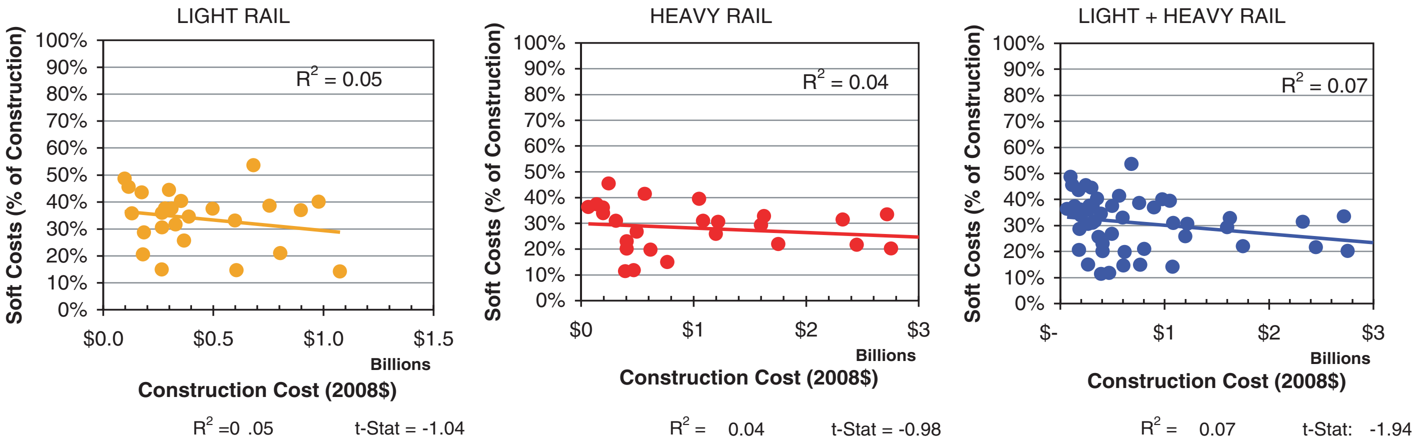

Figure 42. Soft costs as a percentage of construction versus construction cost.

Figure 43, Figure 44, and Figure 45 disaggregate the analysis in Figure 42 summarizing the soft costs by project development phase as defined earlier: preliminary engineering and final design, construction administration and management, and all other soft costs.

Figure 43 presents the combined engineering and design phase costs as a percentage of total construction costs. These subsets combine the project development aspects of the engineering and design phases, the various development functions during the construction phase, and then all of the other supporting project development efforts. The light rail, heavy rail, and combined analysis show no relationship. Heavy rail projects are more complex, especially those with higher project costs. This greater complexity would predict a flat or slightly increasing soft cost percentage of construction costs, yet the combined project database mixes these contrasting relationships with a slightly declining relationship with little statistical reliability. These results confirm that engineering and design costs as a percentage of construction cost do not consistently depend on the total cost of the overall construction project, other things being equal.

Figure 44 presents construction phase soft costs as a percent of construction costs against the dollar value construction cost of a project. In light rail, these project administration and management costs fall in percentage terms as the magnitude of the project grows; however, no statistically significant pattern holds for heavy rail or the combined project database. This finding for light rail is consistent with the same pattern for final design costs and further supports the

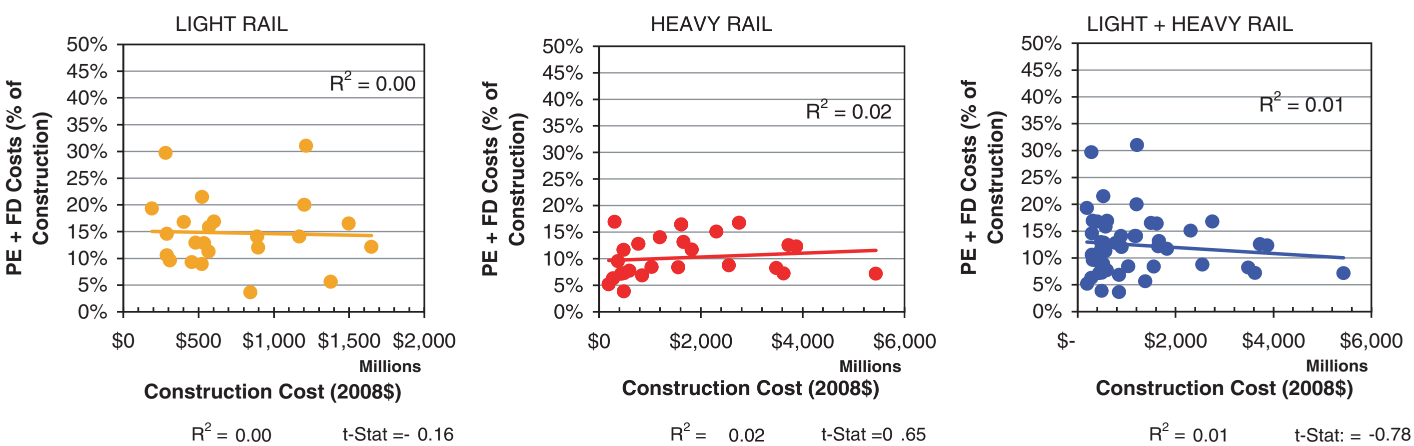

Figure 43. Preliminary engineering and final design costs as a percentage of construction versus construction cost.

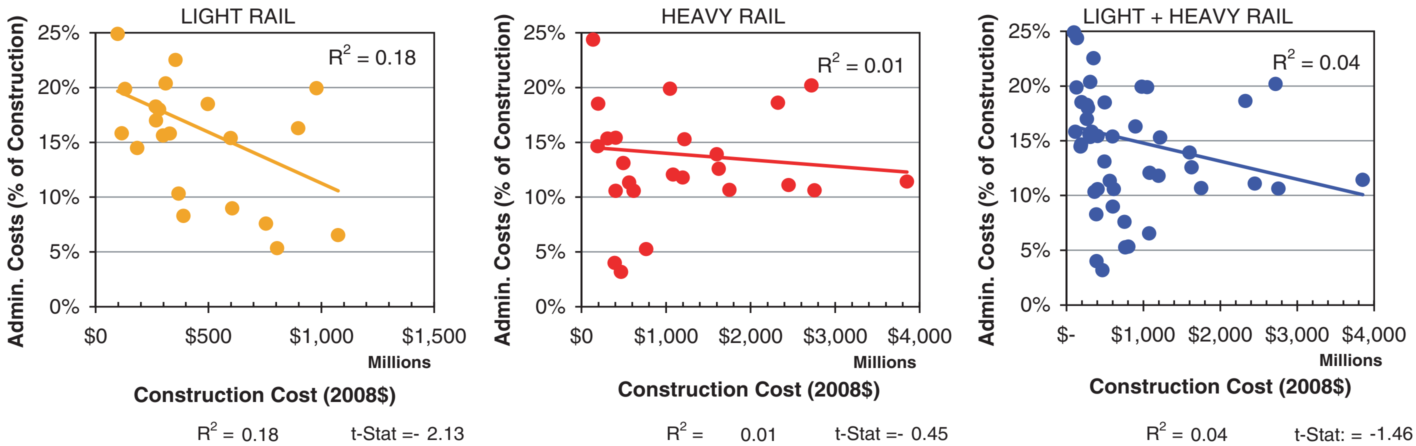

Figure 44. Project administration and construction management costs as a percentage of construction versus construction cost.

hypothesis that light rail is less complex and therefore its soft costs do not scale up with construction costs.

Lastly, Figure 45 completes the analysis by measuring the relationship between dollar value construction cost and all other soft costs not explicitly accounted for in the engineering and construction phases. No relationship is shown, which indicates the relatively inconsistent makeup of other soft costs.

The next refinement of soft costs is to examine the phase breakdown for the engineering and design phases into the preliminary engineering and final design phases. Figure 46 presents the preliminary engineering phase soft costs compared to overall construction costs. The preliminary engineering phase suggests an increase in the soft cost percentage of construction cost with increasing construction costs for both modes, but since the relationship is not significant in statistical terms, it is not clear that the relationship is not zero. Figure 47 presents the same analysis structure for the final design phase. The light rail analysis shows a more (but not profoundly) statistically significant decline in soft cost percentage with the increasing project construction cost. The heavy rail mode results are flat for the full range of construction costs, indicating that the increasing complexity of more expensive heavy rail projects requires greater soft cost resources through a consistent percentage of construction costs.

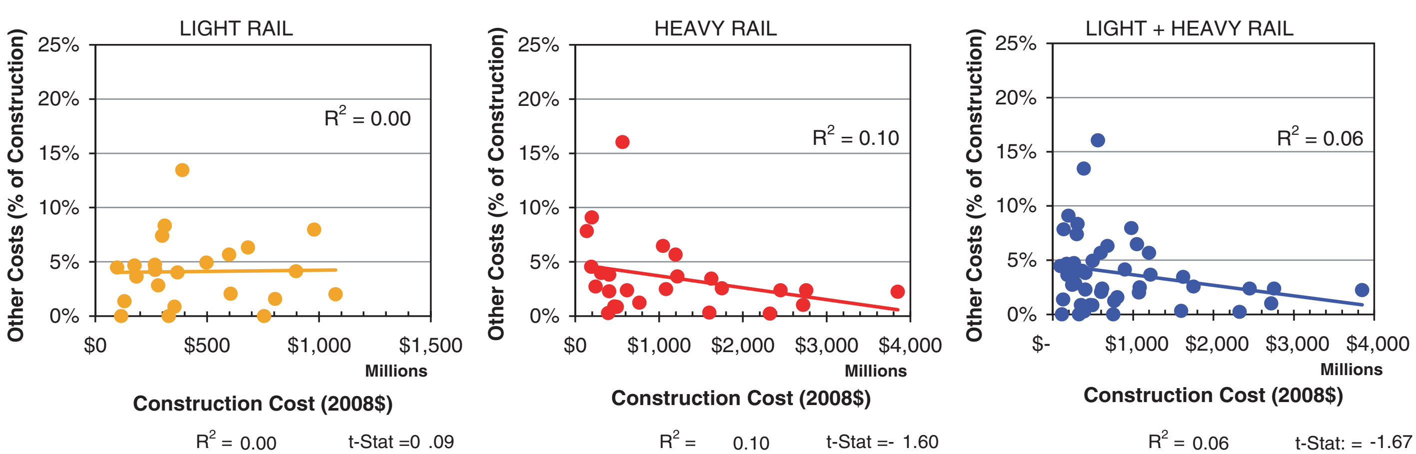

Figure 45. Other soft costs as a percentage of construction versus construction cost.

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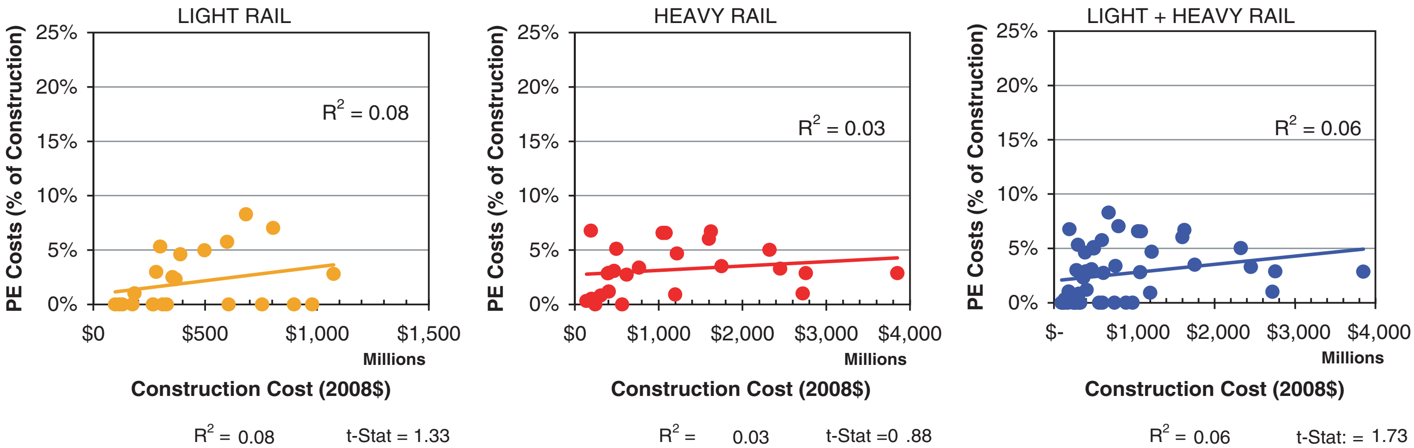

Figure 46. Preliminary engineering costs as a percentage of construction versus construction cost.

This analysis suggests economies of scale in light rail construction, primarily through the reduction of final design expenses, but the results are inconclusive. Heavy rail shows no such trend, nor does the pattern appear for preliminary engineering.

An alternative explanation for the notion of economies of scale in light rail is that certain construction conditions, such as tunneling and bridging, cause overall construction costs to rise much faster than the design and engineering of these conditions. This would cause engineering costs as percent age of construction to decline, not because of economies of scale but because of the way soft costs are measured. The heavy rail analysis in Figure 47 may not show this pattern because of the complexity of heavy rail. This possibility is explored further in sections below.

The preceding exhibits focused on project magnitude as a proxy for complexity, and have magnitude as overall costs and construction costs. Two alternative ways to measure project magnitude may be alignment length and number of stations, as the following figures explore.

Figure 48 measures project magnitude by alignment length (linear feet of guideway) and shows only a weak and statistically insignificant correlation with percentage soft costs. No conclusion can be drawn here.

Number of stations also indicates overall project size. Locating and designing stations can present challenges to the project development process and could be factors influencing soft costs

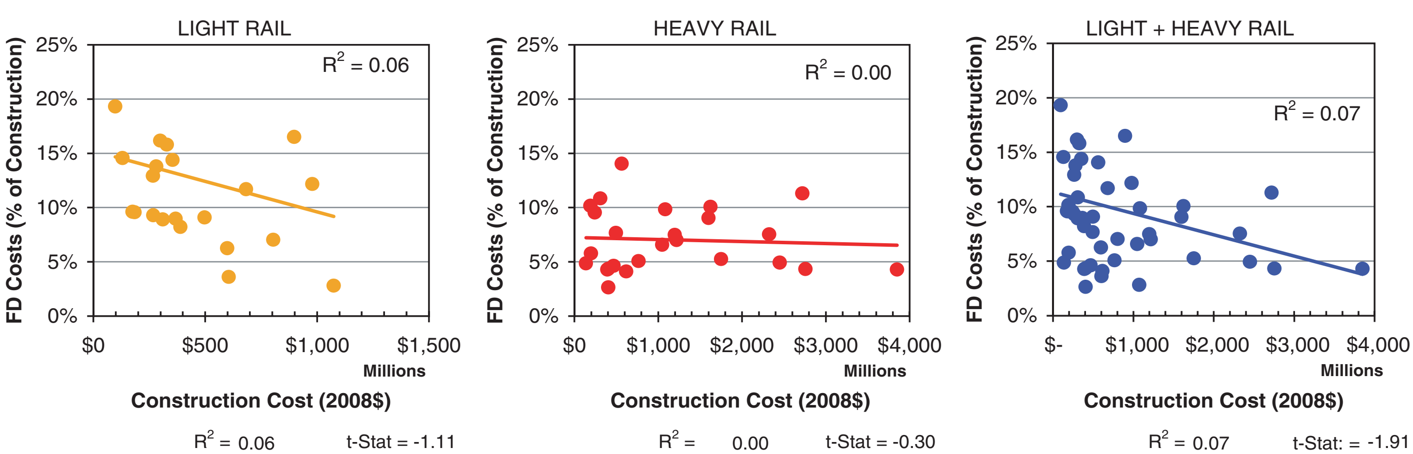

Figure 47. Final design costs as a percentage of construction versus construction cost.

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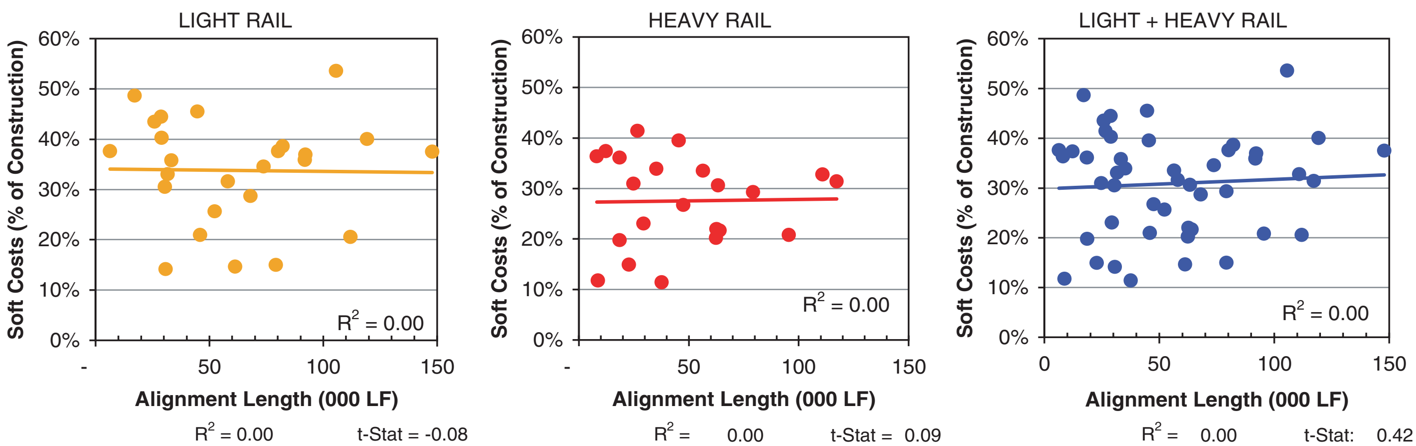

Figure 48. Soft costs as a percentage of construction versus constructed alignment length.

as the design and construction of stations require many professional services functions. Yet, as Figure 49 shows, soft costs do not appear to depend on the number of stations. Soft costs as a percentage of construction appear to decline somewhat weakly with a greater number of stations, but the relationship is not statistically significant. Stations do not appear to have any effect upon soft costs for either mode.

Beyond the simple number of stations, their frequency may also drive technical complexity. Since stations and ancillary facilities (e.g., train control rooms) may require more engineering and design than non-station components, the hypothesis is that a higher mix of stations along the guideway may increase soft costs in percentage terms. Figure 50 compares the number of stations per 10,000 linear feet of guideway to soft costs but finds minimal correlation and no statistical significance.

C.8. Soft Costs by Complexity: New versus Extension

Whether a rail construction project consists of a new line or extends an existing line may influence its soft costs. On the one hand, more professional services or agency staff time may be required, for example, to integrate a guideway extension with existing train control or traction

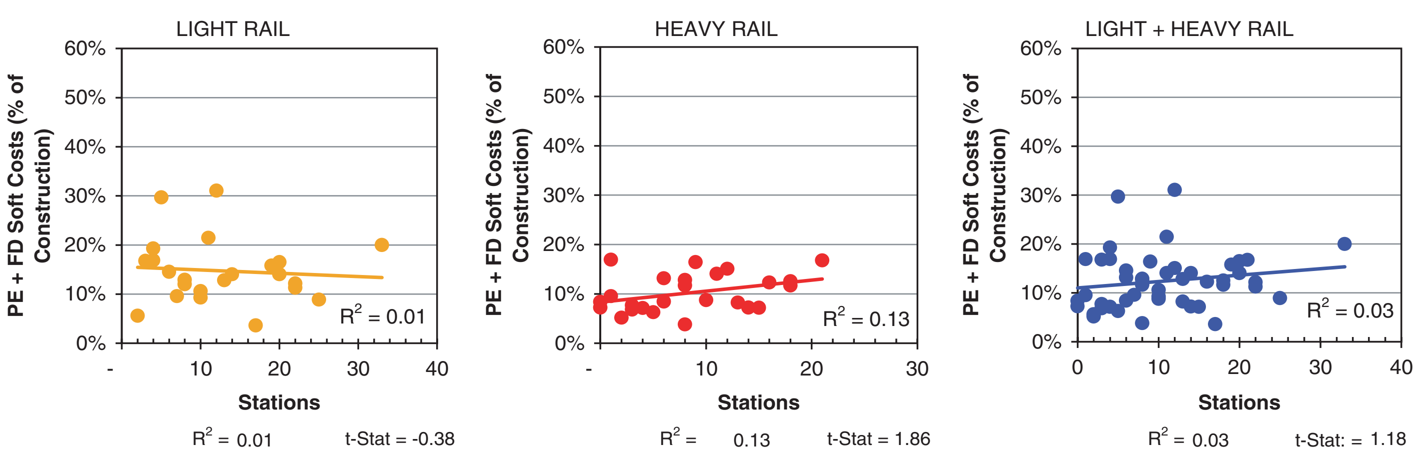

Figure 49. Soft costs as a percentage of construction versus station quantity.

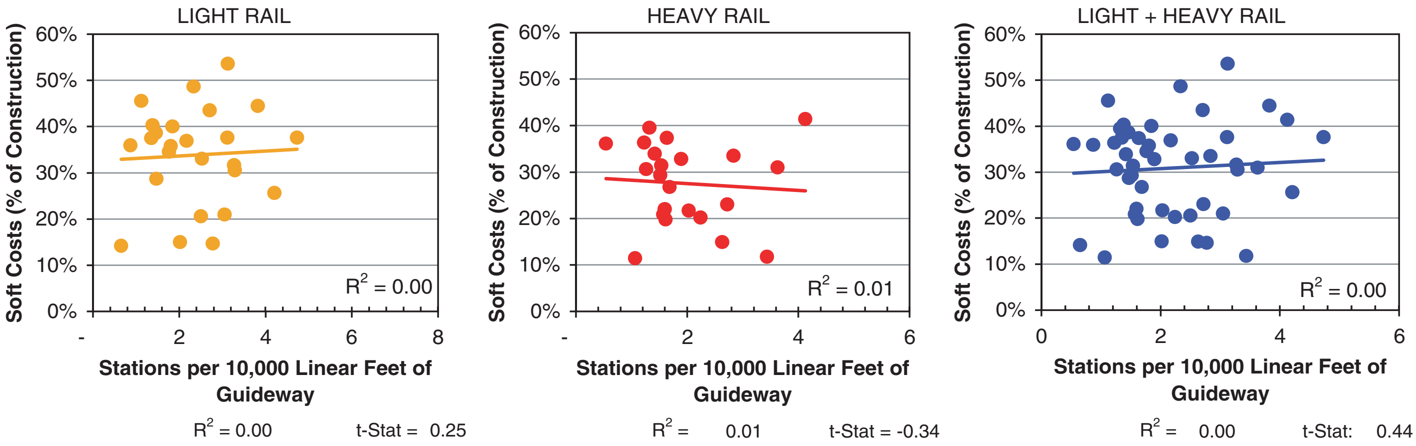

Figure 50. Soft costs as a percentage of construction versus station density.

power systems. On the other hand, a transit agency undertaking an extension project may suggest that relatively experienced agency staff with the necessary expertise be involved, which could result in lower soft costs.

Figure 51 shows average soft costs by mode and by project type (new/extension/rehabilitation). The four rehabilitation projects included in this dataset include: SEPTA Frankford, CTA Brown Line (Ravenswood), CTA Blue Line (Douglas), and NYCT Stillwell Terminal. For both modes, and for both measures, average soft costs do not seem to change whether the project is a new line or an extension. Unexpectedly, extensions, not new rail lines, incurred slightly higher average soft cost percentages. Rehabilitation projects had somewhat higher soft cost percentages, but this sample is limited to four heavy rail projects.

These findings indicate that the provision of professional services may be slightly lower for the initiation of new lines than for the extension or rehabilitation of existing segments.

Figure 52 breaks Figure 51 down into the soft cost components of engineering and design, and project administration and management. Engineering costs appear higher for new and extension light rail projects, while heavy rail engineering costs are fairly consistent between new and extension projects. Heavy rail engineering and design costs are lower for rehabilitation projects.

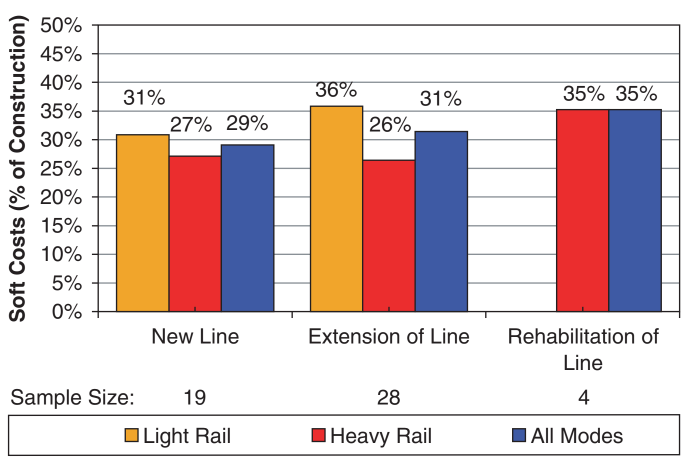

Figure 51. Soft costs as a percentage of construction by project type.

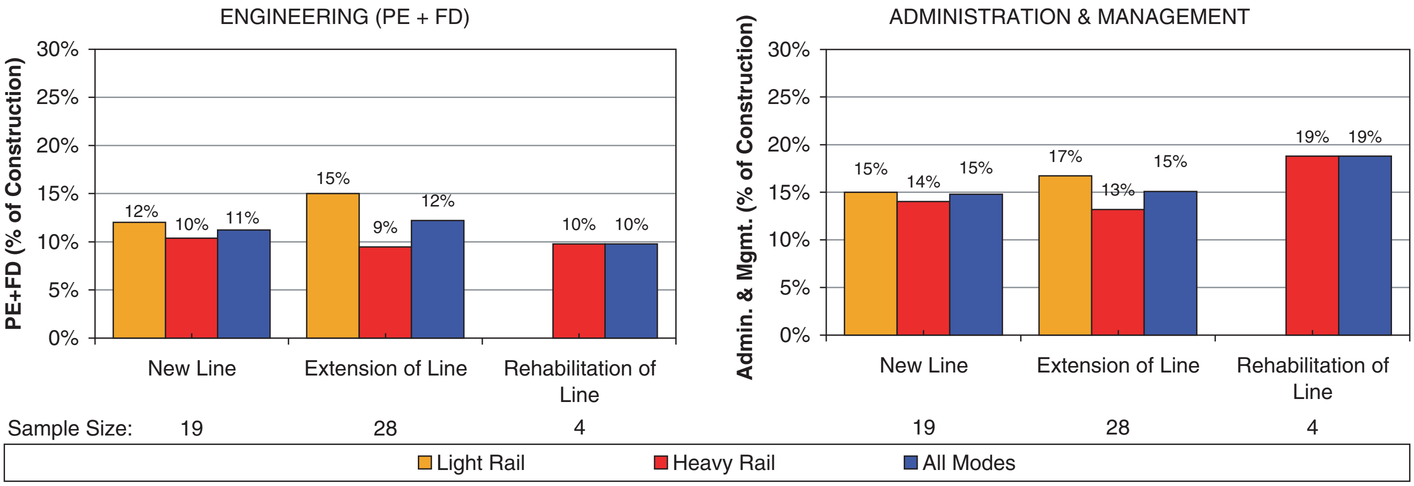

Figure 52. Subtotaled soft cost components as a percentage of construction by project type.

Soft costs for project administration and construction management are higher than engineering-related activities, as shown in the difference between the left and right panes of Figure 52. However, the difference attributable to projects being extensions or new construction appears negligible.

C.9. Soft Costs by Complexity: Percentage of Guideway Not at Grade

Figure 53 extends the examination of project complexity by focusing on preliminary engineering and final design costs, and suggests a similar conclusion. Engineering costs in percentage terms do not appear to be influenced by the extent to which the alignment is not at grade. Light rail projects have a fairly consistent 15% soft cost percent of construction costs. Heavy rail projects are about 10% to 15%, and the combined database is about 13%.

Figure 54 examines the effect of alignment complexity on the construction management and project administration soft costs of a project. Similar to the above findings, the proportion of guideway not at grade does not appear to affect the soft costs as a percentage of construction costs.

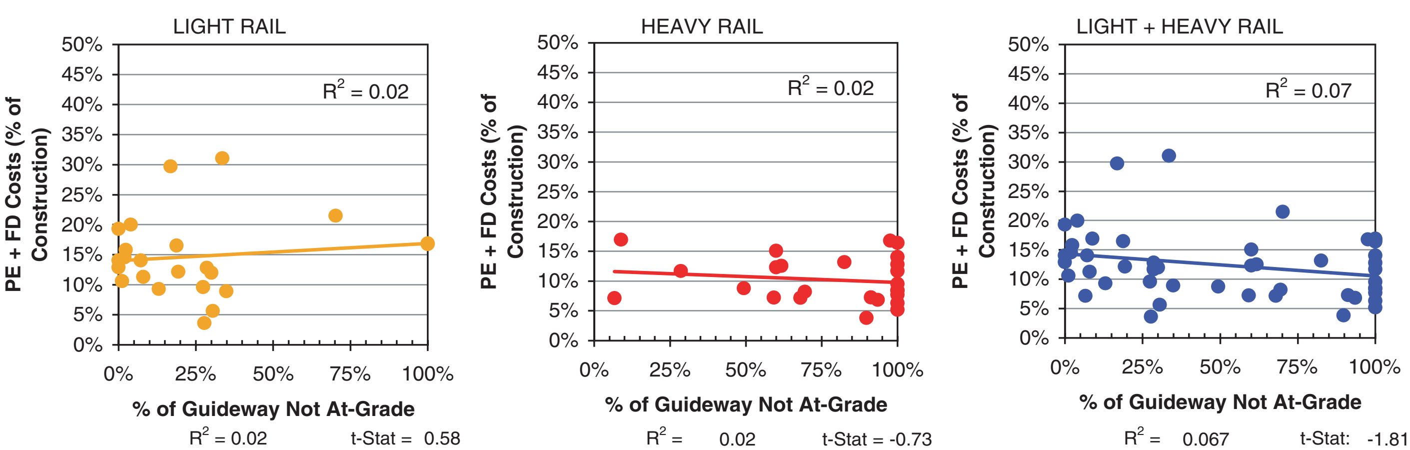

Figure 53. Engineering soft costs as a percentage of construction versus percentage of guideway not at grade.

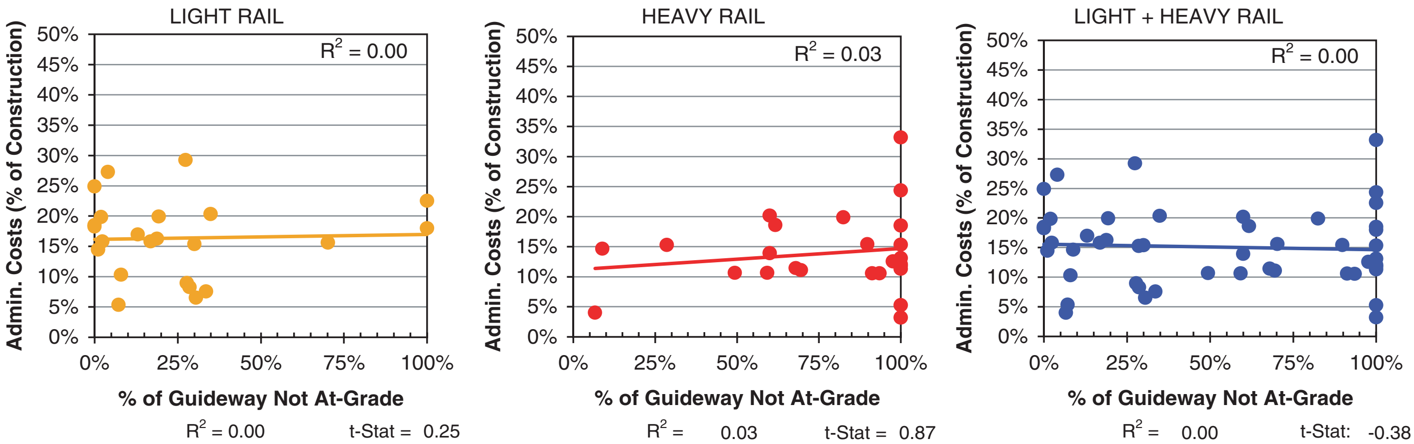

Figure 54. Administration soft costs as a percentage of construction versus percentage of guideway not at grade.

The analysis so far has defined "not at grade" to include aerial structures, underground cut and cover, underground tunnel, retained cut or fill, and built-up fill guideway. Vertical alignment has been applied as proxy for project complexity. However, these three last alignment types (retained cut or fill, and built-up fill) can be designed and constructed with fairly standardized engineering and design requirements that are similar to at-grade alignments. Therefore, Figure 55, Figure 56, and Figure 57 designate these alignment types as "at grade," and re-examine the relationship between soft costs and project complexity. These three figures, then, include only aerial structure, underground cut and cover, and underground tunneling alignments as "not at grade."

Figure 55 is comparable to Figure 28 and produces similarly statistically insignificant findings. Light rail projects are nearly flat at about 39% soft costs as a percentage of construction costs. Heavy rail projects range from about 28% to about 33%. The combined project database is nearly flat at about 35% to 38% soft costs as a percent of construction costs.

Figure 56 and Figure 57 are comparable to the analysis presented in Figure 53 and Figure 54 and are mostly inconclusive. In Figure 56, both rail modes and the combined project database result in a slightly decreasing trend in engineering and design soft costs as a percentage of construction with increasing alignment complexity. The results are mixed for Figure 57, where light

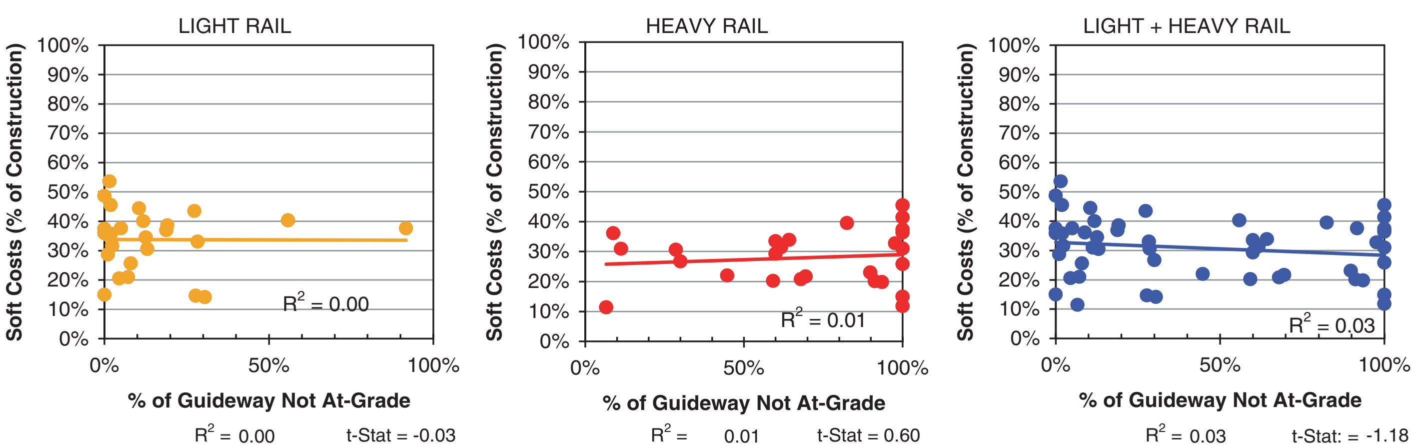

Figure 55. Soft costs as a percentage of construction versus percentage of guideway not at grade (retained cut and built-up fill designated as "at grade").

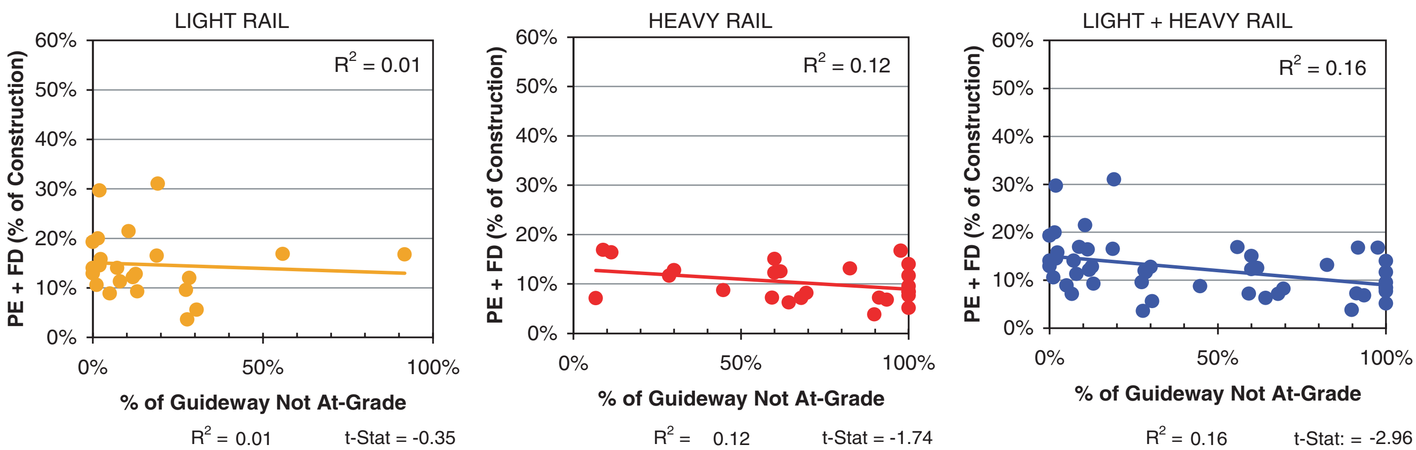

Figure 56. Engineering soft costs as a percentage of construction versus percentage of guideway not at grade (retained cut and built-up fill designated as "at grade").

rail shows a slight downward trend and heavy rail shows a slight upward trend, but the combined project database is flat and all relationships are not statistically significant.

While the relationships are weak, there may be some decline in engineering soft cost percentage with increasing project complexity. The greater capital costs of these more complex alignments results in higher soft costs, even with a slight decline in the soft cost percentage. Combining the two modes produces a weak negative correlation, surprisingly suggesting that soft costs decline as more aerial and tunnel segments are built.

C.10. Soft Costs by Complexity: Percentage of Guideway Below Grade

Underground alignment segments introduce several unique costs that other alignment grades do not, particularly excavation and complex structures. This report so far has used percentage of guideway not at grade as a proxy for complexity; however, the portion of guideway *below* grade may be a useful indicator of complexity as well. Tunneling and excavating may pro-

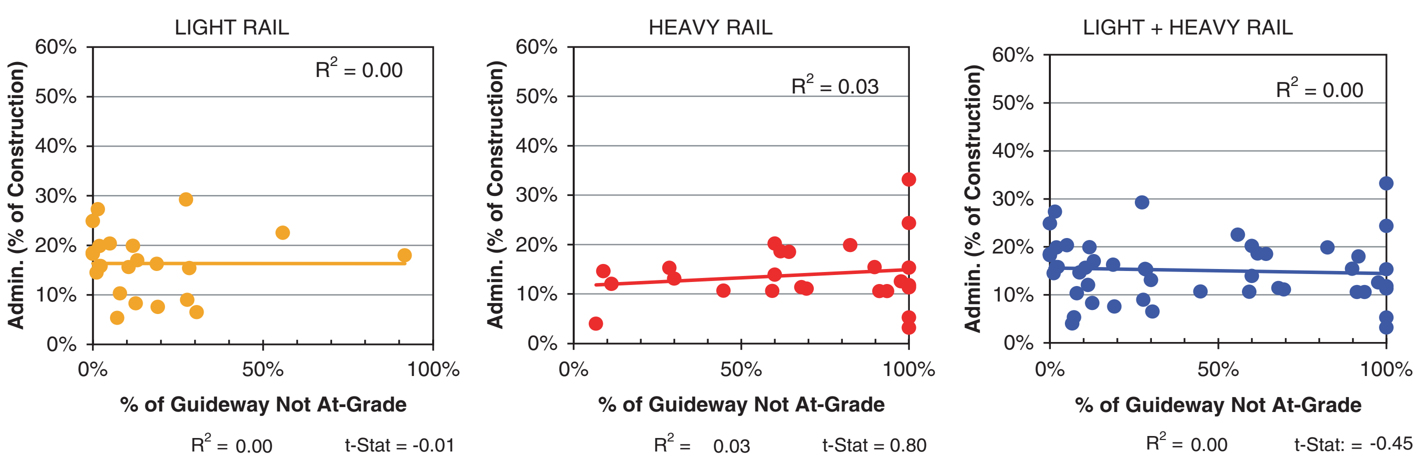

Figure 57. Administration soft costs as a percentage of construction versus percentage of guideway not at grade (retained cut and built-up fill designated as "at grade").

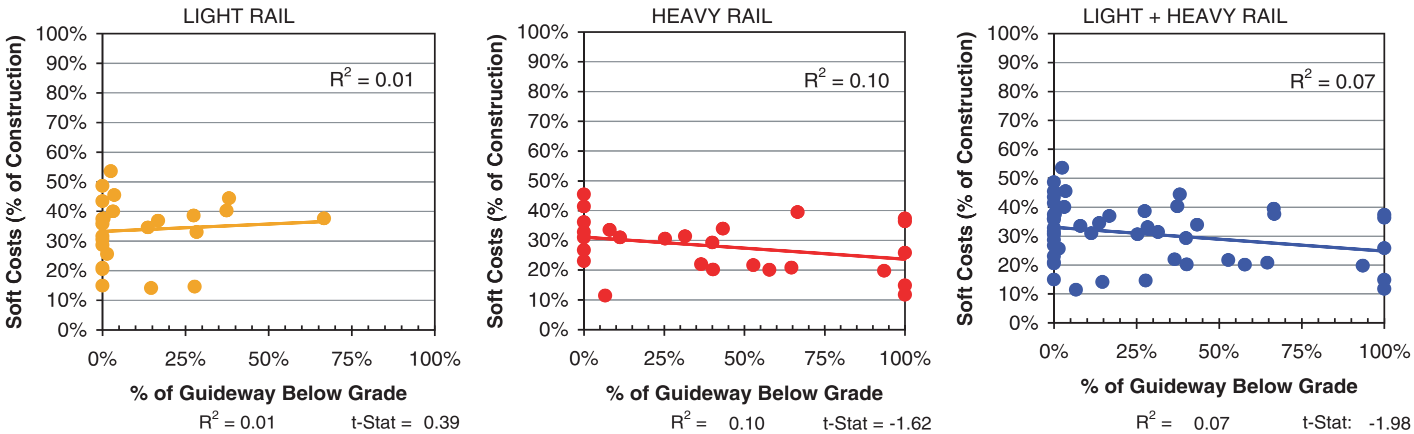

Figure 58. Soft costs as a percentage of construction versus percentage of guideway below grade.

duce a unique set of engineering and management requirements, separate from aerial or built-up fill structures, which might influence project soft costs.

Figure 58 shows that the proportion of the alignment in tunnels (cut and cover or deep-bore) has a mixed effect on soft costs as a percentage of construction. Light rail projects showed a slight increase in soft cost percentages as percentage below grade increased, whereas heavy rail projects showed a slight decrease from 30% to 24% with higher proportions of below-grade guideway. The combined project database shows a decreasing trend as well.

Figure 59 and Figure 60 present this same analysis, but focus solely on engineering and administration soft costs, respectively.

Figure 59 shows that engineering and design soft costs (preliminary engineering and final design) tend to be only slightly negatively correlated to the percentage of guideway below grade, but the pattern is only statistically significant among heavy rail projects. Figure 60 finds a similar general trend for administrative soft costs, but the trend is statistically less significant.

Finally, another view into project complexity and soft costs is presented in Figure 61, which examines the effect of guideway grade on soft costs per linear foot and finds a positive correlation that is statistically significant for light rail and both modes combined. This figure is presented on a logarithmic y-axis scale to more clearly illustrate the relationship. Figure 61 shows that more

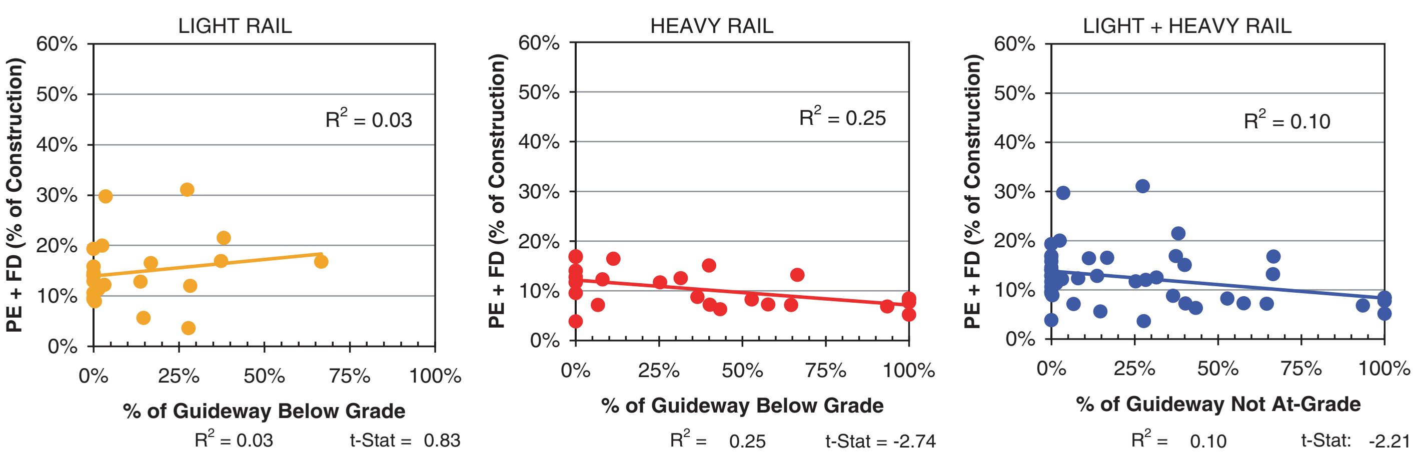

Figure 59. Engineering soft costs as a percentage of construction versus percentage of guideway below grade.

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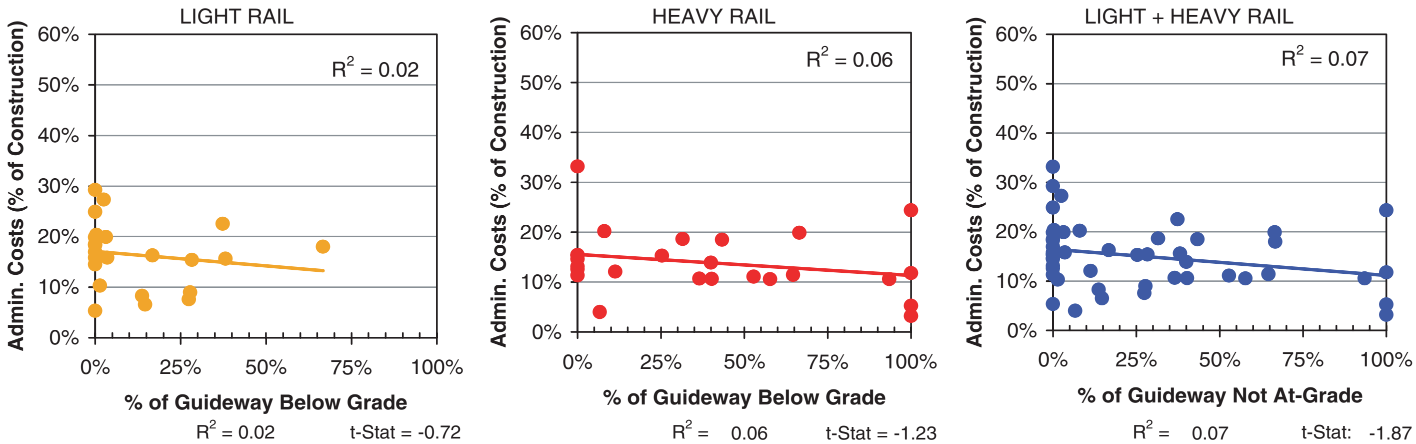

Figure 60. Administration soft costs as a percentage of construction versus percentage of guideway below grade.

complex alignment profiles are consistently tied to higher soft costs per linear foot and that the relationship is statistically significant for light rail and the combined project database.

The percentage of guideway not at grade or below grade therefore appears weakly related to soft costs when measured as a percentage of construction costs. When soft costs are measured in dollar terms per linear foot of guideway, however, a stronger relationship appears: more complex alignment profiles are tied to higher soft costs per linear foot. This finding suggests that more alignment below grade may be driving capital costs in all categories, so that soft costs will rise in dollar value terms but remain unchanged in percentage terms.

C.11. Relationships Among Other Category Unit Costs

Although it is tempting to measure soft costs in dollar value terms because this measure produces more correlation with expected complexity variables, it is worth exploring the measure further. One benefit of measuring soft costs in percentage terms is that the measure controls for variations in unit costs. Soft cost requirements of more expensive projects can be more consistently compared to inexpensive projects in percentage terms. Measuring soft costs in per-linear-foot

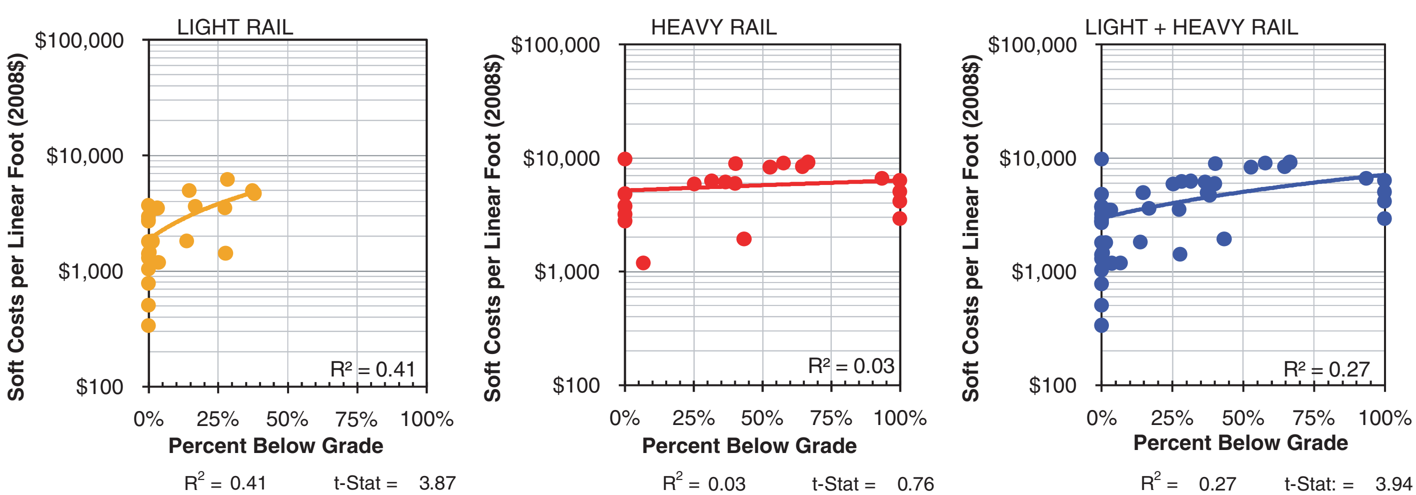

Figure 61. Soft costs per linear foot versus percentage of guideway below grade.

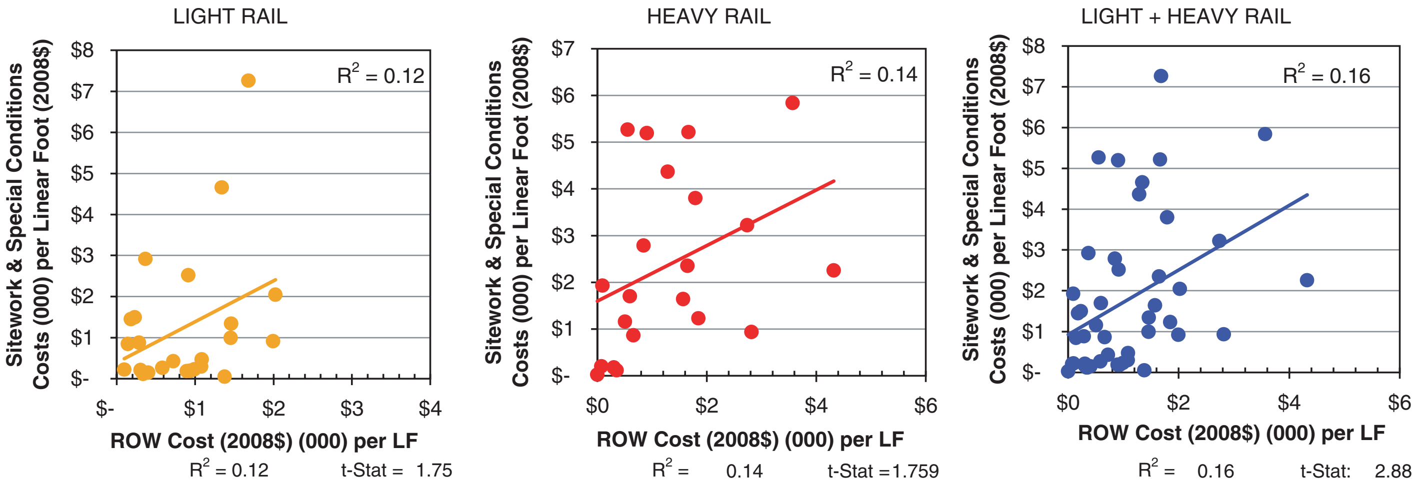

Figure 62. Sitework and special conditions costs per linear foot versus right-of-way costs per linear foot.

terms risks autocorrelation between unit costs—high soft costs could be correlated with higher other costs. In general, the analyses below tend to confirm this hypothesis: in dollar terms, soft costs and most cost categories tend to increase proportionately to construction costs.

Figure 62 shows that right-of-way costs grow along with sitework and special conditions costs. The relationship is weak, but this finding mildly supports the hypothesis that all categories of capital costs may be growing together, which may help explain the previous results showing that soft costs grow in dollar value, but not percentage terms in relation to complexity (i.e., in terms of percent of alignment not at grade or below grade).

Another perspective on the relationships between these soft cost categories is the relationship of guideway costs to right-of-way costs. As shown in Figure 63, these two cost categories appear to be correlated, similar to Figure 30 and Figure 62. The statistical significance is not as pronounced, but the relationship is clear: as right-of-way costs increase, guideway construction costs are also shown to increase. This correlation is best demonstrated for light rail, and the near-zero intercept makes intuitive sense. The heavy rail correlation is statistically insignificant but directionally consistent with light rail. The combined project database also shows a statistical relationship.

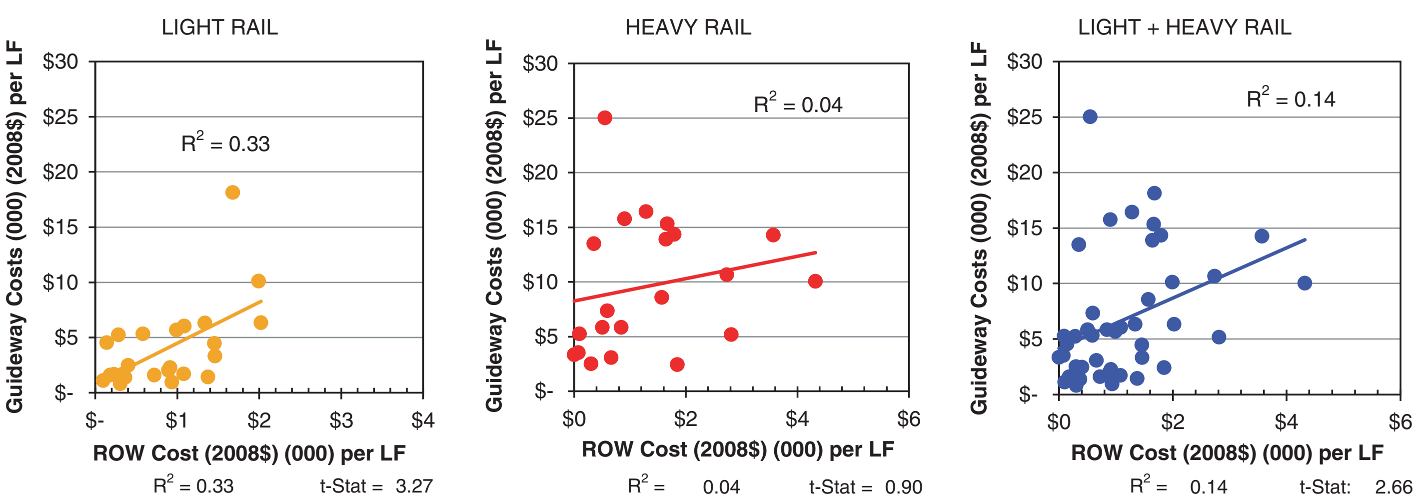

Figure 63. Guideway construction costs per linear foot versus right of way cost per linear foot.

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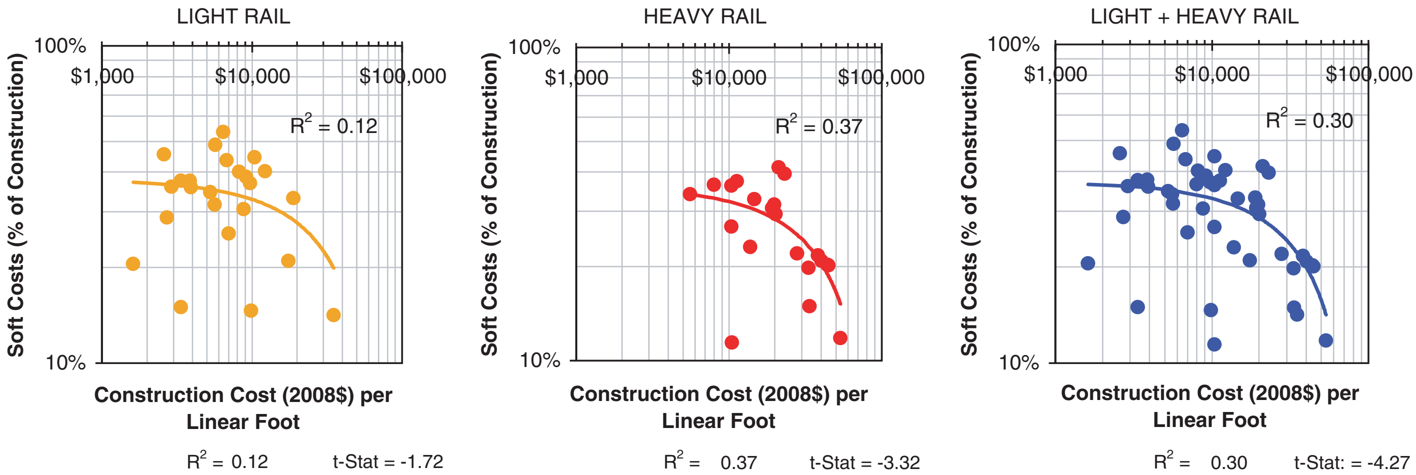

Figure 64. Soft costs as a percentage of construction versus construction costs per linear foot on a logarithmic scale.

In general, Figure 62 and Figure 63 (and Figure 30 in Section 4.5.5) show that all categories of capital costs tend to grow together. These three figures help explain why the data show that soft costs rise in dollar terms but not percentage terms when plotted against expected complexity variables such as alignment profile. To further support this point, Figure 64 can be compared to Figure 30. Both display the same variables on the x- and y-axes; however, Figure 64 measures soft costs as a percentage of construction costs whereas Figure 30 measures these in dollar value terms. When one variable is expressed in percentage terms, as in Figure 64, the correlation is non-existent.

The preceding figures demonstrate that despite the relatively stronger cost relationships produced by measuring soft costs in dollar terms, such a measurement may not provide an accurate understanding of the changing relationship between soft costs and other project characteristics. Indicators of project complexity are correlated with higher soft costs in dollar terms, and with higher costs in all categories.

C.12. Soft Costs by Complexity: Right-of-Way Costs

Right-of-way costs, which are primarily the cost to acquire real estate and relocate existing residences and businesses, appear to be mildly related to soft costs as a percentage of construction costs. High expenditures to acquire real estate and relocate land uses may be correlated with projects in more dense, urban areas where soft costs might be relatively high in proportion to the construction budget. Figure 65 compares soft costs as a percentage of construction cost to right-of-way costs and shows that right-of-way costs as a percentage of total costs appear to explain a small amount of soft cost variation.

Figure 66, however, shows that ROW costs per linear foot are not correlated with soft cost percentages. These relationships indicate that soft cost percentages do not change significantly as right-of-way costs increase per linear foot.

C.13. Soft Costs and Project Development Budget

As a project is developed through the planning and design phases, its budgeted cost is likely to change as the project is further defined. Similarly, a project can face cost overruns during construction phases due to a variety of factors such as unforeseen subsurface conditions, inaccurate

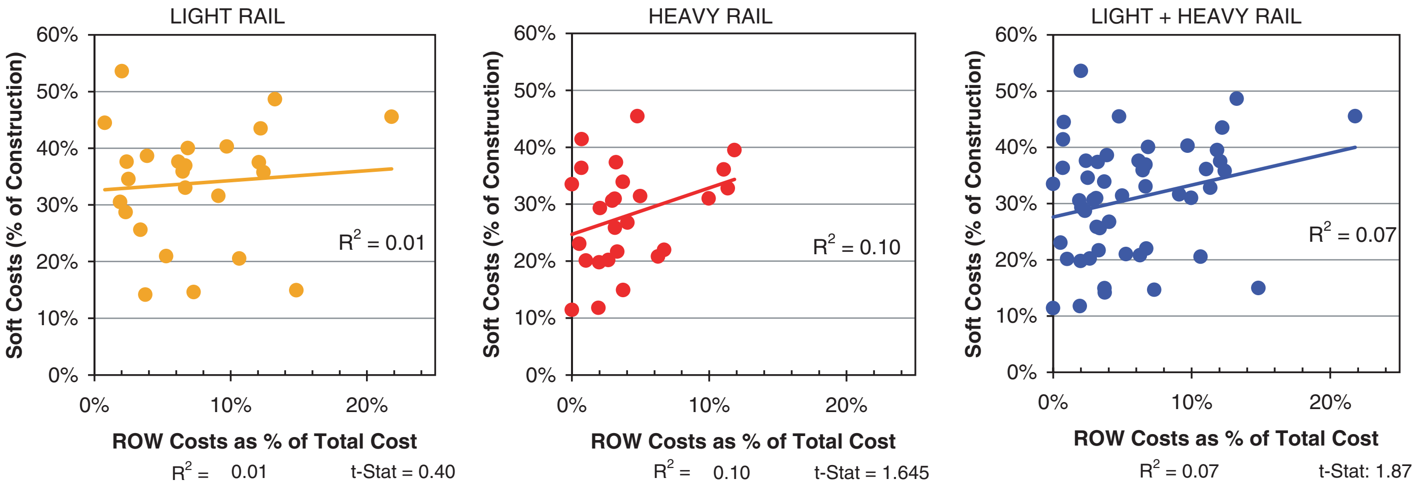

Figure 65. Soft costs as a percentage of construction with right of way costs as a percentage of total cost.

preliminary estimates, and unexpectedly high bids from contractors. To explore the potential effects of early budget estimates on actual soft cost expenditures, this report used data from the report from TCRP Project G-07 (Booz Allen Hamilton Inc., 2005). This data, provided for 22 projects in the original database, is summarized in Table 18.

Figure 67 graphs the data above (outliers removed) and show that budget overruns have little impact on a project's final proportion of soft costs. Cost overruns were measured by dividing the actual as-built cost by the total project cost as it was estimated during the preliminary engineering phase. The outlier shown with significant cost overruns is the Tren Urbano project in San Juan, whose project requirements and design sequence changed substantially during project development, impacting the budget of the project.

Soft costs as a percentage of construction decline slightly as the projects increase in cost escalation, but this trend is not statistically significant. This slight decline was not evident for construction phase project administration costs. This pattern is consistent with the previous figures: since soft costs may tend to grow in relation to other project cost categories, cost overruns have

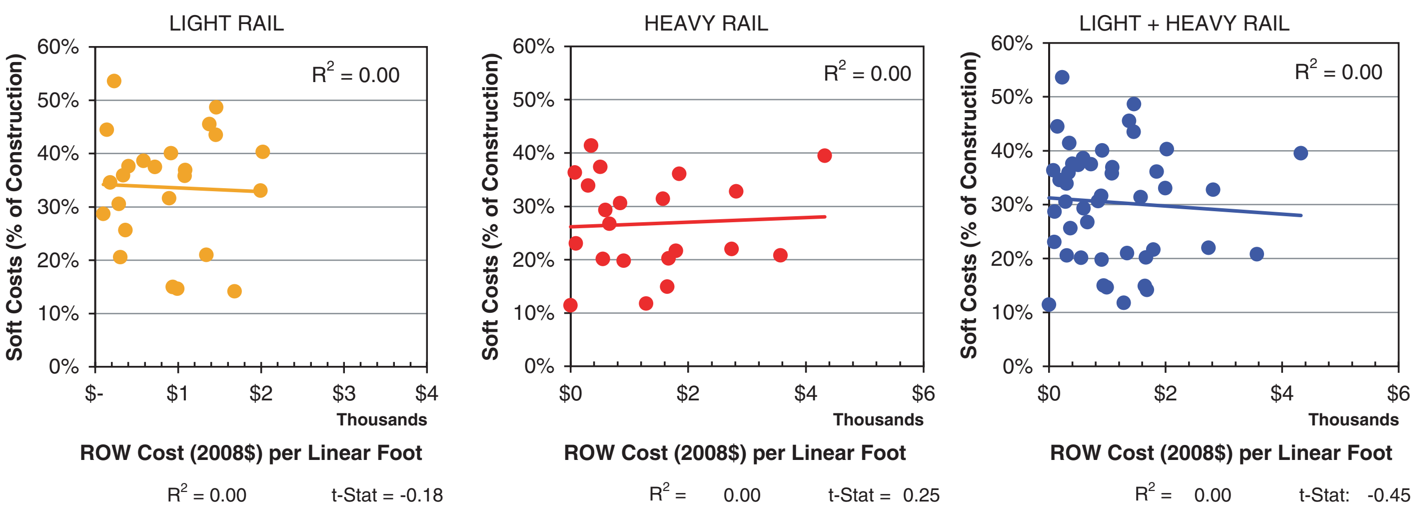

Figure 66. Soft costs as a percentage of construction with right of way costs per linear foot.

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Table 18. Project development budgetary database used.

Project	Cost Estimated at PE	As-Built Cost	Actual Cost as % of PE Estimate
Portland MAX Segment 1	$214.0	$246.8	115%
Hudson-Bergen MOS-I	$775.0	$1,113.0	144%
Hiawatha Corridor	$548.6	$715.3	130%
Portland MAX Interstate	$301.8	$349.4	116%
St. Louis Clair County Extension	$359.1	$336.5	94%
Salt Lake North-South	$261.3	$311.8	119%
Portland MAX Westside/Hillsboro	$913.0	$963.5	106%
Pasadena Gold Line	$803.8	$677.6	84%
Denver Southwest Corridor	$142.5	$175.0	123%
Portland South Corridor	$125.0	$127.0	102%
VTA Tasman West	$327.8	$280.6	86%
VTA Tasman East	$275.9	$276.2	100%
VTA Capitol Segment	$147.1	$162.5	110%
VTA Vasona Segment	$269.1	$316.8	118%
MARTA Dunwoody Extension	$438.9	$472.7	108%
CTA Orange Line	$496.0	$474.6	96%
LA Red Line Segment 1	$914.4	$1,417.8	155%
LA Red Line Segment 2	$1,446.4	$1,921.7	133%
LA Red Line Segment 3	$1,310.8	$1,313.2	100%
San Juan Tren Urbano	$950.6	$2,250.0	237%
BART SFO Extension	$1,070.0	$1,550.2	145%
NYCT 63rd Street Tunnel	$537.9	$632.3	118%

Note: all dollar amounts in year-of-expenditure dollars.

little impact on the relative proportion of soft costs. In short, dollar value costs tend to increase together for a given project, regardless of the characteristics of the project.

C.14. Soft Costs and Project Development Schedule

The length of time it takes to plan, design, and construct a rail transit project may impact soft cost expenditures, as may schedule delay during the project development process. As pre-construction project development phases extend, design costs and project management costs may tend to increase. In addition, delay from the original schedule may also increase soft costs, as certain soft costs continue to be incurred steadily through these schedule delays.

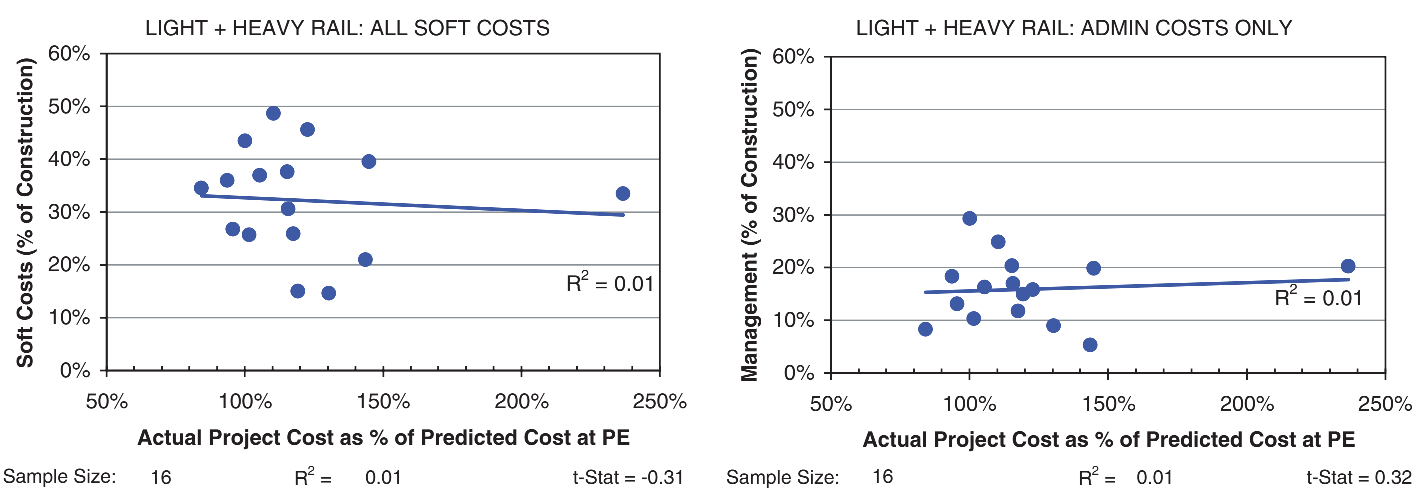


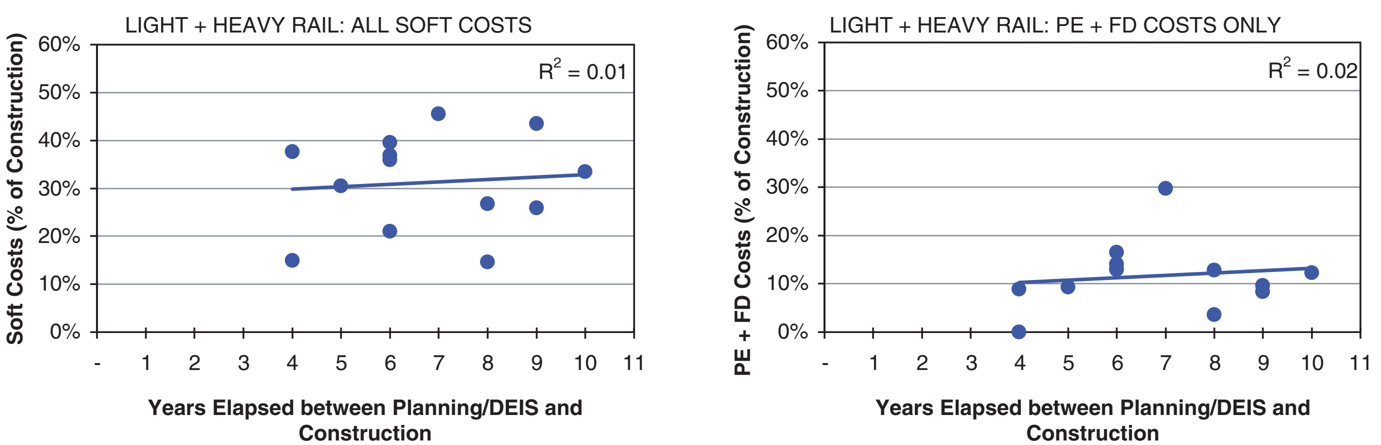
Figure 67. Soft costs as a percentage of construction versus cost overruns.

Table 19. Project development schedule data used.

Project	Planning/ DEIS	PE/FEIS	Final Design	Constr-uction	Operation
Portland MAX Segment 1	1980		1983	1984	1986
Hudson-Bergen MOS-I	1993	1996	1997	1999	2002
Hiawatha Corridor	1993	1999	2000	2001	2004
Portland MAX Interstate	1999	2000	2002	2004	2004
St. Louis Clair County Extension	1995	1998	1999	2001	2001
Salt Lake North-South	1994	1995	1998	1998	1999
Portland MAX Westside/Hillsboro	1990	1991	1994	1996	1998
Pasadena Gold Line	1993	1996	2000		2003
Denver Southwest Corridor	1992	1996	1997	1999	2000
Portland South Corridor		1995	1997		2001
VTA Tasman West	1992	1993	1996	1999	
VTA Tasman East	1992	1995	1999	2001	
VTA Capitol Segment		1999	2000	2004	
VTA Vasona Segment		1999	2000	2005	
MARTA Dunwoody Extension	1990	1991	1994	1998	2000
CTA Orange Line	1982	1984	1986	1990	1993
LA Red Line Segment 1	1983	1988		1989	
LA Red Line Segment 2	1983	1990		1994	
LA Red Line Segment 3	1983	1993		1998	
San Juan Tren Urbano	1992	1995	1996	2002	2004
BART SFO Extension	1992	1996	1997	1998	2002
NYCT 63rd Street Tunnel	1989	1992	1994	1998	2001

To explore this potential, this report again turned to data provided from the report from TCRP Project G-07, *Managing Capital Costs of Major Federally Funded Public Transportation Projects* (Booz Allen Hamilton Inc., 2005). Table 19 shows the project schedule data used in this analysis. This data represents the year in which a project phase began, which is somewhat different from the midyear of expenditure used in other sections of this analysis. When data was not available for all project phases, or when phases appeared to be unreasonable, projects were omitted where appropriate. Resulting sample sizes are noted in the figures, as well as in Table 17.

Figure 68 shows the effect of pre-construction duration (from Planning/DEIS to construction phases) on soft costs as a percentage of construction. Total soft costs are presented in the left pane, and engineering costs (preliminary engineering and final design) costs are presented in the right pane. Note that it may be difficult to identify a single year for the "Planning and DEIS"



Sample Size: 13 R^2 = 0.01 t-Stat = 0.32

Sample Size: 13 R^2 = 0.02 t-Stat = 0.46

Figure 68. Soft costs as a percentage of construction versus years elapsed between completion of the draft environmental impact statement and construction.

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phase for a project since the long-range planning process may be very different for each metropolitan area or agency. The correlation is positive, as expected, but the relationship is statistically insignificant.

Measuring soft costs on a per-linear-foot basis, however, produces a stronger relationship, as shown in Figure 69. Total soft costs are presented in the left pane, and engineering costs (preliminary engineering and final design) costs are presented in the right pane. In the right pane, the results are pronounced from an x-axis intercept at four years toward a maximum range of about $20,000 per linear foot at about 15 years between the DEIS completion and construction. This relationship holds for engineering soft costs as well, as shown in the right pane.

These findings seem to suggest that the duration of pre-construction phases should be considered within the estimate of soft costs. However, the findings in Figure 69 may simply show that costly projects take longer to plan and design. Caution should be given due to the relatively small sample size (15) and the role of four relatively costly projects in this chart.

Figure 70 measures the effect of a more narrowly defined pre-construction phase (PE/FEIS to construction) on soft costs, and shows insignificant findings. The relationship shows the correct direction of increasing soft cost percentage with increasing schedule duration but is statistically insignificant. The relative magnitude of soft costs, including engineering costs only, appears to be unaffected by the years elapsed between the preliminary engineering and construction phases.

Figure 71 extends the above analysis to include the duration through construction all the way to operations, and finds similarly inconclusive results. Total soft costs are presented in the left pane, and construction management and administration costs are isolated in the right pane. Administration costs are shown here to test the hypothesis that construction and other administration costs may be more likely to be affected by the duration of the construction phase. Although soft costs do tend to go up for lengthier projects in Figure 71, the relationship is not statistically significant.

The duration of a project may not cause soft costs to increase as much as delay or deviation from a prior schedule. During a delay, if construction costs and project scope remain stable, but administration activities continue steadily, soft costs in relation to construction costs might increase.

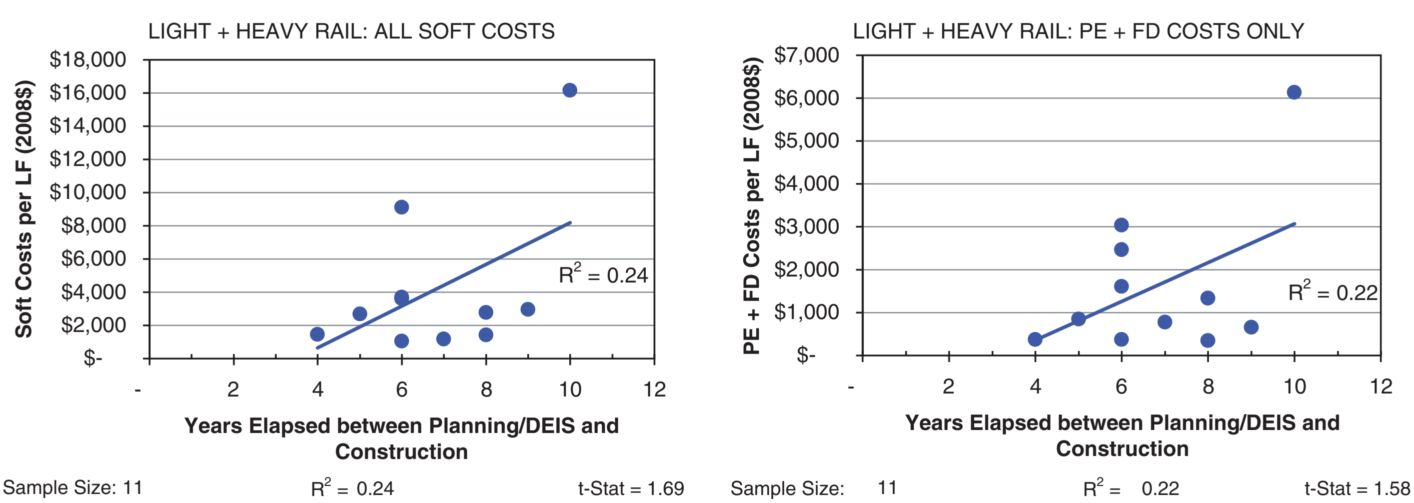

Figure 69. Soft costs per linear foot versus years elapsed between completion of the draft environmental impact statement and construction.

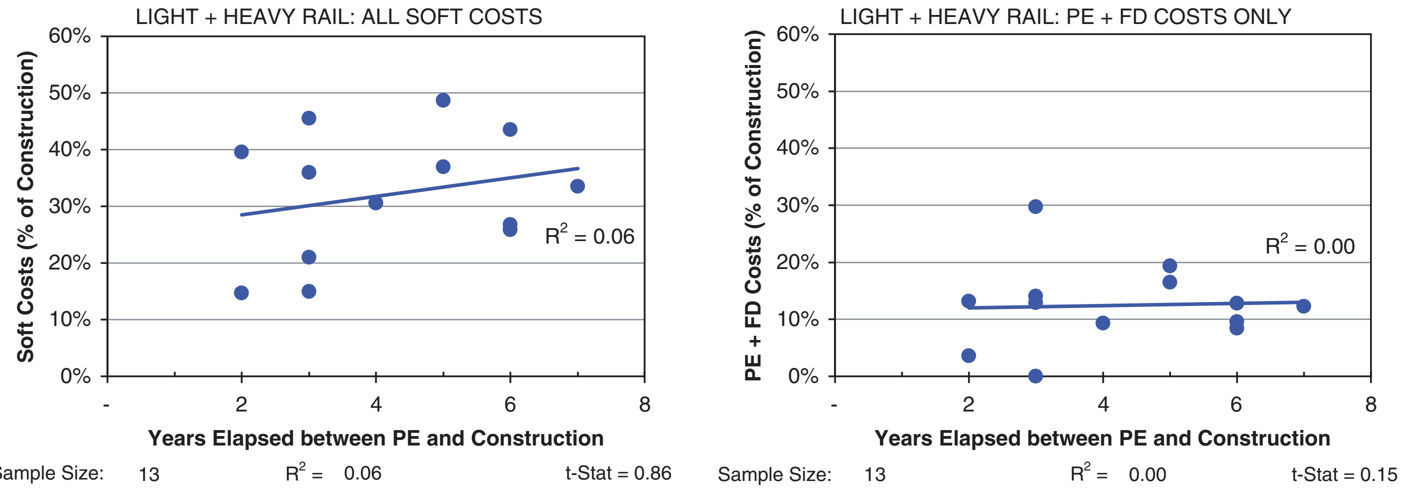

Figure 70. Soft costs as a percentage of construction versus years elapsed between preliminary engineering and construction.

Figure 72 presents the variance between the project opening date projected during the preliminary engineering phase and the actual project opening date and compares this to soft costs as a percentage of construction. Presumably, a deviation from the opening date predicted during engineering phases represents a delay. Note that many projects in this dataset were not delayed at all (zero years), while two actually opened ahead of schedule. Figure 72 shows no strong relationship with years of delay and the proportion of soft costs.

C.15. Vertical Profile and Soft Cost Measurement

Somewhat surprisingly, this soft cost analysis found a relatively weak correlation between vertical profile (and by extension, project complexity) and a variety of soft costs measured as a percentage of construction costs. One possible explanation for this finding is that tunneling and aerial structures increase construction costs so rapidly that soft costs as a share of the project do not change measurably beyond the construction costs and increase the soft cost proportions.

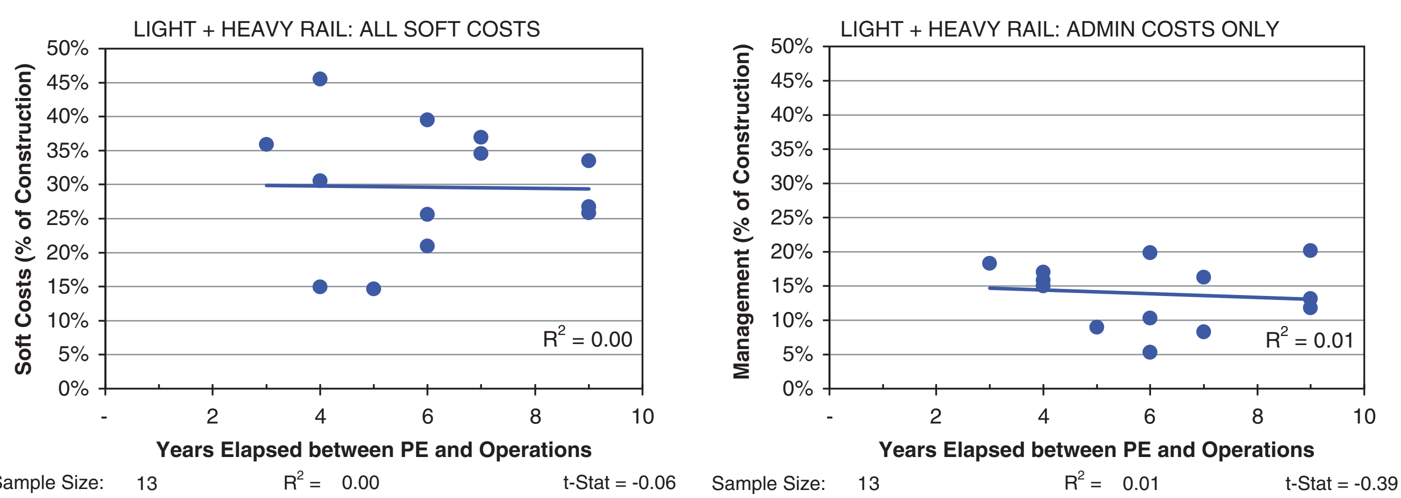

Figure 71. Soft costs as a percentage of construction versus years elapsed between preliminary engineering and operations.

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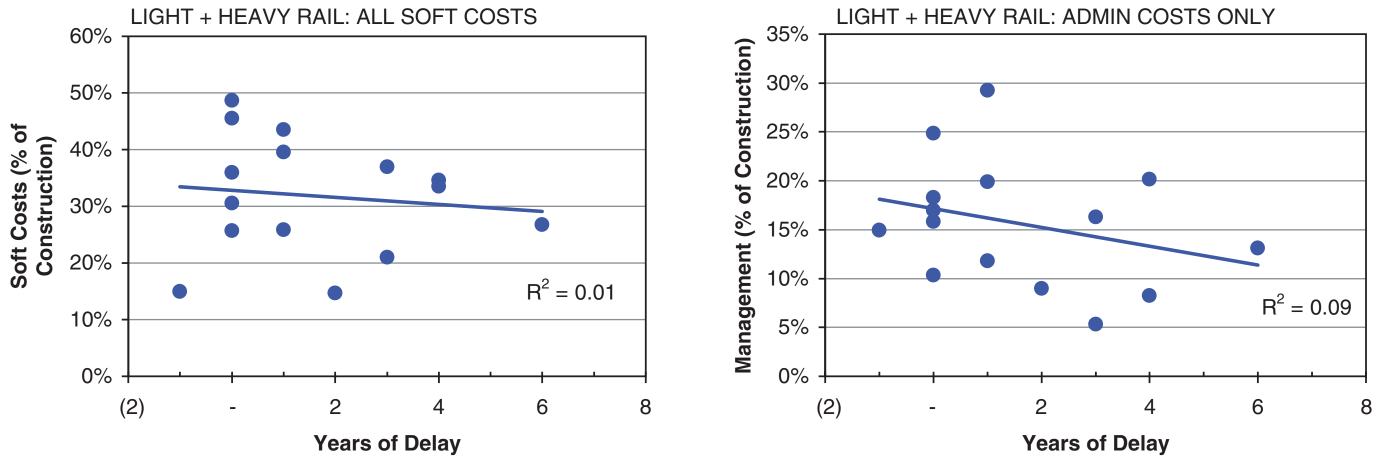


Sample Size: 15 R^2 = 0.01 t-Stat = -0.43 Sample Size: 15 R^2 = 0.09 t-Stat = -1.14

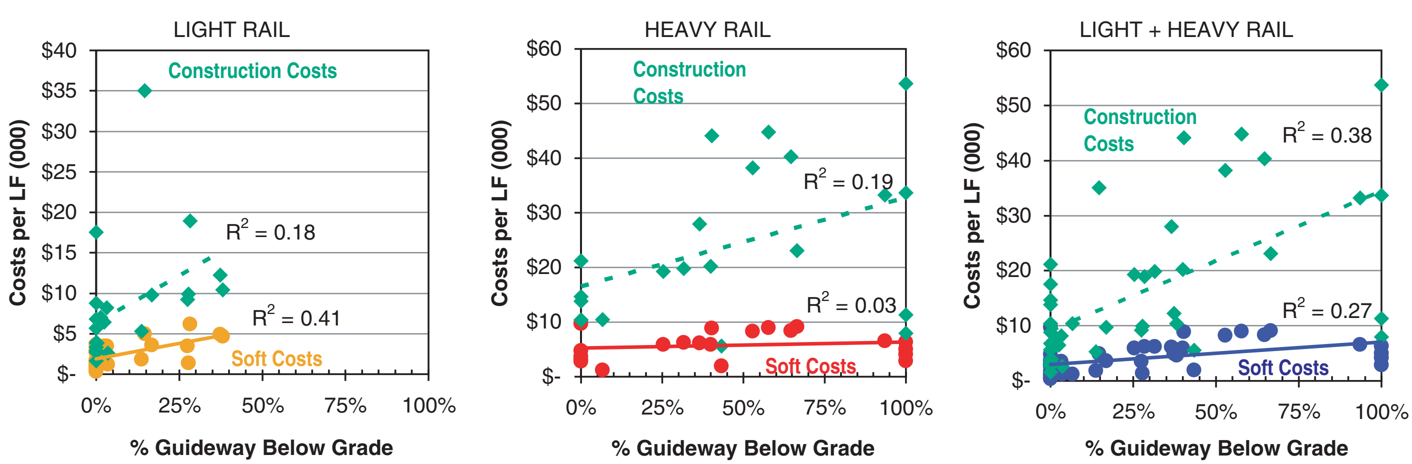
Figure 72. Soft costs as a percentage of construction versus years of delay in opening.

Figure 73 and Figure 74 examine this potential explanation by comparing the rate of growth of soft and hard costs as the vertical profile becomes more complex. Soft and construction costs are on a per-linear-foot basis, and in every pane construction costs are shown as green diamonds, with a green dashed trend line.

Figure 73 shows that for light and heavy rail and both modes combined, as more of the alignment is in cut and cover and tunnels, construction costs rise faster than soft costs. Figure 74 shows a similar trend when alignment is simply not at grade, although the pattern is less strong. These trends affirm that when the alignment moves from at grade to more complex tunnel, bridge, or aerial structures, construction costs expand rapidly, sometimes faster than soft costs.

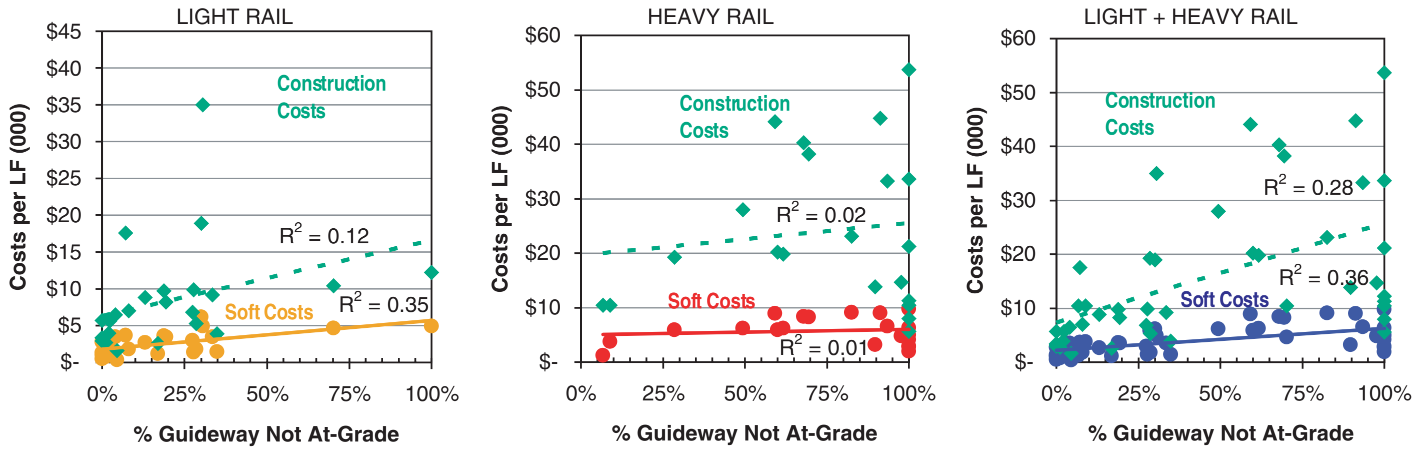
C.16. Isolating Agency-Specific Effects

One potential source of variance within the dataset used here is that financial and construction management practices differ from agency to agency. Where one agency maintains construction inspectors and managers on staff through the operating budget, another agency might



Soft Costs trend: R^2 = 0.41 t-Stat = 3.87 R^2 = 0.03 t-Stat = 0.76 R^2 = 0.27 t-Stat: = 3.94

Figure 73. Soft costs and construction costs per linear foot with percent of guideway below grade.



Soft Costs trend: R^2 = 0.35 t-Stat = 3.45 R^2 = 0.01 t-Stat = 0.52 R^2 = 0.36 t-Stat: = 4.88

Figure 74. Soft costs and construction costs per linear foot with percentage of guideway not at grade.

charge these employees to the project's capital budget, for example. In another case, certain agencies collect internal staff, force account, and contractor staff into separate operating accounts and then allocate them back to specific projects. These differing approaches may have some impact on the soft cost amount used in this analysis.

The philosophy or style of agency management might have just as much impact on soft costs as the alignment profile or number of stations. However, it is particularly difficult to control for agency-specific effects given the range of potential impacts and the generally small number of new rail construction projects per agency.

The dataset contains twelve distinct projects for Washington, DC, presenting an opportunity to try to isolate agency-specific effects. Examining only projects constructed by WMATA means analyzing projects with very similar project development processes and cost allocation practices. WMATA has expanded its Metrorail system incrementally over the past four decades, with each extension or new line treated as a discrete project in the database. This section of the report restates some of the previous analysis for WMATA projects only.

Figure 75 shows that soft costs for WMATA projects have been increasing in percentage terms over time. From the initial Metrorail segments completed in the 1970s through the projects completed in the late 1990s, WMATA has seen an increasing trend in soft costs. The initial segments of Washington DC's rail system had soft cost percentages of construction at about 20%. Through the rail extensions in the 1980s, soft cost percentages were mixed, with projects higher and lower than 20%, with a range from as low as 11% to as high as 38%. The three projects completed in the 1990s, however, had more consistent soft cost values of about 38%.

Figure 76 examines the soft cost percentage of construction costs with the percent of project alignment not at grade. In contrast to the full database for heavy rail, WMATA projects suggest a declining trend in soft costs with more complex alignments. The heavy rail project database showed an increasing trend from 27% to 36% with a statistical relationship, but little correlation. The WMATA statistical relationship is also insignificant, but does result in a declining trend more similar to the combined project database. Analysis of the full project database suggests that this pattern may be caused by other project categories growing faster than soft costs for these alignment types.

Figure 77 presents a similar analysis but is focused on only the proportion of alignment that is below grade for WMATA projects. The results of this WMATA analysis are similar to those

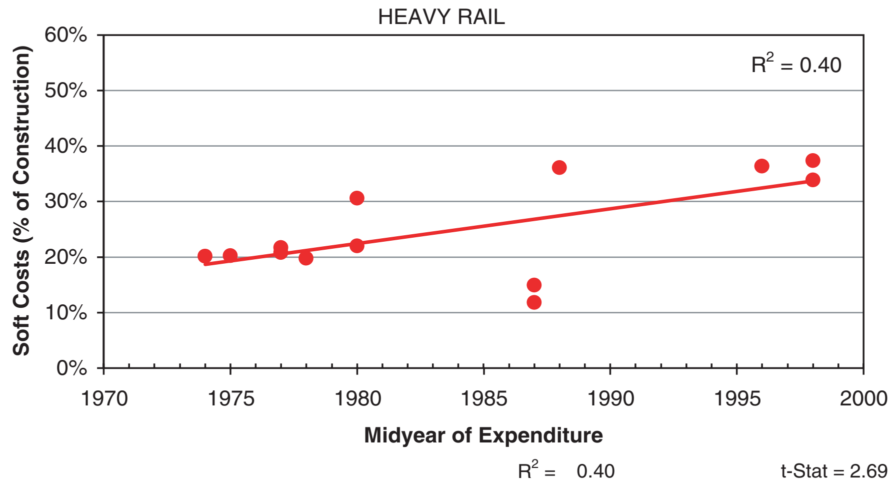


Figure 75. Soft costs as a percentage of construction versus midyear of expenditure, WMATA only.

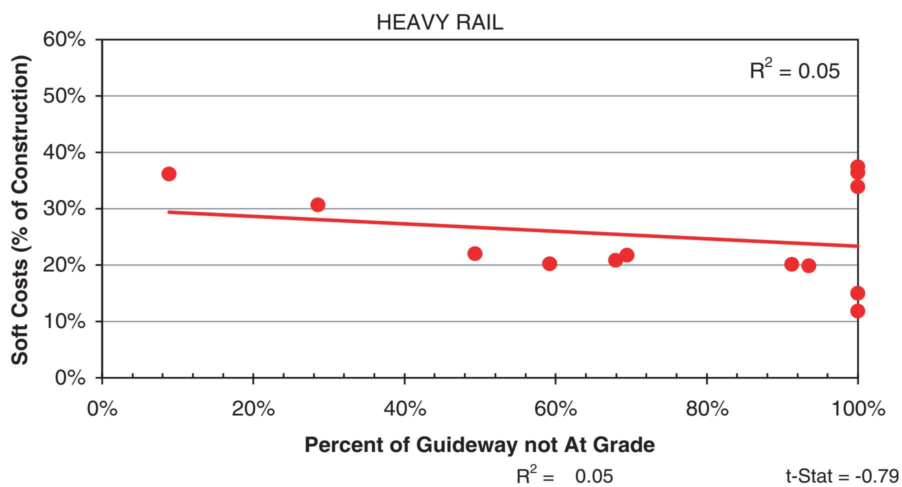


Figure 76. Soft costs as a percentage of construction with percentage of guideway not at grade, WMATA only.

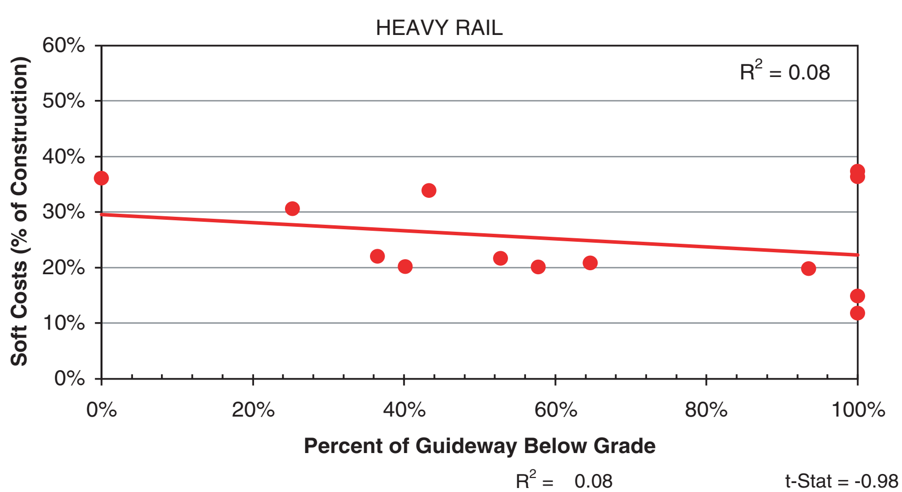


Figure 77. Soft costs as a percentage of construction with percentage of guideway below grade, WMATA only.

from the full database of heavy rail projects. The trend line shows a declining trend from a high of 30% to a low of about 22%, but the relationship is not statistically significant. Note that some WMATA projects are 100% below grade. These results suggest that below-grade alignment has no effect on soft costs as a percentage of construction costs.

These WMATA Metrorail results do not support the full heavy rail database, nor do they demonstrate consistent relationships that may be expected for projects from the same agency.

The results from the preceding WMATA-only data demonstrate the difficulty in identifying project characteristics that can be used to help estimate construction soft costs of major public transportation capital projects.

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

VERIFICATION

I, J. Christopher Kaufman Jr., affirm under penalties of perjury that the foregoing representations are true and correct to the best of my knowledge, information, and belief.

J. Christopher Kaufman Jr.

Date: 8/30/2018

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