Cost Escalation Rate Study for Caltrans District 4 Projects

2009 Update

May 2009

Caltrans
DISTRICT 4

Cost Escalation Rate Study

for

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<u>2009 UPDATE</u>

Prepared for

California Department of Transportation
District 4

Prepared by

URS CORPORATION

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EXECUTIVE SUMMARY

In 2007, the California Department of Transportation ("the Department," or "Caltrans") decentralized the process for determining escalation rates to be applied to construction cost estimates. Each Caltrans District was authorized to calculate and apply its own escalation rate to project cost estimates within their district rather than the traditional statewide rate of 3%.[1] As a result, District 4 undertook this Cost Escalation Rate (CER) Study to develop a methodology to calculate annually a rate appropriate for projects within that district.

For the purposes of this study, *escalation* is defined as the effect on a contractor's bid for a construction project (of fixed, known, scope) from changes in input costs (labor, materials, equipment, supplies) and other construction market conditions (overhead and profit). *Contingency*, on the other hand, is applied to a cost estimate to account for unknown site conditions, unforeseen changes in a project's scope, and other unknowns. Definitions and applications of escalation and contingency are further detailed in Section 1.0.

Cost escalation methods currently used by Caltrans and other state DOTs are explored in Section 2.0. Interviews with staff of these agencies resulted in two primary findings:

- The 'basket' of construction inputs (steel, concrete, grading, etc.) used to calculate construction cost indexes (CCIs) vary considerably among the agencies surveyed. Further, there are considerable differences as to which inputs constitute the majority of the overall construction costs experienced.
- Forecasts by private companies such as Global Insight and Engineering News-Record (ENR) and by educational institutions as the UCLA Anderson School of Management are currently being used to provide escalation rate inputs by District 3.

The study team conducted a comparison of two forecasting approaches and determined that construction input price forecasts (for materials, labor, and equipment), rather than historical bid data, can more accurately reflect changes in the market and more effectively calculate future costs of construction projects.

In Section 3.0, cost inputs for District 4 are matched with externally-provided economic forecasts (e.g., from Global Insight) in the District 4 CER Forecasting Model ("CER Model," or "Model"), a CER forecasting tool developed by the study team. Important drivers of escalation and the principal components of the Model are: (1) increases in materials prices and wage rates, (2) industry practice in accounting for "mark-up" costs such as mobilization and field overhead, and (3) the relative competitiveness of the construction market at the time of bid.

In order to provide a check of the CER Model's effectiveness at an initial level of validation, the Model was run for the years 2003 through 2008. Cost escalation rate estimates produced by the Model were compared to actual construction CERs for these years as represented by the California Construction Cost Index and other, independent sources. Results demonstrate that the Model provides a reasonable assessment of anticipated escalation rates. Sensitivity analysis was also conducted to identify the cost forecast inputs that contribute the most significant amount of uncertainty to model results. Labor costs were found to have largest effect on CER forecasts, as followed by costs for key materials and supplies.

[1] In the past, a single escalation rate for the Department (based on a California Department of Finance forecast) has been applied to the estimated construction cost for all projects in the STIP.

CER Model forecasts for FY2009-13 and FY2010-14 are provided in Sections 4.1 and 4.2, respectively. The FY2009-13 forecasts, completed in July 2008 and based on input data for the 2nd quarter of 2008, are as follows:

- **FY 2009 – 1.7 percent**
- **FY 2010 – 4.0 percent**
- **FY 2011 – 7.3 percent**
- **FY 2012 – (1.8) percent**
- **FY 2013 – (2.4) percent**

New forecasts completed in March 2009 for the FY2010-14 period, using GI input cost forecasts released the 4th quarter 2008 that reflect changes in the economy during the second half of 2008, are:

- **FY 2010 – 0.8 percent**
- **FY 2011 – 5.6 percent**
- **FY 2012 – 8.3 percent**
- **FY 2013 – 3.2 percent**
- **FY 2014 – (1.2) percent**

Reasons for the differences in the two sets of forecasts are discussed in Section 4.2 Model documentation can be found in Appendix D of this report.

Fifteen (15) recommendations are provided in Section 5.0, outlining additional opportunities for enhancements and improvements to: (1) construction cost data collection and analysis, (2) the CER Model itself, and (3) project cost estimation and contractor bid process requirements and procedures. Among the most important of these recommendations are:

- Save all data from the Caltrans Construction Cost database in Microsoft Excel™ format, or create database code to allow such data to be easily exportable to Excel. Produce historical data in this format going back five years (to 2002).[2]
- Update the California Construction Cost Index (California CCI) to include a new and enlarged "basket" of cost components (BEES codes), with a goal to cover at least 70% and perhaps as much as 80% of all direct costs.[2]
- Review and critically evaluate alternative third-party forecast providers: Global Insight, UCLA, and ENR to determine which has had the best forecasting track record.[2]
- Establish a formal peer review process to periodically evaluate the CER Model structure and inputs. Use mail-out surveys and/or expert panel(s) of industry experts, focusing on the types of costs included in the Model, the appropriate matching of those costs with external forecast series, and formulas for weighting inputs.
- Create "early warning system" to track short-term changes in market conditions and provide estimators and managers with evidence of potentially large movements in prices, risk, and contractor premium.

[2] As of early 2009, this recommendation has either been implemented or work is actively underway.

- Work with other Caltrans Districts and Headquarters to review and revise the BEES code structure and make modifications as necessary to establish more standard definitions and usage of inputs among all Caltrans units.
- Establish a more detailed bid reporting format, similar to that used by contractors for their internal estimates: WBS items (BEES codes) broken out by cost components (labor, materials, equipment, time, risk, etc.). It is understood that this is a long-term recommendation with significant cost and complexity implications. (See Section 5.0.)

1.0 INTRODUCTION

1.1 Cost Estimation and Escalation: Elements, Structure, and Process

In 2007, the California Department of Transportation's (Caltrans) Chief Engineer and Chief Financial Officer announced that the escalation rates previously applied on a statewide basis to planned and programmed projects would now be determined and applied by each of the District offices. This decentralization of the escalation forecasting process would enable each District to include or exclude factors as applicable to their geographical area, business climate, and other unique situations.

To develop an appropriate mechanism for calculating a cost escalation rate (CER) for its projects, District 4 engaged URS in early 2008 to conduct a comprehensive study that included:

- An assessment of current programming requirements;
- The clarification between contingency rates and escalation rates;
- An analysis of escalation rate calculations by other Caltrans Districts;
- An analysis of escalation rate and construction cost indexes of other states;
- A recommendation of the escalation rate inputs and methodology for District 4; and
- A consideration of the Risk Analysis with the recommended escalation rate.

Ultimately, a cost escalation rate model ("CER Model" or "Model") was developed to calculate individual escalation rates for five years into the future. The resulting rates, when applied to current year cost estimates for planned and programmed projects, provides a reliable estimate of the funding required to *construct* projects in future years ("year-of-expenditure dollars") and assist with the programming of future projects.

As construction is the most costly phase of project development, and as construction costs are most affected by changes in external costs (labor, materials, and equipment), the study focused on *construction* cost only. Thus, this report – and the CER Model – do not address escalation rates for other project costs such as right-of-way, planning, engineering, environmental studies, and utility relocation. (The District may wish to develop an escalation methodology for one or more of these costs in the future.)

Further, the CER method described in this report deals only with future changes in unit costs due to price changes, overhead allowances, and contractor profit margins. It does not consider uncertainties in cost estimating generally, which are typically handled through use of a *contingency*. *Contingency* is an allowance to cover unknown conditions and unforeseen work. *Escalation* is the movement of input prices over time. Differences between escalation and contingency are discussed further in Sections 1.3 and 1.5.

This report differs from other industry research by its focus solely on *input price escalation.* Other recent studies have employed a more general definition of 'escalation.' For example, the National Cooperative Highway Research Program (NCHRP), in their *574 Report: Guidance for Cost Estimation and Management for Highway Projects During Planning, Programming, and Preconstruction* (September 2006), conducted a nationwide assessment of the elements that contribute to construction projects costing more that originally estimated. In this report, 'escalation' is used as a collective term for anything that can contribute to a project costing more than originally estimated such as, for example, changes to project scope and poor base calculations. The *574*

Report provides policy guidance to help transportation departments generate more accurate base cost estimates and contingencies.

Indeed, the *574 Report* suggests use of a 5% add-on to the base project cost estimate to account for inflation. However, as has been experienced in recent years, a fixed 5% inflation rate may not always be applicable to estimating future costs of a construction. The CER study was commissioned to produce an escalation rate to be applied to base (current year) cost estimate to escalate it to a future year-of-expenditure cost level.

Cost estimates are comprised of input elements required to complete the project. Inputs are typically categorized as:

- **Labor** – Costs associated with the people and the person hours required to complete the work. Labor is typically based on an hourly rate that accounts for salaries, benefits, and overhead.
- **Equipment** – Costs associated with the machinery, tools, and other construction related activities necessary for the completion of the project and may include cost for acquisition, transport, maintenance, and operations.
- **Materials** – Costs associated with the elements that will be used for the construction of the project. Construction costs typically include concrete, steel, asphalt, and other materials that contribute to the project.

Caltrans uses the Basic Engineers Estimate System (BEES) to estimate project costs during design. The BEES contains a listing of hundreds of potential inputs into a construction project. The types of input and quantities of material are entered into the BEES. Items not already in the system will require a description when entered into the BEES. The output from the BEES is a total cost estimate for the project in present day dollars.

1.2 Construction Cost Index

The California Construction Cost Index (California CCI) provides information on cost increases over time. Seven construction materials inputs are used in the index: Roadway Excavation, Aggregate Base, Asphalt Concrete Pavement, Portland Cement Concrete (pavement), Portland Cement Concrete (structure), Bar Reinforcing Steel, and Structural Steel. The cost of labor to transport or use the material is typically included in the unit cost for these materials. If there is a significant change in labor rates, this will be reflected in the unit cost for these materials during the calendar year for which the contracts were awarded.

The California CCI could be used as a forecasting tool to estimate potential price escalation based on historical data and bid prices. However, it is not used in this way by Caltrans.

The following BEES codes are used in calculating the California CCI:

- Roadway Excavation: 190101
- Aggregate Base: 260201, 260301
- Asphalt Concrete Pavement: 390102, 390103, 390106, 390155, 390160
- Portland Cement Concrete (Pavement): 401000
- Portland Cement Concrete (Structure): 510051, 510053, 510060
- Bar Reinforcing Steel: 520101, 520102, 520103
- Structural Steel: 750501, 750503, 550203, 550204

In accordance with the Pareto principle, 80% of the overall cost of the project is attributed to 20% of the budgeted line items. Typically cost indexes focus on the value of inputs that account for the largest percentage of overall construction costs.

The elements of the California CCI were originally selected as they comprised the majority of the cost for a construction project. Depending on the type of roadway or structure being built, these seven inputs would typically comprise 60-70% of the entire budget for a roadway/bridge structure. Other projects, such as Intelligent Transportation System (ITS) projects, are not reflected in the California CCI.

Review of the 2007 Construction Costs for District 4 revealed that the nineteen (19) BEES codes currently used in the Caltrans California CCI accounted for only twenty-one percent (21%) of the District's total construction expenditures. Three of the codes – 390103, 390155, and 390160 – were not used at all by District 4 in 2007. In addition, the District used other, similarly named codes in its estimates, codes which are not part of the California CCI. This suggests that the components and structure California CCI should be reviewed and modified to address these concerns (see Chapter 4.0).[3]

1.3 Nature and Management of Uncertainty

When anticipating the future expenditure for a construction project, one must conduct two types of analysis: Cost (what are the anticipated costs) and Risk (what are the unanticipated costs).

1.3.1 Cost Analysis

Cost analysis is the assessment of the anticipated funding necessary to cover the project cost based on the labor and materials necessary to complete the project. The cost analysis includes the type and amount of materials, labor, and equipment that will be necessary to complete the project as specified. A cost analysis considers the inflation rate from the initial cost estimate year to the construction year. The gap between the initial estimate year and the actual construction year could range from five to twenty years depending on the type and location of the project. A cost analysis can be done at 5% design, or 95% design. As the level of confidence in design (quantities) goes up, then the size of the contingency will reduce.

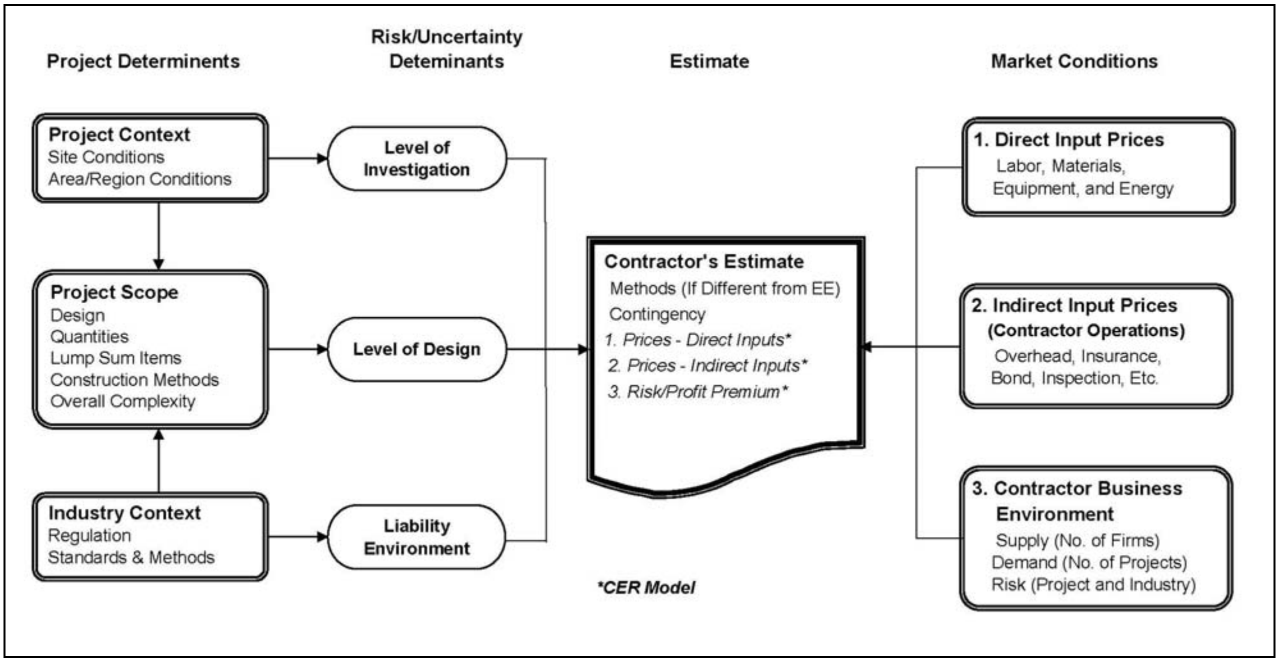
1.3.2 Risk Analysis

Risk analysis considers the probability of a future uncertain event and its consequences. Construction bid risk is accommodated through <u>contingency</u> and <u>escalation</u>. Both anticipate resources yet they account for two different risk elements. Contingency is an allowance to cover unforeseen work. Escalation is the estimation of price movements over time. For example, additional work may occur do to unforeseen ground conditions, while prices for key materials (steel, asphalt, etc.) may spike due to changes in world markets.

Risk must be considered when taking a base cost estimate and advancing it to a future cost estimate based on inflation. It is possible that several materials could increase in cost far above the rate of inflation, as occurred in 2004 and 2005. Risk analysis can be done throughout the design process, and the level of uncertainty surrounding different cost items will diminish as the project proceeds from 5% to 95% design. **Figure 1** demonstrates the role of risk within the estimating process.

[3] The review of the California CCI is now underway, with the goal of revising the set of inputs to provide a better representative sample of actual costs.

Figure 1 – Contractor Bid Determinants and Risk



1.3.3 What Contingency Anticipates

Contingency is a mark-up applied to a base cost to account for uncertainties in quantities and minor risk events related to quantities, work elements, or other project requirements during project development. As the project evolves, the contingency is reduced as more information becomes available about the project scope and anticipated costs. Contingencies remain through construction to cover costs of unexpected items such as:

- Weather delays
- Accidents
- Traffic control
- Contract change orders
- Mitigation issues
- Discovery of archeological artifacts or remains
- Replacement/repair of equipment

The contingency fund set aside for a project will vary based on the risk associated with the type of project: time of year, ownership of equipment, location, proximity to supplies, complexity of construction, schedule constraints, etc.

1.3.4 What Escalation Anticipates

Unlike contingency, which covers delays and unanticipated incidents, escalation covers the potential increase in cost of the project's inputs. Any changes in the market supply or demand of an input will impact the price and availability of that input. Escalation reflects market behavior and reacts to substantial events or trends that affect input prices. Disasters may alter market trends as inputs are re-allocated to meet a need. International events, such as wars and embargos, can also alter input availability.

The Federal Highway Administration (FHWA) has reported, for example, that the continuing escalation of global fuel prices contributed to the recent construction cost increases nationwide. Of note is the price of Hot Mix Asphalt, which is estimated to be 36% dependent on petroleum product prices. In 2005 and early 2006, several construction input prices rose much faster than consumer or producer price indices, both in California and nationally. In addition to the high fuel costs, other factors that may have previously contributed to a spike in construction costs during this period:

- Localized material shortages (e.g., those tied to the 2001-06 California housing boom)
- Consolidation of construction companies, resulting in a reduction in number of bidders
- Increased construction in other areas (e.g. housing)
- A reduction in refinery capacity
- Shortages of skilled labor and increases in wages/benefits in key areas

Though both the California Construction Cost index and FHWA index increased rapidly in 2004, 2005 and 2006, there is now a downward trend in unit costs in 2008. This can be attributed to the slowing economy and recent downturn of the housing industry, which is freeing up materials, labor, and contractors for transportation projects. In particular, the slackening of demand for construction services has led to greatly increased competition among contractors and lower bids.

1.4 Purpose and Scope of this Analysis

While contingency rates can be reduced as a project nears construction, escalation can fluctuate for numerous economic reasons over the course of the project. As escalation rates require a comprehensive and dynamic approach to provide a reasonable assessment on potential future construction costs, an assessment to the inputs and means of calculation of the escalation rate is important for the overall project estimation.

The purpose of the analysis documented in this report is to generate an escalation rate applicable to construction cost estimates for projects within District 4. The scope of this analysis is to review the current cost escalation practices used by other Caltrans Districts and other state DOTs, assess the benefits of the various methodologies, provide an estimated cost escalation rate (CER) for FY 2009 through FY 2013, and to provide a recommended methodology for calculating cost escalation rates in the future. This analysis will also include recommended topics for additional study that could provide additional benefit to the District.

1.5 Key Definitions and Assumptions

1.5.1 Construction Costs Versus Project Costs

For the purposes of this document, all references to cost estimating and cost escalation are for *construction* only. While escalation does occur with other *project* costs such as right of way acquisition and relocation, environmental mitigation, Caltrans staff time, and consultant services (planning, environmental, design, and construction services), the high cost associated with construction and the extensive impact on overall project cost associated with changes in construction cost warrants a focus on construction activities and their resulting costs.

1.5.2 Contingency Rates

A contingency rate is the percentage applied to the base construction cost to calculate an amount of additional funds that should be held to cover unknown or undefined expenses. Prior to completion of project Plans, Specifications, and Estimate (PS&E), an engineer will include a contingency to cover future unknowns.

Contingency rates decrease as the project advances through the design phases. In the initial phase, the contingency can be as high as 50%. As the project evolves through advanced study and detailed design, the elements of the project and its surroundings become clearer and there are fewer unknowns. The contingency rate should be 5% to 10% at the end of PS&E, when the project is certified and deemed ready to list. [4] While contingencies will vary based on specific elements of the project, the typical contingency at each phase is as follows:

Project Initiation Document (PID)	25%-50%
Project Approval and Environmental Document (PA/ED)	15%-20%
Plans, Specifications & Estimates (PS&E)/ Ready to List	5% -10%

1.5.3 Escalation Rates

Escalation is defined as an increase in cost due to upward changes in prices due to changes in market conditions. Because costs typically increase over time, escalation rates must be developed for future forecasting purposes. The rates are in the form of annual percentage change, which are used to "escalate" the base year estimate to the projected future year of actual bid and expenditure. Actual escalation rates vary from year to year, and can be forecast to vary in future years as well. Though less common, escalation rates can be negative as well, reflecting decreases in one or more prices.

Escalation rates are influenced by many factors, such as increases in development and building costs, legislation, and general economic conditions. The effect of these factors can be estimated but cannot be determined with any real certainty. Input data used in establishing escalation rates may be found in assessed value trends from resales, the direction and trends of future development of areas, private and governmental forecasts, and construction and building cost indices. Past experience in estimating, appraising, and acquisition in the subject area should not be overlooked as judgment and experience aid the estimator in determining the proper rate. Improved methods of determining proper rates should be continuously sought.[5]

Unlike contingency rates that decline as a project advances through design, escalation rates can increase or decrease throughout the life of the project. For purposes of project programming in the STIP or SHOPP, current year project cost estimates are escalated to the year the programmed moneys are to be encumbered or expended, typically at the beginning of PA/ED, PS&E, and construction. Construction costs should be escalated to the year of construction, except where unusual circumstances dictate otherwise.[6]

[4] Contingency rates can also be applied to right-of-way acquisition, relocation assistance, clearance/-demolition, and title and escrow costs. Contingency provides for possibilities such as administrative settlements, condemnation awards, utility overruns, interest payments, and unanticipated goodwill payments. Contingency rates in regards to right-of-way activities are not a part of the scope of this study.

[5] For the purposes of this study, escalation rates for right of way, utility relocation and other non-construction costs were not assessed. The Department may wish to consider implementation of a CER process for those costs at a future date.

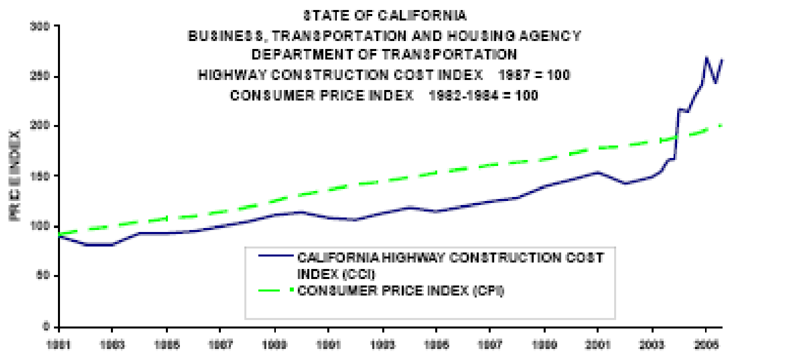
[6] Traditionally, construction cost estimates have been escalated to the mid-point of construction, based on the assumption that contractor bids will reflect some increase in prices over the period of construction. More recently, District 4 has enacted a policy of escalating only to the beginning of construction to offset recent declines in bids relative to engineer's estimates. The escalation rates presented in this report are presumed to be set at mid-year (July 1) and can be applied going forward using either approach.

1.5.4 Relationship Between Inflation and Escalation

Inflation is the process of continuously rising prices, or equivalently, of a continuously falling value of money. The Consumer Price Index (CPI) is the most widely used measure of inflation. It provides information about price changes in the nation's economy to government, business, labor, and private citizens and is used by them as a guide to making economic decisions. The Producer Price Index (PPI) measures inflation at the wholesale level, and is viewed as a more appropriate general index for heavy construction.

Inflation and escalation, though related, are not interchangeable. While escalation can be driven by general inflation related to the money supply, escalation is also driven by changes in technology, practices, and particularly supply-demand imbalances that are specific to a good or service in a given economy. For example, while general inflation reflected in the CPI in the US was less than 5% for 2003-2007, steel prices escalated by over 50% because of supply-demand imbalance. This is demonstrated in **Figure 2**.

Figure 2 – Comparison of CCI (California) & CPI (US)



Source: Ten-Year State Highway Operations and Protection Plan, Caltrans, 2007

1.5.5 Other Definitions

This section includes the definitions of several terms used throughout this report.

Analogous Estimating*:* Using the actual cost of previous similar projects as a basis for estimating the cost of the current project. While this method is less costly than other methods, it is also generally less accurate and does not reflect market driven factors and escalation.

Construction Cost Index (CCI)*:* Published monthly or quarterly by many state Departments of Transportation (DOT), the CCI provides a price index for a standard bundle of construction related commodities. The bundles vary among states. Caltrans produces quarterly updates of its CCI.

Consumer Price Index (CPI): Published monthly by the Bureau of Labor Statistics, the CPI measures changes in the prices of a standard bundle of commodities purchased under a similar set of circumstances. As with the CCI, the index is expressed in the form of a ratio of current year prices to some base year times (X) 100. The base year index, therefore, is defined as 100.0. If the index in a given year is 122.5 for example, then there has been a 22.5 percent increase in prices since the base year.

Cost Estimating*:* Developing an approximation of the expenses for all resources needed to complete a project, including but not limited to professional staff time, labor, materials, equipment, services, supplies, right-of-way, insurance, etc.

Forecasting*:* Making estimates or predictions of conditions in the project's future based on information and knowledge available at the time of the forecast.

Mobilization: As defined in the Public Contract Code, "…includes preparatory work and operations, including, but not limited to, those necessary for the movement of personnel, equipment, supplies and incidentals to the project site, for the establishment of all offices, buildings and other facilities necessary for work, on the project, and for all operations which must be performed or cost incurred prior to beginning work on the various items on the project site."

Overhead: The general cost of running a business that cannot be directly attributed to a specific part of the work operation.

- Cost-Related Overhead includes licenses, permits, bonding, liability insurance, and profit; compensation is included in the prices paid for contract items. Overhead can be applied to a field office (FO) or to a main office, where it is often referred to as "General & Administrative" cost (G&A).

- Time-Related Overhead (TRO) also reflects field office and home office costs. TRO is used to compensate contractors on projects estimated over $5 million for overhead costs associated with schedule delays not attributable to the contractor. TRO is based on the number of working days originally specified in the contract and the daily price competitively bid by the contractor.

1.6 Organization of This Document

The remaining sections of this report are as follows:

Chapter 2 – Survey of Current CER Approaches
Chapter 3 – Approach to District 4 Cost Escalation Rate Forecasting
Chapter 4 – Model Results
Chapter 5 – Recommendations

Appendix A – Acknowledgments
Appendix B – References
Appendix C – Model Input Data
Appendix D – Model Output (Results)

2.0 SURVEY OF CURRENT COST ESCALATION FORECASTING METHODS

The programming of transportation project funding is a multi-year, multi-agency effort that relies on the accuracy of project construction cost estimates made early in the project development process. Funding must be programmed for each project phase during development. The cost estimates will be revisited throughout each phase; however, the initial cost estimate should provide an adequate estimate as to the actual future cost for the project.

When a cost associated with a primary project input increases, the impact to the overall project cost is higher than if the cost of a lesser input increased. The additional cost for five hundred pairs of safety goggles will have a lesser impact on the overall budget than a price increase on five hundred tons of asphalt.

The following sections summarize the current programming process used in California, the current escalation calculation efforts used in California and other state departments of transportation (DOTs), and lessons learned.

2.1 Context: STIP and SHOPP Programming Processes

2.1.1 Overview

The State Transportation Improvement Program (STIP) is a four-year planning document that commits transportation funds for increasing capacity and improving operations related to rail, mass transportation, local highways, and the state highway system. The STIP funding capacity or Fund Estimate (FE) is derived from the estimate of the State Highway Account (SHA), Public Transportation Account (PTA), Transportation Investment Fund (TIF), and the Transportation Facilities Account (TFA).

In addition, given that the SHA is the sole funding source for the State Highway Operation and Protection Program (SHOPP), the FE also determines SHOPP capacity over the same four-year period for state highway maintenance and safety projects.

2.1.2 Project Stages and STIP/SHOPP Update Process

The STIP and SHOPP programs are updated annually. Generally, new projects are added in even-numbered years, while modifications to previously programmed projected are made in odd-numbered years. Occasionally, new projects are added in odd-numbered years as well. Project Initiation Documents (PIDs) – both new and updated – are finalized in September for inclusion in the new STIP and SHOPP in the following April. Thus, updated escalation rates should be prepared by June to enable sufficient notice throughout the District as to the appropriate rate to be applied for project in the upcoming calendar year.

2.2 Recent Caltrans CER Policy and Methods

Traditionally, the Caltrans CER has been based on general inflation forecasts prepared by the State Department of Finance (DOF), to the extent of using the DOF forecast directly, without modification.

2.2.1 California Construction Cost Index (California CCI) and Contract Cost Data Book

At Headquarters, the Caltrans Office Engineer maintains responsibility to compile the California CCI, the price index for selected highway construction items. The index reflects the average prices for highway contract items and is updated quarterly. The value is determined by the bid prices for a select group of items during the quarter.

Annually, the Office Engineer's Office of Contract Awards and Services produces *The Contract Cost Data* book, a listing of standard contract items for major highway contracts for which bids were awarded during that calendar year. Prices shown in this book reflect a "mechanically weighted average of the awarded bidders' prices and affected by location, time, quantity in the job and size of the item (relative to the size of the job)." (Source: Caltrans *2007 Contract Cost Data Book*.) As these data reflect current pricing for inputs, an appropriate escalation rate will need to be applied to the BEES result to provide an anticipated project cost realized at the time of construction.

While the BEES allows for a *contingency* of 5% to be added, it does not address the anticipated increases in project inputs - *escalation* - and thus an escalation rate is required in addition to the contingency to establish an appropriate funding estimate to cover construction costs.

2.2.2 Previous Approach to CER Forecasting

Historically, the Headquarters Division of Programming provided the cost escalation rate for projects. Using the best information available at the time, Headquarters used the California Department of Finance's escalation rate (most recently 3%) as the statewide escalation rate applied to all transportation projects. However, California is a large state with varied geographic and economic situations within each district. Thus a single statewide rate did not always reflect the changes in local construction costs or market conditions. As a result, Rick Land, Chief Engineer, and Cindy McKim, Chief Financial Officer, jointly issued a memo dated March 13, 2007 instructing the districts to determine their own cost escalation rates based on regional data and local market conditions.

2.3 Current Approaches to CER Forecasting by Others

Cost escalation forecasting is undertaken by all Caltrans Districts, all state DOTs and, prior to 2007, the Federal Highway Administration. This section provides a brief survey of approaches taken by a sample of these other entities.

2.3.1 Other Caltrans Districts

2.3.1.1 District 1

During the period 2003-06, District 1 was escalating projects at a rate of 3.0 to 3.6%. However, this did not cover actual cost escalation, which was 10% or higher. Since the beginning of 2008, however, costs have been decreasing. For projects that are less than 180 days (one construction season or less) and that are going out to bid within a year, construction costs are not being escalated at all. For projects that are over 180 days (two or more seasons), estimates are escalated to the midpoint of construction. The District is currently using 3.6-5% as the escalation rate. The rate is adjusted as necessary based on the number and type of bids received.

District 1 feels that the current bids are artificially low because of the declining housing market: more firms are bidding on jobs, which is creating competition and lowering the bids. Firms from the Bay Area that have never bid in District 1 are now doing so. Most firms are underbidding to get the jobs. If this continues, the smaller firms will not be able to compete with the larger firms and will most likely go out of business at the end of the year. The number of bidders and bid prices is expected to stabilize by summer 2009. The high price of diesel is impacting the cost of all inputs and while this cost may not be reflected in the cost of construction materials, it will soon be to catch up with the high price of fuel.

During the Project Initiation phase, Advance Planning establishes a cost for a project and escalates it by 5%. The Estimating Office felt that this escalation rate was too low, especially for a project with a long lead time, and escalated the Advanced Planning estimate by an additional 5%.

At the 95% Design Phase, the Estimating Office escalates each construction item by an additional 3-5%. The application of an escalation rate at multiple points during project development helps to keep up with the true market costs of construction projects, though funding is fixed at the time of initial programming.

The Estimating Office used 10% escalation to catch up with the rising construction costs. When the cost of materials started to flatten out, the escalation rate was dropped to 7%. Now that the costs of construction are artificially deflated, an escalation of 3.6-5% is being used for this season's projects.

2.3.1.2 District 3 (North Region with District 1 & 2 Oversight)

Escalation is applied at the program level. The California CCI provides historical data but does not provide forecasting. District 3 references Global Insight data which provide forecast information through its Street and Highways Index. This forecast, though not 100% accurate, does provide a general forecast trend, as it incorporates additional inputs beyond traditional highway projects. Global Insight forecasts have been noted to be closer to actual cost escalation than what is implied by the California CCI.

The 2004-05 period was atypical because of the impact of residential construction on the overall construction market. Global Insight had forecast escalation as 3.7% for 2007, 0.6% for 2008, and 0.6% for 2009. In 2007, District 3 anticipated that 0.6% was too low of an escalation rate and added 3%, thus worked with escalation rates for 2008 and 2009 of 3.6%.

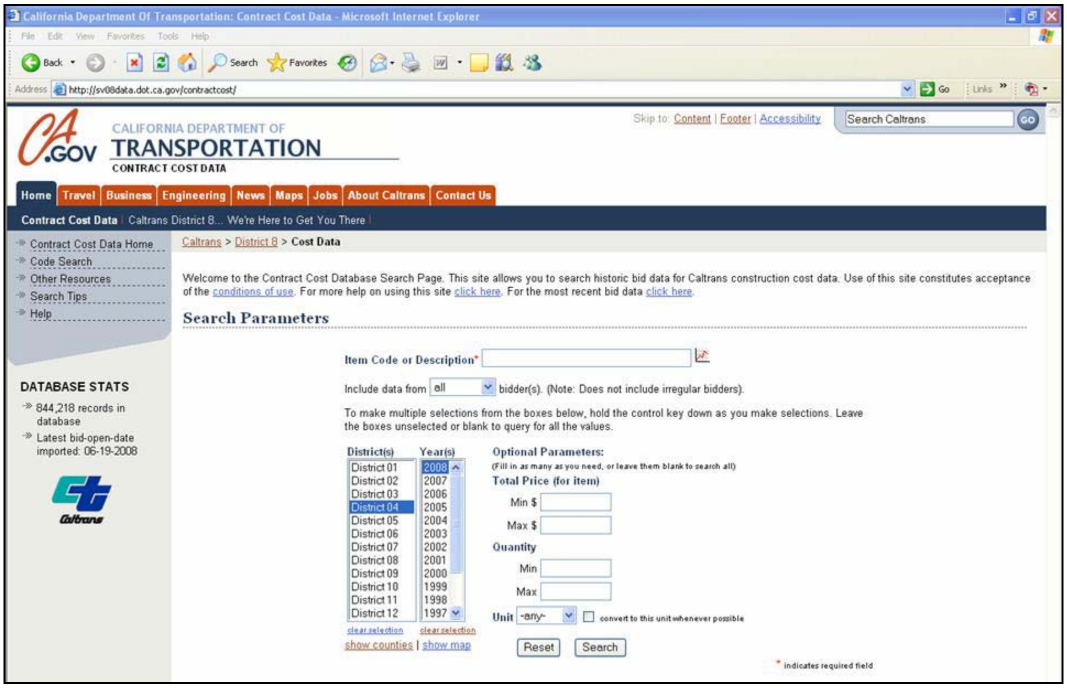
However, in reviewing recent bid estimates, it appears that Global Insight was more accurate than the District, as escalation was actually negative in 2007 (-6.8%). The UCLA Anderson School of Management's Forecast put the escalation rate at -0.2% in 2007, and thus was much closer to the actual escalation than Global Insight's 0.6% prediction.

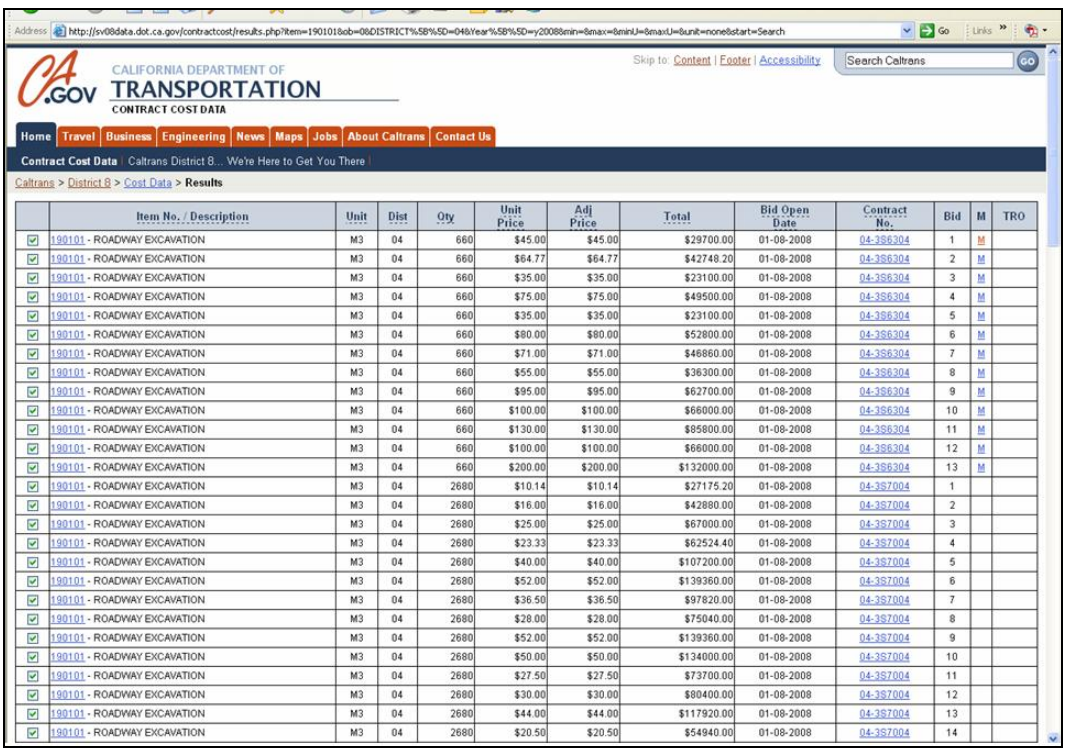
The Estimator for District 3 recommended using an Index from Global Insight or UCLA for the base escalation rate, but local adjustments should be made if certain elements are experiencing a trend unique to the project area.

2.3.1.3 Central Region (Districts 5, 6, 9, 10)

Estimating for the Central Region was previously done with the aide of the District 8 website that contains the previous bid price information for each district (see **Figure 3**, next page)**.** While this information was helpful, as the reports could only be pulled for an entire district rather than by county or local jurisdiction. A district-wide assessment of price typically did not reflect regional or local pricing.

Figure 3 – Caltrans Construction Cost Database





	Item No. / Description	Unit	Dist	Qty	Unit Price	Adj Price	Total	Bid Open Date	Contract No.	Bid	M	TRO
☑	190101 - ROADWAY EXCAVATION	M3	04	660	$45.00	$45.00	$29700.00	01-08-2008	04-3S6304	1	M	
☑	190101 - ROADWAY EXCAVATION	M3	04	660	$64.77	$64.77	$42748.20	01-08-2008	04-3S6304	2	M	
☑	190101 - ROADWAY EXCAVATION	M3	04	660	$35.00	$35.00	$23100.00	01-08-2008	04-3S6304	3	M	
☑	190101 - ROADWAY EXCAVATION	M3	04	660	$75.00	$75.00	$49500.00	01-08-2008	04-3S6304	4	M	
☑	190101 - ROADWAY EXCAVATION	M3	04	660	$35.00	$35.00	$23100.00	01-08-2008	04-3S6304	5	M	
☑	190101 - ROADWAY EXCAVATION	M3	04	660	$80.00	$80.00	$52800.00	01-08-2008	04-3S6304	6	M	
☑	190101 - ROADWAY EXCAVATION	M3	04	660	$71.00	$71.00	$46860.00	01-08-2008	04-3S6304	7	M	
☑	190101 - ROADWAY EXCAVATION	M3	04	660	$55.00	$55.00	$36300.00	01-08-2008	04-3S6304	8	M	
☑	190101 - ROADWAY EXCAVATION	M3	04	660	$95.00	$95.00	$62700.00	01-08-2008	04-3S6304	9	M	
☑	190101 - ROADWAY EXCAVATION	M3	04	660	$100.00	$100.00	$66000.00	01-08-2008	04-3S6304	10	M	
☑	190101 - ROADWAY EXCAVATION	M3	04	660	$130.00	$130.00	$85800.00	01-08-2008	04-3S6304	11	M	
☑	190101 - ROADWAY EXCAVATION	M3	04	660	$100.00	$100.00	$66000.00	01-08-2008	04-3S6304	12	M	
☑	190101 - ROADWAY EXCAVATION	M3	04	660	$200.00	$200.00	$132000.00	01-08-2008	04-3S6304	13	M	
☑	190101 - ROADWAY EXCAVATION	M3	04	2680	$10.14	$10.14	$27175.20	01-08-2008	04-3S7004	1		
☑	190101 - ROADWAY EXCAVATION	M3	04	2680	$16.00	$16.00	$42880.00	01-08-2008	04-3S7004	2		
☑	190101 - ROADWAY EXCAVATION	M3	04	2680	$25.00	$25.00	$67000.00	01-08-2008	04-3S7004	3		
☑	190101 - ROADWAY EXCAVATION	M3	04	2680	$23.33	$23.33	$62524.40	01-08-2008	04-3S7004	4		
☑	190101 - ROADWAY EXCAVATION	M3	04	2680	$40.00	$40.00	$107200.00	01-08-2008	04-3S7004	5		
☑	190101 - ROADWAY EXCAVATION	M3	04	2680	$52.00	$52.00	$139360.00	01-08-2008	04-3S7004	6		
☑	190101 - ROADWAY EXCAVATION	M3	04	2680	$36.50	$36.50	$97820.00	01-08-2008	04-3S7004	7		
☑	190101 - ROADWAY EXCAVATION	M3	04	2680	$28.00	$28.00	$75040.00	01-08-2008	04-3S7004	8		
☑	190101 - ROADWAY EXCAVATION	M3	04	2680	$52.00	$52.00	$139360.00	01-08-2008	04-3S7004	9		
☑	190101 - ROADWAY EXCAVATION	M3	04	2680	$50.00	$50.00	$134000.00	01-08-2008	04-3S7004	10		
☑	190101 - ROADWAY EXCAVATION	M3	04	2680	$27.50	$27.50	$73700.00	01-08-2008	04-3S7004	11		
☑	190101 - ROADWAY EXCAVATION	M3	04	2680	$30.00	$30.00	$80400.00	01-08-2008	04-3S7004	12		
☑	190101 - ROADWAY EXCAVATION	M3	04	2680	$44.00	$44.00	$117920.00	01-08-2008	04-3S7004	13		
☑	190101 - ROADWAY EXCAVATION	M3	04	2680	$20.50	$20.50	$54940.00	01-08-2008	04-3S7004	14		

The Central Region is piloting the use of cost estimation software, “Bid Tab Professional,” produced by Oman Company (www.omanco.com). This program contains all the bid information for California with factors specific to California and the capacity to pull data at the county level. The database also provides information about the contractors such as previous bids.

The Central Region is experiencing construction price decreases this year and is currently applying a 5% escalation rate. The Region anticipates that prices will continue to decline this year, but higher prices are anticipated for next year. In previous years, projects may have received one or two bids, which drove up the construction costs. This year, twelve to sixteen bids are being received per job, driving down costs as the bidders are competing. By the next construction season, bidders will either have work or have been forced out of business which will normalize bid prices. For this year, reductions of 15% are typical on construction costs.

The role someone holds in regards to a project may impact the amount of funds held in reserve for the construction of the project. The Project Engineer and Project Manager have a goal to have enough money to complete a project. Having more money than necessary is more important than leaving money on the table, and thus over-budgeting is considered as a better tactic than providing an accurate cost estimate. However, the Project Estimator has a goal of keeping the project within 10% of the cost estimate.

Despite the increase in competition and decrease in overall costs, some construction costs have increased greatly over the last few years. For example, last year trucking was costing $55/hour. In 2008, the cost of trucking rose to $118/hour.

With the high competition for construction jobs, the Estimator indicates that the construction companies appear to be willing to take on more risk to ensure getting a job. For example, in District 10, a project included the movement of dirt. However, it was still yet to be determined if the dirt could be moved to a neighboring property at a cost of $280,000 or if the dirt had to be hauled away and thus requiring the completion of environmental clearance at a cost of $5 million. The lowest bid was $5 million less than the next lowest bid because the firm was willing to take the risk as to whether or not the dirt had to be moved.

The Estimator reports that the software is easy to use. Oman inputs all the data so the estimating team only needs to pull the reports. The spreadsheets were also set up to reflect new methods of estimating construction elements. Previously, construction bids estimated that 10% of the overall project cost would be for mobilization of the construction team to and from the job site. However, with a detailed spreadsheet of the true inputs to mobilization efforts, the mobilization was assessed at a lower cost, which often saves millions of dollars compared to the Project Engineer's estimate. The Region has drafted spreadsheets for almost all elements of a construction project.

2.3.1.4 District 12

District 12 has successfully relied on 2-3% annual rate for escalation of their roadway/structures projects anticipated for construction in ten to twenty years. The District relies on the Office Engineer's materials cost estimates.

2.3.2 Other State DOTs

All State Departments of Transportation are tasked with producing cost estimates for projects. Each state adheres to a Construction Cost Index (CCI), which is tailored to highlight the project inputs that constitute the majority of the overall cost of a project. The CCI is used to estimate cost escalation of present day cost estimates to future year construction costs.

2.3.2.1 Washington

The Washington State Department of Transportation (WSDOT) CCI is calculated through three primary components: 58% for materials, 15% for Equipment, and 27% for labor. These inputs are detailed further in the following table with the appropriate weighting for each input. The weight for all the individual material inputs equal 100%.

The WSDOT previously used the FHWA's CCI but in 2005, it found that the index did not properly reflect the economic situation in Washington and, as a result, began to produce its own Index. To calculate the CCI for Washington State, the WSDOT calculates Total Materials cost by tracking nine typical bid items that are the most common items in construction projects. In addition to Total Materials, WSDOT now incorporates Labor and Equipment into the Construction Cost Index. See the table to the right for the list of inputs and their weight upon the CCI.

Washington State DOT Highway Construction Cost Index (CCI)	**Weight**
Labor	**27%**
Total Materials	**58%**
Aggregate (Sand, Gravel, Crushed Stone)	24%
Portland Cement	7%
Lumber and Piling	2%
Reinforcing Steel Bars	8%
Structural Steel (for bridges)	11%
Ready-Mix Concrete	14%
Bituminous Paving Materials	24%
Concrete Culvert Pipe	3%
Petroleum Products	8%
Equipment	**15%**

Once the cost estimate in current dollars is completed, the risks and set of contingencies are established. The CCI is then used to inflate the estimate to the midpoint of construction. The WSDOT is using a different escalation rate for the three main phases of a project. For planning and initial design phase, the applied escalation rate is less than 1%. For Right of Way, another escalation rate is applied that reflects the real estate market. The third escalation rate is for construction. For projects going to construction in the short term, the escalation rate may be as low as 1%. For longer lead time projects, an annual escalation rate of 2-4% may be applied.

2.3.2.2 Ohio

The Ohio Department of Transportation (ODOT) uses a Construction Inflation Rate rather than an escalation rate. Whereas Caltrans uses seven inputs in the CCI, the ODOT uses ten inputs for their In-Place CCI and weighs each with its overall percentage of construction projects.

The ODOT begins the estimating process by taking the base cost estimate and inflating the cost to the estimated mid-point of construction.

Unique to the ODOT Index is the inclusion of '*Maintenance of Traffic'* which refers to the detours, flagmen, and other elements necessary to direct traffic through the construction site.

'*Structures including Maintenance*' is the collective term for tracking Structural Steel, Piles, Structural Concrete, and Rebar costs.

ODOT In-Place Construction Cost Index	Weight
Aggregate Base	3%
Asphalt (Surface & Intermediate Courses)	26%
Asphalt Bituminous Base	4%
Drainage	7%
Earthwork	11%
Guardrail	3%
Maintenance of Traffic	9%
Pavement Marking	3%
Portland Cement Concrete Pavement	5%
Structures including Maintenance	28%

Much of the ODOT's bridge work, for example, falls into this category and therefore this sub-index helps to better represent what is happening with bridge items and bridge building/maintenance expenses. Through this methodology, the ODOT calculated and currently uses 5% for the escalation rate.

2.3.2.3 Colorado

The Colorado CCI is composed of six parts: Earthwork (excavation and embankment), Hot Bituminous Pavement, Concrete Pavement, Structural Steel, Structural Concrete, and Reinforced Steel. The index is based on bid prices relative to the unit prices of 1987 (unit index=100). The index varies based on the type and location of projects, such as the distance from Denver and other urban communities where labor and materials are more readily available. Another factor in the determination of the escalation rate is the number of bidders on a project. Some more rural areas of the state tend to receive fewer bids on a project compared to projects located closer to urbanized areas. The index will also be impacted due to changes in overall economic conditions.

2.3.3 FHWA

Up until 2007, the Federal Highway Administration (FHWA) provided a nationwide CCI. A comparison of the FHWA CCI with the CCI of several states demonstrates the variety of results that can be achieved from the different methodologies used to calculate the CCI. **Table 1** demonstrates how some states calculated a reduced CCI while others saw an increase. As noted in the previous examples, each state uses a unique basket of inputs to calculate the cost impacts in their region. The range of CCIs suggests that a state as large as California may be better served by locally produced construction cost rates rather than lumping together statewide project analysis.

2.4 Summary and Conclusions

While each jurisdiction calculates a construction cost index, the majority of those jurisdictions examined use a unique bundle of construction related inputs that reflect the core construction costs specific to their local economies.

At present, several Caltrans districts are incorporating forecast data made available through Global Insight and the UCLA Anderson School of Management to produce escalation rates reflective of market forecasts instead of relying only on past market trends. Forecast data may contribute towards an escalation rate that may reflect future construction costs more accurately than relying on historical trends.

Table 1 – Selected Construction Cost Indices: 1990-2008

Year	FHWA		California		Colorado		Oregon		South Dakota		Utah		Washington	
	Index[1]	Pct Chg	Index[1]	Pct Chg	Index[1]	Pct Chg	Index[1]	Pct Chg	Index[1]	Pct Chg	Index[1]	Pct Chg	Index[2]	Pct Chg
1990	109	--	114	--	103	--	107	--	112	--	128	--	110	--
1991	108	-0.9%	108	-5.3%	111	7.8%	119	11.2%	114	1.8%	126	-1.6%	121	10.0%
1992	105	-2.8%	107	-0.9%	111	0.0%	109	-8.4%	112	-1.8%	126	0.0%	108	-10.7%
1993	108	2.9%	113	5.6%	115	3.6%	115	5.5%	117	4.5%	151	19.8%	106	-1.9%
1994	115	6.5%	119	5.3%	119	3.5%	112	-2.6%	120	2.6%	135	-10.6%	105	-0.9%
1995	122	6.1%	115	-3.4%	122	2.5%	138	23.2%	133	10.8%	166	23.0%	124	18.1%
1996	120	-1.6%	119	3.5%	142	16.4%	135	-2.2%	133	0.0%	176	6.0%	124	0.0%
1997	131	9.2%	125	5.0%	140	-1.4%	150	11.1%	147	10.5%	163	-7.4%	139	12.1%
1998	127	-3.1%	129	3.2%	158	12.9%	142	-5.3%	149	1.4%	146	-10.4%	116	-16.5%
1999	137	7.9%	139	7.8%	159	0.6%	155	9.2%	169	13.4%	143	-2.1%	120	3.4%
2000	146	6.6%	146	5.0%	171	7.5%	148	-4.5%	180	6.5%	132	-7.7%	128	6.7%
2001	145	-0.7%	154	5.5%	157	-8.2%	130	-12.2%	153	-15.0%	153	15.9%	129	0.8%
2002	148	2.1%	142	-7.8%	150	-4.5%	164	26.2%	154	0.7%	153	0.0%	139	7.8%
2003	150	1.4%	149	4.9%	154	2.7%	172	4.9%	161	4.5%	127	-17.0%	145	4.3%
2004	154	2.7%	216	45.0%	168	9.1%	162	-5.8%	202	25.5%	153	20.5%	170	17.2%
2005	184	19.5%	268	24.1%	255	51.8%	206	27.2%	196	-3.0%	260	69.9%	176	3.5%
2006	221	20.1%	281	4.9%	256	0.4%	248	20.4%	246	25.5%	294	13.1%	228	29.5%
2007	--	--	261	-7.1%	271	5.9%	241	-2.8%	268	8.9%	253	-13.9%	230	0.9%
2008	--	--	NA	--	NA	--	NA	--	NA	--	NA	--	241	4.8%

1\. 1987=100 2. 1990=110

Notes:
1. The FHWA CCI was discontinued in 2007.
2. Washington in 2003 and 2004 adjusted CCI data points to correct for spiking bid prices on structural steel.

3.0 APPROACH TO DISTRICT 4 COST ESCALATION FORECASTING

3.1 Methodology and Data Requirements

In recommending a CER for Caltrans District 4, URS analyzed and compared a range of different methods that other heavy construction industries are currently using for cost escalation. In deciding on a preferred approach, the consultants sought to develop a method that:

- Is transparent and repeatable;
- Uses existing forecast indices;
- Considers the majority of construction costs; and
- Models uncertainty explicitly.

In developing a <u>CER Forecasting Model</u> for District 4 ("CER Model," or "Model"), we proposed a framework for thinking about how contingency and escalation relate to economic factors, scope and context factors and indirect factors. This framework is shown below as **Table 2**, and can be compared with the contractor bid risk relationships depicted in **Figure 1** (on page 4).

Table 2 – Framework of Influences on Construction Cost Estimates

Element	Description	Influences	Contingency	Project Stage Influence	Escalation
ECONOMIC FACTORS					
Prices	Labor Materials Equipment Energy (Fuel) Services	General Inflation Market Conditions: Contractors, Labor, Materials (and Energy) Monetary and Fiscal Policy Job Location (Region)	No	None	**Yes**
Overhead & Profit		Contractor Market Conditions (Competition) Taxes	No	None	**Yes**
SCOPE/CONTEXT FACTORS					
Quantities	Quantities put "in place." Includes labor, equipment, materials, and overhead.	Most affected by materials costs	**Yes**	**High**	No
Lump Sum Activities	Ex: Mobilization, Traffic control, Special training, Special demo/removal, etc.	Affects mostly labor and equipment	**Yes**	**Moderate**	No
Overall Job Complexity	Construction methods required, Number of trades, sequencing, etc. Funding sources and requirements	Complexity and difficult site conditions add uncertainty and risk, resulting in higher bids. They mostly afffect labor and equipment costs.	**Yes**	**Moderate**	No
Site and Area Conditions	E.g., site size and local access, site conditions, nearby availability of resources, disposal, etc.		**Yes**	Low	No
INDIRECT FACTORS					
Regulation	Labor………………………………… Environmental……………………… Safety………………………………. Business……………………………..	...Work rules, healthcare, retirement, WC Ins ...Site remediation, site protection, mitigation ...OSHA rules ...Taxes, filings, etc.	**(Yes)**	None	**(Yes)**
Standards & Methods	Design Standards…………………… Construction Methods/Tech………..	...Higher standards add cost ...New/Improved methods reduce cost	No	Low	**(Yes)**

3.1.1 Prices

The price of goods, services, and assets in the market place is determined by the interaction of supply (sellers) and demand (buyers). Prices are influenced by market conditions, monetary and fiscal policy, and job location.

3.1.2 Overhead, Profit, Risk, and Competition

Business overheads are the indirect expenses of running a business not directly associated with a particular item or service sold. Profit is equal to business revenue less the cost of doing business.

The absolute size of overhead and profit is influenced by the level of competition in an industry. When competition is great, there is a greater willingness to reduce profit to ensure that a project is won. When competition is less, there is a decreased need to reduce potential profit and overhead.

3.1.3 Regulation

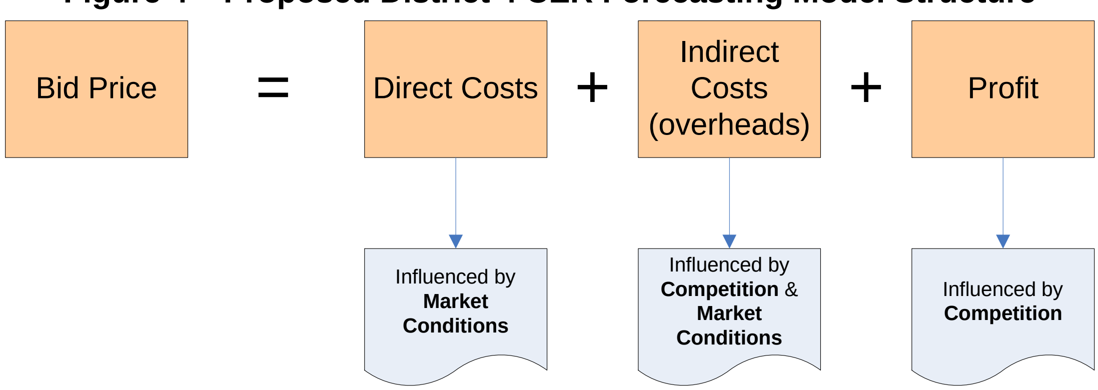
Regulations are legal restrictions imposed by a Government authority which may increase the costs of doing business. Examples include labor rules, health care, site remediation, and environmental protection.

3.1.4 Standards and Methods

Standards govern how projects are designed and constructed. Standards establish uniform engineering or technical criteria, methods, processes and practices. Improved standards will typically increase the costs of compliance. Conversely new and improved construction methods will typically reduce costs.

When calculating escalation rates, factors outside of uncertainties within the scope of the project that influence bid prices are of interest: (1) changes in factor (input) prices and (2) changes in competition. While it is recognized that changes in regulation and changes in standards and methods can influence bid prices over the long term, these are not currently included in the Model. Therefore the cost components and influences considered in the recommended methodology are shown in **Figure 4**, below. (See also **Figure 1** on page 4 for an expanded view.)

Figure 4 – Proposed District 4 CER Forecasting Model Structure



3.2 Proposed Initial Forecasting Method

The proposed method for forecasting CER for District 4 is shown in **Figure 5** below.

Figure 5 – District 4 CER Forecasting Model Calculation Stream

Cost Escalation Ratio = **Relative Costs** X **Price Forecasts** X **Competition Factor**

An Excel™ spreadsheet platform was developed to undertake the calculations of the CER Model. The Model includes data on the top 88 per cent of cost, assumptions on the composition of these costs, and indices to show how each cost component could increase in the future. The Model also uses local and regional data to predict how prices would be affected by competition. Finally, the Model has been developed to allow use of Crystal Ball™ software so that model variables can be modeled explicitly with risk and uncertainty.

3.2.1 Conversion of BEES Costs to Contractor Factor (Input) Costs

Escalation rates are calculated through modeled indices for various inputs. In developing the CER Model, it was desirable to capture as many costs as was necessary to provide a suitable CER. Each of the 803 BEES cost codes were classified into 37 cost classifications (see Appendix C). In developing the CER Model, the top 17 cost classifications representing 88% of total construction related costs (direct, indirect, and overhead) were used.

It is critically important to note, however, that bid data ("Construction Cost Data") are not presented in a way that makes the identification of usable economic indices readily feasible. For example, a BEES cost item – such as concrete pavement – will include costs for construction labor, equipment costs, materials, and supplies. Cost indices for major inputs (labor, equipment, materials, and supplies) and industries (heavy construction) are available from Global Insight and ENR. Therefore before indices can be used to escalate Caltrans project costs, the breakdown of item costs into these cost components is required.

A two-stage process was used to divide BEES cost data in such a way that price index series could be identified. Initially the BEES cost classifications were divided between labor, materials, and equipment. Then the costs were further separated into two labor sub-classifications, nine materials sub-classifications, and 6 equipment sub-classifications. The consultant team was able to secure actual detailed cost estimate breakdowns for two transportation project bids from sources within URS: one for new segmental bridge in Folsom, CA and another for a major interstate highway widening in Colorado. *As these documents contained cost details and assumptions typically not made public by contractors*, the team was able to produce a potential cost data table that was used to determine the division of costs between each of the sub-costs shown in **Table 3**.[7]

A percentage allocation of total cost by category, calculated using these two cost estimates, was applied to actual District 4 bid data to produce the cost breakdown shown in **Table 4**. This allocation was then used in the CER Model to calculate the preliminary cost escalation ratio.

[7] It is understood that the CER Model would benefit from consideration of more than two contractor bid estimates; however, no further estimates were readily available within the time and resource limitations of this study. It is recommended that Caltrans work with the construction industry to procure additional examples for future CER Model updates and improvements.

Materials represent the greatest proportion (53 percent) of total construction cost, followed by Labor (33 percent), and Equipment (13 percent). The most significant materials costs are asphalt, concrete, and steel products. Construction (jobsite) labor was estimated to account for nearly 20 percent of the total bid amount.

Table 3 - Identified Sub-Classifications for BEES Cost Items

Labor	Materials (Incl. Supplies)	Equipment (Rental/Lease and O&M)
Construction Labor	Aggregate Base	Equipment Rental/Depreciation 1
Administrative Labor	Asphalt Base	Equipment Rental/Depreciation 2
	Concrete/Structural & Pavement	Equipment Rental/Depreciation 3
	Concrete Miscellaneous	Fuel 1
	Steel reinforcement bar	Fuel 2
	Structural steel	Maintenance
	Miscellaneous hardware	
	Plastics & Composites	
	Electrical Equipment	

Table 4 - Incidence of Actual District 4 Construction Costs By Sub-Classification in 2007

Sub-Classification	Description	Pct of Total
Equipment		
Equipment Rent/Depreciation 1	Transportation Equipment	2.0%
Equipment Rent/Depreciation 2	Construction Machinery	2.0%
Equipment Rent/Depreciation 3	Trucks, Over 10,000 LBS, GVW	2.0%
Fuel 1	Gasoline	2.2%
Fuel 2	Diesel Fuel	2.2%
Maintenance	Motor Vehicle Parts and Access	2.9%
	Subtotal Equipment	***13.3%***
Materials		
Aggregate Base	Sand, Gravel, & Crushed Stone	1.7%
Asphalt Concrete	Asphalt Paving Mixtures & Blocks	12.8%
Concrete/ Structural & Pavement	Ready-Mixed Concrete	10.6%
Concrete/ Misc	Concrete Products	1.0%
Steel Rebar	Concrete Reinforcing Bar, Carbon Steel	6.0%
Structural Steel	Hot Rolled Sheet, Carbon Steel	1.3%
Misc Hardware	Fabricated Structural Metal Products	10.7%
Plastics and Composites	Plastic Construction Products	7.7%
Electrical Equipment	Electrical Lighting Equipment	1.9%
	Subtotal Materials	***53.7%***
Labor		
Labor (Construction)	Construction and Extraction	19.9%
Labor (Administration)	Office and Administrative Support	13.1%
	Subtotal Labor	***33.0%***
Total		**100.0%**

(Source: Caltrans *2007 Construction Cost Report)*

The data analyzed were limited and therefore the shares of total cost ("Pct of Total") shown in Table 4 would benefit substantially from more data analysis and/or the opinions of expert cost estimators. To further enhance these cost assumptions, it would be helpful to determine different cost allocations for different project types, for example highway upgrades and interchanges versus road rehabilitation or safety improvements. In both cases, the richness of the data would be improved by presenting the data as a probabilistic distribution with upper and lower ranges.

3.2.2 Factor (Input) Price Forecasts

In developing the CER Model, forecast data on how prices are predicted to change in the future were taken from Global Insight.[8] In developing this model further, it is recommended that Caltrans obtain several years worth of forecast data from each of the major forecasting entities to determine how well each has performed in forecasting price movements.

It also would be useful to examine how accurate each forecasting entity has been in the short-run (1-2 years) and the longer-run (3-5 years) by comparing previous forecasts of a given year with actual outcomes for that year. In addition to assessing the absolute performance of each provider of forecasts data, the results of this analysis could be used to provide measures of uncertainty for each of the indices used. (See Chapter 5.0 for more recommendations.)

The preliminary GI data series used to develop the CER Model are shown in **Table 5** (next page). The large 2008 numbers (included to provide a basis for the 2009 forecast) are due to the large percentage change in diesel fuel and gasoline prices, and the large annual change in steel prices.

3.2.3 Competition Forecasts

Competition and its effect on contractor profit were introduced into the CER Model as an explanatory factor that either increases or decreases the total cost escalation rate calculated. The competition element of the Model reflects first, how busy (and, therefore, competitive) the construction industry is or will be, second, how busy Caltrans will be (the number of road contracts advertised), and last, the relative size of the contracts being advertised. For more information, refer to Appendix C.

Estimates of construction industry profit (as a proportion of total cost) were assigned based on projected annual change in construction employment ("supply" of construction services). The year-over-year change in projected profit was then applied to the "competition" component of the CER Model, and further adjusted by estimates of change in Caltrans bid activity and average bid size as measures of "demand" for contractor services. Thus, the combined CER for competition in any given year is equal to the percent change in total cost due to change in profit, multiplied by the weight for "projects advertised" and the weight for "project size." The three elements and their weights used to assess competition and its impact on the CER are shown in the **Table 6** (page 23).

Recommendations regarding actions to improve the Model further are provided in Chapter 5.0.

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[8] Caltrans maintains an ongoing data subscription with Global Insight (see Appendix C).

Table 5 – Cost Types and Global Insight Forecast Series: 2008 to 2018

Cost Types	GI Indices	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
		Percentage Change (%)										
Equipment												
Equipment Rent/Depr 1	Transportation Equipment	2.3	2.0	0.4	0.8	0.9	1.4	1.3	1.3	1.4	1.4	1.4
Equipment Rent/Depr 2	Construction Machinery	2.5	4.5	2.3	3.7	0.4	0.2	0.2	1.4	2.2	2.3	2.1
Equipment Rent/Depr 3	Trucks, Over 10,000 LBS, GVW	2.0	4.5	1.7	1.9	2.4	1.9	1.9	1.9	1.9	1.9	1.9
Fuel 1	Gasoline	29.1	-2.2	-5.8	-4.0	-4.2	-6.2	-4.9	-1.2	0.4	0.4	0.4
Fuel 2	Diesel Fuel	56.9	-3.9	-7.4	-2.6	-2.4	-3.3	-3.5	-0.4	0.9	0.8	0.8
Maintenance	Motor Vehicle Parts and Access	0.5	0.3	-1.1	-0.4	-0.1	0.3	0.2	0.1	0.1	0.1	0.1
Materials												
Aggregate Base	Sand, Gravel, & Crushed Stone	6.5	3.0	0.3	1.5	2.4	2.3	1.9	2.0	2.3	2.3	2.2
Asphalt Concrete	Asphalt Paving Mixtures & Blocks	6.5	7.3	0.0	0.4	1.8	1.3	0.5	0.6	1.0	1.2	1.0
Concrete/ Structural & Pavement	Ready-Mixed Concrete	2.1	0.9	0.9	5.1	3.2	2.0	2.0	2.1	2.2	2.2	2.2
Concrete/ Misc	Concrete Products	3.2	2.3	0.1	2.0	3.7	2.9	1.8	1.7	1.9	2.1	1.8
Steel Rebar	Concrete Reinforcing Bar, Carbon Steel	42.6	-7.2	-0.8	-7.7	5.0	2.8	2.7	2.6	2.6	2.8	2.4
Structural Steel	Hot Rolled Sheet, Carbon Steel	78.4	-22	-7.6	-8.7	8.6	1.6	2.4	-1.9	2.6	3.6	3.3
Misc Hardware	Fabricated Structural Metal Products	9.5	3.4	-0.1	0.3	2.7	1.9	1.4	1.5	1.7	1.8	1.7
Plastics and Composites	Plastic Construction Products	1.9	1.0	-1.1	-0.2	1.6	1.9	1.7	1.7	1.9	2.0	2.2
Electrical Equipment	Electrical Lighting Equipment	1.8	0.5	-0.7	-0.4	0.5	0.5	0.2	0.4	0.5	0.6	0.7
Labor												
Labor (Construction)	Construction and Extraction	3.0	1.7	4.1	3.5	3.0	3.0	3.1	3.0	3.0	2.9	3.0
Labor (Admin)	Office and Administrative Support	3.1	3.1	3.0	3.0	3.2	3.4	3.4	3.3	3.2	3.2	3.2
Competition												
Construction Employment	Competition	-5.8	-4.3	1.4	4.7	3.6	1.9	1.0	0.9	1.1	0.8	1.0

Table 6 – Preliminary Weights for Competition Forecast

Item	Profit
Construction Employment (GI Index)	
Less than -12% annual change	0%
Between -7% and -12% annual change	1%
Between -2% and -7% annual change)	4%
Between +2% and -2%	8%
Between +2% and +4% annual change)	12%
Between +4% and +7% annual change)	16%
Between +7% and +12% annual change)	20%
Between +12% and +17% annual change	25%
Greater than +17% annual change	30%
Projects Advertised	**Weight**
Declining	0.7
Stable	1.0
Increasing	1.3
Average Project Size	**Weight**
Smaller	0.8
Larger	1.2

3.3 CER Model Validation

3.3.1 Validation Purpose and Approach

In order to provide a check of the CER Model's effectiveness at an initial level of validation, the Model was run using changes in input costs (labor, materials, and equipment) for the years 2003 through 2008. The resulting CER Model escalation estimates were then compared to actual construction cost escalation recorded for these years as represented by the California CCI and other, independent sources.

Construction cost indices used as benchmarks to compare CER Model results were: (1) the California Construction Cost Index (California CCI); (2) the Engineering News Record (ENR) index for San Francisco (ENR-SF); (3) the ENR index for the nation (ENR-N); and (4) the Global Insight national cost index (GI-N). Two of these indices capture construction cost changes nationally while two of them capture state and regional changes. The 2003 through 2008 values for all of these indices are presented in **Table 7**.

Table 7: 2003 – 2008 Benchmark Construction Cost Indices

	2003	2004	2005	2006	2007	2008
California CCI	4.5%	45.5%	24.1%	4.6%	-7.0%	-3.2%
ENR-SF	1.9%	5.6%	2.8%	7.6%	0.3%	7.1%
ENR-N	2.4%	6.3%	4.7%	4.1%	2.8%*	3.1%*
GI-N	2.9%	6.5%	7.8%	9.7%	6.2%*	6.6%*

* Preliminary estimates

The CER Model was run and results were obtained using two different GI input data sets. The first GI input data set used was forecasted cost changes. These GI forecasts were estimated and published in the second quarter of 2004 and therefore represent what was expected to occur from 2004 through 2008. The second GI input data set used was actual changes. This is GI historical data of what actually occurred for costs from 2004 through 2008. These two different input data sets were used in order to be able to separate the performance of the Model from the accuracy of the input forecasts themselves.

In the first case, Global Insight (GI) forecasts of labor, materials, and equipment costs prepared beginning in the second quarter of 2004 were used. This evaluation of the CER Model shows how the Model would perform if it had been used in the second quarter of 2004 with the forecast data available at that time. The evaluation using this data demonstrates how the Model performs while incorporating the error associated with using uncertain forecast data.

The second evaluation was based on actual historical cost changes for labor, materials, and equipment over the period 2004-08 as provided by GI. The evaluation using this data demonstrates how the CER Model would perform when based on actual cost changes that occurred from 2003 through 2008, thereby removing the uncertainty associated with the forecast (input) data and showing how the Model translates the actual changes in input costs into an overall prediction.

3.3.2 Results Using *Forecast* Input Data

Using Global Insight labor, materials, and equipment cost forecast data for the second quarter of 2004 yielded the results presented in **Table 8**.

Table 8: 2003-08 CER Model Results – Using GI Forecast Input Data

	2003	2004	2005	2006	2007	2008
Input Cost Annual Escalation	2.8%	6.2%	-0.9%	1.3%	1.7%	1.6%
Profit Annual Escalation	0.0%	3.0%	0.0%	0.0%	0.0%	-4.3%
CER Model (Combined Input & Profit Elements)	**2.8%**	**9.3%**	**-0.9%**	**1.3%**	**1.7%**	**-2.7%**

Figure 6 (next page) shows how these model results compare to state and regional construction indices measuring actual cost changes (not forecasts). As can be seen, the Model does not capture the magnitude of the construction cost increase represented in the California CCI for 2004 and 2005 using forecast data, though it does a better job of representing the ENR-SF index for these years. The Model does capture the trend of the California CCI over the entire period, however, as cost estimates increase in 2004 and then decrease and trend to around zero for 2005 through 2008. The California CCI and the Model results are both negative for 2008.

Figure 7 (next page) shows how the Model results using forecast data compare to national construction indices. The Model is much closer to the 2004 national prediction as there was no corresponding spike in the national indices as was observed in the California CCI (**Figure 6**, next page). The results for 2005 through 2008 underestimate both national indices for all years. In this way, the Model results more closely follow the California CCI during this time period as the California CCI is also below both national indices.

Figure 6: CER Model Results Compared to Actual State and Regional Cost Trends Using GI Forecast Input Data

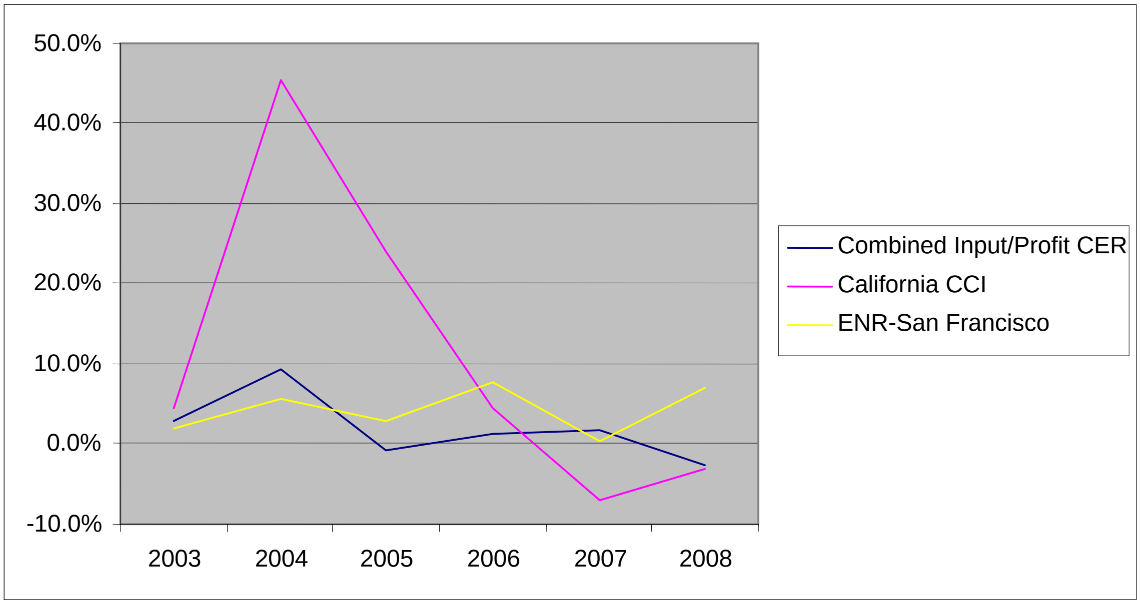
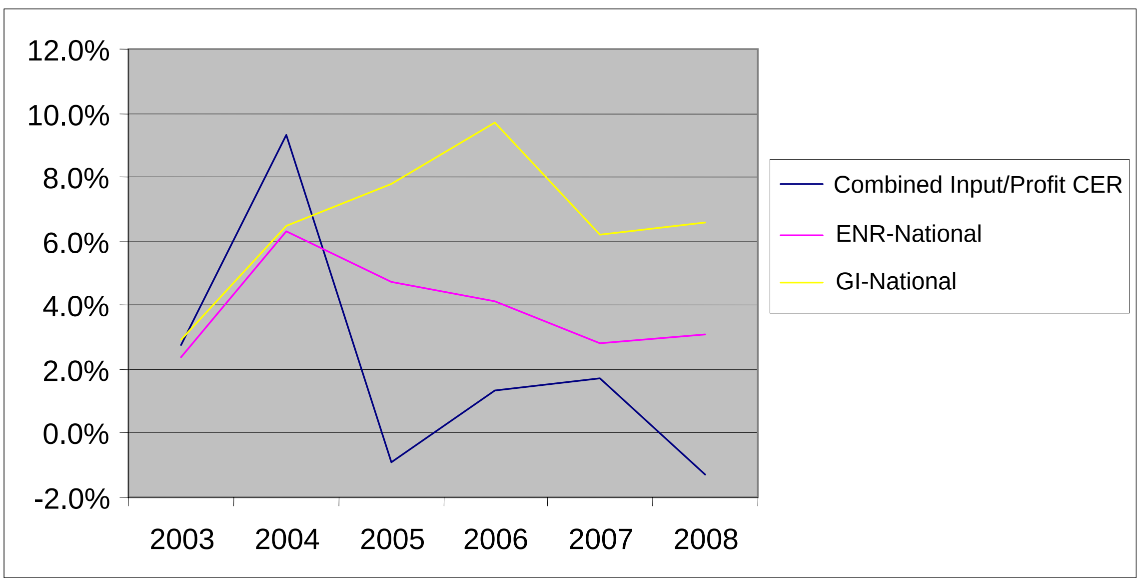


Figure 7: CER Model Results Compared to Actual National Cost Trends Using GI Forecast Input Data



3.3.3 Results Using *Actual/Historical* Input Data

Using Global Insight (GI) labor, materials, and equipment historical cost data yielded the following model results presented in **Table 9**.

Table 9: 2003-08 CER Model Results – Using Actual/Historical Input Data

	2003	2004	2005	2006	2007	2008
Input Cost Annual Escalation	2.8%	9.6%	7.1%	9.5%	5.0%	13.0%
Profit Annual Escalation	0.0%	3.0%	2.9%	0.0%	-8.3%	-4.4%
Combined Input/Profit CER	**2.8%**	**12.8%**	**10.1%**	**9.5%**	**-3.7%**	**8.0%**

Figure 8 shows how the Model results using historical data compare to the regional construction indices. Again, the Model is unable to capture the magnitude of the increase in the California CCI in 2004 even using historical data of actual changes in cost inputs. However, the Model once again does a good job of capturing the relative direction of the cost changes and does well at approximating the magnitude of the California CCI changes for 2006 and 2007. Using historical data, the Model yields an increase in costs for 2008 that is more reflective of the ENR-SF index than the California CCI.

Figure 8: CER Model Results Compared to Actual State and Regional Cost Trends Using Actual/Historical Input Data

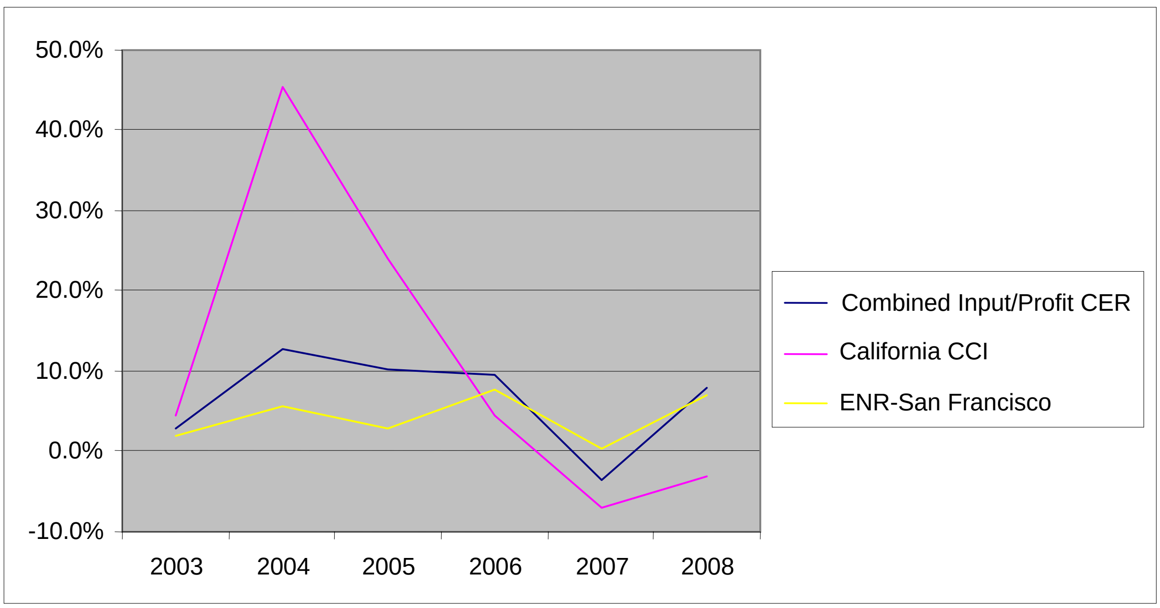
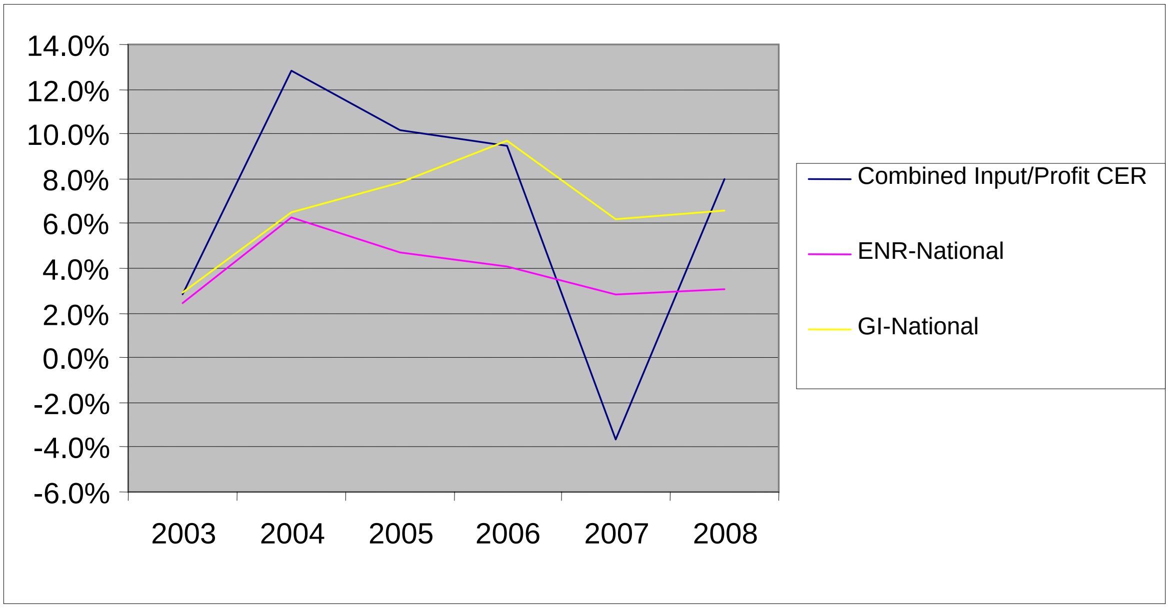


Figure 9 (next page) shows how the Model results using historical data compare to the national indices. The observed increase in 2004 is captured, and while the Model still underestimates the national indices in 2007, as it did using the forecast data (**Figure 7** above), the estimates for 2006 and 2008 are now in-line with the GI national index for these years.

3.3.4 Conclusions

This validation exercise demonstrates that the CER Model does a good job of tracking the direction and magnitude of actual cost changes. *Indeed, while the Model did not capture the unprecedented change in the California CCI in 2004 (45.5%), using historical data it did predict a significant cost increase that year – one that was approximately double the increases predicted by the other national and regional indices examined in this evaluation.*

Figure 9: CER Model Results Compared to Actual National Cost Trends Using Actual/Historical Input Data



Estimates from the Model are more in-line with the California CCI when historical data is used as compared to forecast data, thus showing the amount of error that is a result of the uncertainty in the forecast data itself as opposed to the specification of the Model. Specifically, model performance using historical data improves with respect to the California CCI as seen in the increase in model estimates for 2004, 2005 and 2006 and the decrease in 2007.

As noted in other sections of the report, there are assumptions made concerning the estimation of competition effects on costs that could be refined to improve model performance. For example, this evaluation used small project size and stable project numbers for all years, as was assumed in other sections of the report. Model performance may be improved if data were collected to vary these parameters and set them accordingly. The same is true for the mapping of changes in construction employment to a profit rate and the adjustment weights used for the impact of bid numbers and project size. CER Model performance could be enhanced further through additional research directed towards refining this model structure and the assumptions used to represent the effect of competition on contractor pricing.

3.4 CER Model Sensitivity Analysis

The amount of variability in the rates that are generated by the CER Model is a function of the amount of uncertainty that is incorporated through the use of estimated GI cost forecasts. All cost forecasts will have some amount of uncertainty associated with their use. This section provides a discussion of a sensitivity analysis that was conducted to identify the particular GI cost forecast inputs that contribute the most variability to Model results. Future reductions in the uncertainty associated with these key inputs will have the greatest potential to reduce variability in Model rates resulting from forecast uncertainty.

Sensitivity analysis was conducted using Crystal Ball software and all GI cost forecasts were incorporated into the model as a range of potential values.[9] This use of a range of values represents the uncertainty associated with each of the forecasts. Monte Carlo analysis was conducted with cost forecast values chosen from these ranges and used as inputs in the model with the corresponding CER rates estimated. This process was repeated 5,000 times and a measure was obtained for the amount of variation in the CER Model rates resulting from the uncertainty associated with each of the GI forecasts. Crystal Ball calculates this measure by computing correlation coefficients between every cost forecast and the resulting CER Model rate. These correlation coefficients provide a meaningful measure of the degree to which changes in the cost forecasts result in changes in the CER rates. For example, if a forecast and a CER rate have a high correlation coefficient, it means that when the cost is forecast to be large, it greatly influences the CER rate to also be large. Therefore, efforts to reduce the uncertainty associated with such an influential cost forecast would reduce the variability of Model results.

Results of this sensitivity analysis indicate that five key cost forecasts account for almost all of the variability in CER Model rates. Two GI labor cost forecasts for construction and extraction labor and office and administrative labor contribute the largest amount to result variability. District 4 may wish to make refinement of labor cost forecasts a priority in future model development. In addition, three key materials and supplies cost forecasts – asphalt paving mixtures and blocks, ready-mixed concrete and fabricated structural metal products are also key inputs impacting the variability of model results. It should be noted that these sensitivity results are based on the cost assumptions for two transportation project bids for which the consultant team was able to secure actual detailed cost estimate breakdowns.[10] Additional research refining this cost breakdown will impact these sensitivity results and should also be a consideration in future model development. Other recommendations regarding enhancements to the Model, data collection and tabulation, restructuring of the California CCI, and modifications to the BEES code structure are offered in Chapter 5.0.

[9] As distribution information for GI cost forecasts was not available, GI forecast data were assumed to be normal in their distribution with a mean equal to the GI reported forecast and a standard deviation equal to 10% of the mean.
[10] See section 3.2.1 for details.

4.0 MODEL RESULTS – DISTRICT 4 CER FORECASTS

The following two sections provide recommended CER rates for two time periods. The first section provides rates for FY09 through FY13 using GI 2008 2nd quarter forecast data. The second section provides an update of rates for FY10 through FY14 using the most recent GI 2008 4th quarter forecast data.

4.1 CER Rates for FY09 through FY13 (July 2008)

The results of the chain of calculations from the D4-CFM for the next five years can be found in Appendix D. Based on input price increases alone (without allowing for the level of competition in the heavy construction industry), the recommended CER rates are:[11]

- **FY 2009 - 1.7 percent**
- **FY 2010 - 0.9 percent**
- **FY 2011 - 1.3 percent**
- **FY 2012 - 2.4 percent**
- **FY 2013 - 2.0 percent**

After allowing for competition, and assuming a stable number of project advertisements and no significant change in the proportion of small and large projects, the adjusted CER rates are:

- **FY 2009 - 1.7 percent**
- **FY 2010 - 4.0 percent**
- **FY 2011 - 7.3 percent**
- **FY 2012 - (1.8) percent**
- **FY 2013 - (2.4) percent**

It is very important to note that these forecasts are the first to come from the new District 4 CER Forecasting Model and forecasting process which, as described previously in Chapter 3.0, has limited development in a number of important areas. That said, however, it is believed that the numbers presented here are consistent both with past experience and with general perceptions of current trends in the construction industry seen at Caltrans and elsewhere, and so they are provided with some confidence.

4.2 Updated CER Rates for FY10 through FY14

The availability of more recent 2008 4th quarter GI forecast data allows for an update of CER rate estimates for FY 2010 through FY 2014. Based on input price increases alone (without allowing for the level of competition in the heavy construction industry), the updated CER rates are:

- **FY 2010 - 0.8 percent**
- **FY 2011 - 2.4 percent**
- **FY 2012 - 2.3 percent**
- **FY 2013 - 3.2 percent**
- **FY 2014 - 3.1 percent**

[11] Note: due to minor modifications to the Model, these results differ slightly from those presented in the August 2008 draft.

After allowing for competition, and assuming a stable number of project advertisements and no significant change in the proportion of small and large projects, the adjusted CER rates are:

- **FY 2010 - 0.8 percent**
- **FY 2011 - 5.6 percent**
- **FY 2012 - 8.3 percent**
- **FY 2013 - 3.2 percent**
- **FY 2014 - (1.2) percent**

Differences in these updated rates as compared to those presented in Section 4.1 are a result of the changing economic conditions that occurred between mid- and late-2008. These changes resulted in GI updating its forecasts to reflect downward pressure on the input cost escalation estimates in the Model beginning in 2009 followed by an increase peaking around 2013 based on expectations of the timing of an economic recovery. To illustrate this change, **Table 10** provides a comparison of the 2nd and 4th quarter GI cost forecast data for 2009 and 2013 for key cost inputs.

Table 10: 2nd and 4th Quarter 2008 Cost Forecast Data – Percentage Change

Cost Item	2009			2013	
	2nd	4th		2nd	4th
Sand, Gravel, & Crushed Stone	3.0	0.5		2.3	2.6
Ready-Mixed Concrete	0.9	-1.8		2.0	1.4
Concrete Products	2.3	-0.8		2.9	3.1
Concrete Reinforcing Bar, Carbon Steel	-7.2	-27.8		2.8	16.5
Hot Rolled Sheet, Carbon Steel	-21.5	-36.3		1.6	21.1
Fabricated Structural Metal Products	3.4	0.5		1.9	3.0
Plastic Construction Products	1.0	-1.7		1.9	2.1
Transportation Equipment	2.0	1.2		1.4	1.7
Construction Machinery	4.5	2.3		0.2	1.7
Trucks, Over 10,000 LBS, GVW	4.5	1.5		1.9	2.5
Gasoline	-2.2	-39.5		-6.2	6.0
Diesel Fuel	-3.9	-50.9		-3.3	4.4
Construction Employment	-4.3	-6.5		1.9	4.1

As the economy worsened in the second half of 2008, GI updated its cost forecasts to reflect the impact of these changing economic conditions. Forecasts for all of these key 2009 cost components decreased between the 2nd and 4th quarter of 2008, thus resulting in the Model estimating lower CER rates beginning in this period. The opposite is true for 2013, where GI updated its forecasts between the 2nd and 4th quarter of 2008 predicting increases in almost all of these key cost components as the economy recovers, thus explaining the Model estimating higher CER rates peaking in this time period.

District 4 may wish to update the FY 2010 through FY 2014 CER rates over the next few quarters given the current economic climate. This exercise demonstrates how rapidly changing conditions and perceptions of the current economy can impact the GI forecast data that is input into the Model. Such changes in the forecast data can lead to variations in the CER rate estimations.

5.0 RECOMMENDATIONS

5.1 Purpose and Scope of Recommendations

During the course of this study, the project team encountered a number of issues that could warrant further study and action, but which fell outside the scope of the current effort. In this section, a number of recommendations and suggestions are offered regarding potential improvements to various aspects of the project cost estimation and cost escalation processes.

These recommendations, documented here to provide a potential launching point for future work, fall into three general categories:

- Data Collection, Tabulation, and Analysis
- Cost Escalation Rate (CER) Model Enhancements
- Cost Estimating and Contractor Bid Process

It is suggested that these recommendations, if accepted, be implemented based on considerations of need (potential benefit), complexity, cost, and availability of appropriate staff resources.

NOTE: A recommendation was made in the August 2008 CER report to save all data from the Caltrans Construction Cost database in Microsoft Excel™ format, or create database code to allow such data to be easily exportable to Excel. That recommendation has been implemented. In addition, note is made below where work has been completed or is underway on other recommendations.

5.2 Data Collection, Tabulation, and Analysis

1. Given that projects consist of varying mixes of labor, materials, equipment, and indirect costs, it is recommended that the District (and the Department) collect, tabulate, and code bid cost data for the Construction Cost database by typical project:

   - Type (e.g., interchange, widening, resurfacing, etc.),
   - Size (value),
   - Duration (length of construction period), and
   - Setting (e.g., heavy urban, rural, level, hilly, etc.).
   - Project Location (County)

   This additional identifying information could provide significant new insights into factors that influence cost escalation trends. It could also provide a basis for creating specific – and therefore, more accurate – cost escalation rates by project type, size, length, and/or setting. This recommendation is currently limited by the capabilities of BEES. (<u>Work on this recommendation is currently underway</u>.)

2. Going forward, upgrade construction bid cost database reports to allow detail and summary reporting of average, maximum, minimum, and variance of bid prices, by project and by BEES code. It is also suggested that the number of bids, variance among bidders by BEES item, and divergence from engineer's estimate (by BEES item) be provided by project and for selected groupings of projects. (This would not require collection of any new data.) This recommendation is currently limited by the capabilities of BEES. (<u>Work on this recommendation is currently underway</u>.)

3. It is recommended that the District (and the Department) update the California Construction Cost Index (California CCI) to include a new and enlarged "basket" of cost components (BEES codes). The California CCI currently reflects only approximately 20% of all direct costs (labor, materials, and equipment) bid in District 4. See Section 1.2 for additional discussion on this point.) The goal of the new index would be to cover at least 70% and perhaps as much as 80% of all direct costs. Note that such an enhanced index could be automated to draw data from the California CCI with a minimum of user input and effort. This is currently an ongoing effort. (Work on this recommendation is currently underway.)

5.3 Cost Escalation Rate (CER) Model Enhancements

4. Should pre-2007 construction bid data become available in readily manipulable form (see Recommendation 1, above), it is suggested that the Caltrans District 4 Cost Escalation Model (CER Model, prepared under this task order) be run using pre-2007 data to compare model-calculated escalation rates with actual escalation rates which occurred during those years. This is an important "validation" process used for most model development, regardless of purpose. (This recommendation has been implemented with this update to the CER Report.)

5. Conduct a sensitivity analysis of key direct (e.g., concrete pavement) and indirect (e.g., insurance) cost inputs in order to determine the relative influence of these inputs on total cost. Use these results to refine the CER Model and allow staff to focus on only the most important and volatile inputs. (This recommendation has been implemented with this update to the CER Report.)

6. Review and critically evaluate alternative third-party forecast providers: Global Insight, UCLA, and ENR to determine who has had the best forecasting track record. In the short-term, track the accuracy of their forecasts by comparing prior year forecasts with actual outcomes – i.e., compare a forecast for 2007 made in 2006 with actual results in 2007. (Work on this recommendation is currently underway.)

7. Add an indirect costs module (for overhead, insurance, bond, etc.) to the current CER Model presented in this report (which includes direct costs and risk/profit modules only) to provide an independent estimate for escalation of these cost items. (Note: Indirect costs are currently treated as fixed markups of direct costs and thus are not allowed to change independently.)

8. Create "early warning system" to track short-term changes in market conditions and provide estimators and managers with evidence of potentially large movements in prices, risk, and contractor premium. Such a system could be tied to the CER Model structure and simply require input of quarterly data for comparison with forecasts.

9. Establish a formal model peer review process to periodically evaluate the CER Model structure and inputs. Use mail-out surveys of contractors, engineers, academics and/or convene expert panel(s) of the same types of individuals. In particular, focus on the types of costs included in the Model, the appropriate matching of those costs with external forecast series, and formulas for weighting inputs to arrive at the aggregate CER forecast.

10. As this engagement has focused solely on construction costs and an escalation rate applicable to construction inputs, the District should consider expanding the CER Model to address other project costs, including:

- Right-of-Way/Relocation;
- Environmental Mitigation;
- Preconstruction Activities and Support (Planning, Environmental Clearance, Design, and Permitting); and
- Caltrans Management and Overhead.

In particular, these enhancements would improve escalation of estimates for the PID, PR/PSR, PA/ED, and PS&E phases of project development.

5.4 Cost Estimating and Contractor Bid Process

11. It is recommended that the District (and the Department) establish a more detailed bid reporting format, similar to that used by contractors for their internal estimates: WBS items (BEES codes) broken out by cost components (labor, materials, equipment, time, risk, etc.). In general, nearly 25% of construction-related costs in District 4 are defined as add-ons or markups – that is, as fixed percentages of other costs. Further, a significant portion of BEES cost codes (35%) are defined as either "lump sum" or "each" items. It is understood that this is a long-term recommendation with significant cost and complexity implications.

12. Review and consider using one or more of several existing Central Region cost templates (Excel spreadsheets) to improve estimates of various "lump sum" or "markup" items, particularly mobilization. As mobilization is currently treated as a "reserve" by many contractors, a more explicit method for costing this activity could result in more accurate estimates for other bid items, thus providing a more accurate picture of cost trends.

13. Develop a consistent way for treating indirect costs which are currently treated as markups on direct costs: "special items," field OH, Home OH (G&A), site inspection, weather, insurance, bond, etc. Provide detailed guidance to bidders on how these items should be priced and presented.

14. Work with other Districts and Headquarters staff to review and revise the BEES code structure and make modifications as necessary to establish more standard definitions and usage of among all Caltrans units. A review of 2007 California Construction Cost data reveals that BEES code usage varies significantly, to the extent that some codes that are used extensively in some districts are not used at all in other districts. In addition:

    - Where possible, consolidate codes which may have had a special purpose but are no longer used or rarely used.
    - Consider revising BEES code terminology to provide a consistent structure with regard to activity. Thus, add words such as "place," "pour," and "lay" in addition to "remove," "reconstruct," and "furnish." While most contractors are probably familiar with the intent of the codes, new or inexperienced bidders might misunderstand and misstate their estimates, making cost tracking and forecasting more difficult.
    - To the extent possible, minimize the use of "lump sum" codes. These items are not as conducive to inclusion in the CER Model, and they make it more difficult to evaluate whether a contractor is shifting cost to other items for potential advantage from future change orders.
    - If consistent with Department policy, eliminate use of metric codes. (This recommendation will be implemented over time.)

15. Work with other Districts and Headquarters staff to create a cost estimating training course or to incorporate cost estimation elements into existing training opportunities. The training would enhance the staff's ability to prepare cost estimates and conduct risk analysis through increased familiarity of techniques and available calculation tools. Include elements such as:

    - Overview of Caltrans' existing techniques and tools
    - Cost estimation under changing economic conditions
    - Cost estimates when demands for materials change
    - Available methodologies and appropriate uses
    - Streamlined risk analysis
    - How do deal with unknowns or hard to cost items.

    Create a manual from the training session materials to serve as a resource document for all Districts and Headquarters. The materials could be made available on-line. (Work on this recommendation is currently underway and training is to be delivered starting in early fiscal year 2009/10.)

APPENDIX A
Acknowledgments

Thank you to the staff of the Estimating and Construction Management offices of the Departments of Transportation who provided insight to the cost estimation process:

- California Department of Transportation, Headquarters and Districts 1, 3, 4, 5, 6, 8, 9, 10, and 12
- Colorado Department of Transportation
- Nevada Department of Transportation
- Ohio Department of Transportation
- Washington State Department of Transportation

A special thank you goes to the Headquarters Office of the Office Engineer, California Department of Transportation, for their assistance with the Construction Cost Index and input data.

APPENDIX B
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APPENDIX C
Model Input Data

District 4 Bid Prices from BEES

Cost data were provided by District 4 from their Basic Engineering Estimate System (BEES). The data summarized the item code, item description, unit cost, and quantity of costs incurred during the 2007 year. In analyzing this cost data, the consultants classified each of the costs into 37 different cost classifications. The purpose of this was to group like costs where the drivers of costs would be considered similar. From this "grouping," the 14 cost classifications that comprised 82 percent of total costs were identified. These cost classifications are shown in **Table A**.

Table A: Percentage of Caltrans costs within each cost classification.

Cost Classification	Description	%	CUM %
MGT-ADM	Progress schedule – 0.3% Time-related overhead - 11.8% Mobilization – 12.2%	24.3%	**24.3%**
ASPHALT	Asphalt concrete, emulsion, case, liquid	16.2%	**40.5%**
CONCR-STRUCT	Structural concrete for various applications, including: bridge, retaining wall, approach slab, etc.	7.0%	**47.5%**
STEEL-RBAR	Bar reinforcing steel for various purposes, including: bridge, retaining wall, box culvert, pumping plant, sounding wall	5.8%	**53.3%**
EXCAV	Roadway excavation, structure excavation, ditch excavation	5.3%	**58.6%**
REMOVE	Removal of various items, including: culverts, manhole, fence, gate, markers, traffic stripes, pavement markings, signs, asphalt concrete, dikes, curbs, pipe	4.5%	**63.1%**
TEMP	Temporary items, including: fencing, supports, culverts, signage, pavement markings, crash cushions	3.1%	**66.2%**
MGT-OPS	Construction site management, water pollution control, street sweeping, traffic control system, work area monitoring, existing traffic management	3.1%	**69.3%**
CONCR-BARRIER	Different types of concrete barrier, including: K, 25, 60S, 732B, etc.	3.0%	**72.3%**
DRAINAGE	Pipe culverts, pipe liners, plastic pipe, permeable material, underdrain, anchor assembly, sewer pipe, etc.	3.0%	**75.3%**
PILING	Various pilings (concrete, furnish, drive) for various purposes (sign foundation, barrier, sound wall)	2.5%	**77.8%**
CONCR-PVMT	Concrete pavement and replace concrete pavement, Portland cement concrete base	2.2%	**80.0%**
AGGREG	Lightweight aggregate, aggregate subbase	2.0%	**82.0%**
EARTHWK	Backfill, imported fill and earth retaining structures	1.8%	**83.8%**
CONCR-MINOR	Minor concrete structures	1.6%	**85.4%**
SIGNS	Furnish and install sign structures and roadside signs	1.4%	**86.8%**
SIG &LIGHT	Signals and Lighting	1.4%	**88.2%**
OTHER	Includes: masonry, landscaping, fencing, survey & maintenance	11.9%	***100%**
TOTAL		***100%**	

**Total of all percentages may not equal 100% due to rounding.*

The two most substantial costs associated with Caltrans construction projects are Time-Related Overheads (TRO) and Mobilization which accounted for 24.3% of District 4's overall construction costs in 2007. The next largest cost is that associated with Asphalt (16.2%). Concrete related costs including structures, barriers, and pavement represented 12.2% of total costs. Of the 37 collective cost classifications, the top eight classifications (22% of the classifications) represent almost 70% of the total costs.

The available cost data are not presented in a way that makes the identification of indices obvious. For example, the data included in BEES for a particular cost classification may include construction labor, equipment costs, materials, and supplies. However, cost indices are provided separately for labor, equipment, materials, and supplies. Therefore before indices can be used to escalate project costs, information on the breakdown of cost items into cost components is required.

Global Insight Indices

Global Insight produces long term forecast tables for a large variety of indices and individual cost items. The description of information series provided by Global Insight is shown in **Table B**.

Table B: Series Categories that Global Insights Provides (Quarterly 2008 to 2011 and Annually 2006 to 2018)

Aggregate Inflation Measures
Demand Measures
Energy Prices
AHE - Labor Costs By Industry
ECI - Labor Costs By Occupation
Steel Prices
Fabricated Metal Prices
Nonferrous Metal Prices
Chemical Prices
Building Material Prices
Electronic Components Prices
Non-Electrical Machinery Prices
Electrical Machinery Prices
Transportation Equipment Prices
Measuring & Controlling Instruments Prices
Transportation Services Prices
Paper and Packaging Prices
Corporate Expenses
Maintenance, Repair, and Operation (MRO)
Defense/Aerospace Prices and Wages

The following Global Insight series are relevant to Caltrans' future construction costs, as they encompass some of the major line-items in Caltrans' historical costs of construction:

- ❖ Construction-Related Indices
  - PPI, All Commodities
  - PPI, Metals & Metal Products
  - PPI, Machinery & Equipment
  - Highway, Street & Bridge Construction
  - Fuels & Related Products
  - Concrete Products
  - Asphalt Paving & Mixtures
  - Concrete Reinforcing Bar, Carbon Steel
- ❖ Labor Costs & Productivity
  - Output Per Hour, Non-farm Business Sector
  - Compensation, Professional & Related
  - Compensation, Construction & Extraction
- ❖ Competition
  - Housing Starts, Private Including Farms
  - Employment in Construction Index for the US (seasonally adjusted)

In reviewing this Global Insight forecast data we graphed a range of relevant cost data over the years 2006 to 2018. The resulting graphs for selected construction-related series are shown below as **Figure A**.

Figure A: Selected Construction Related Series (2006 Base)

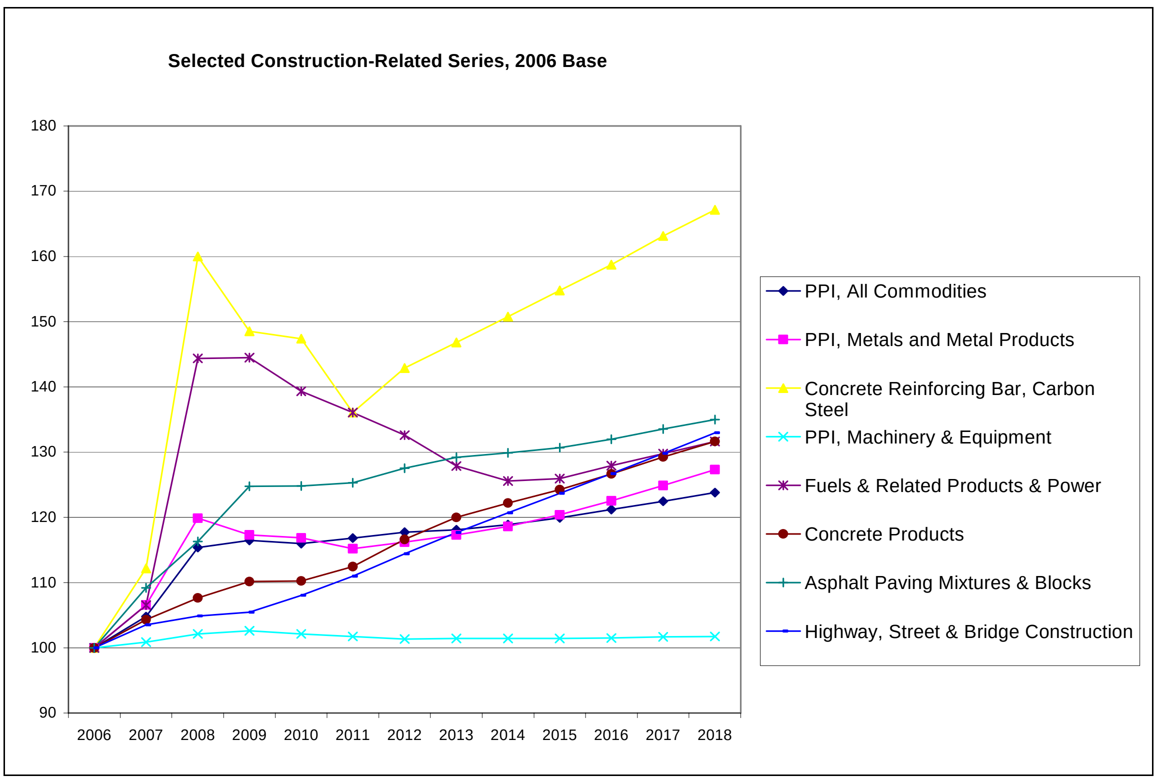
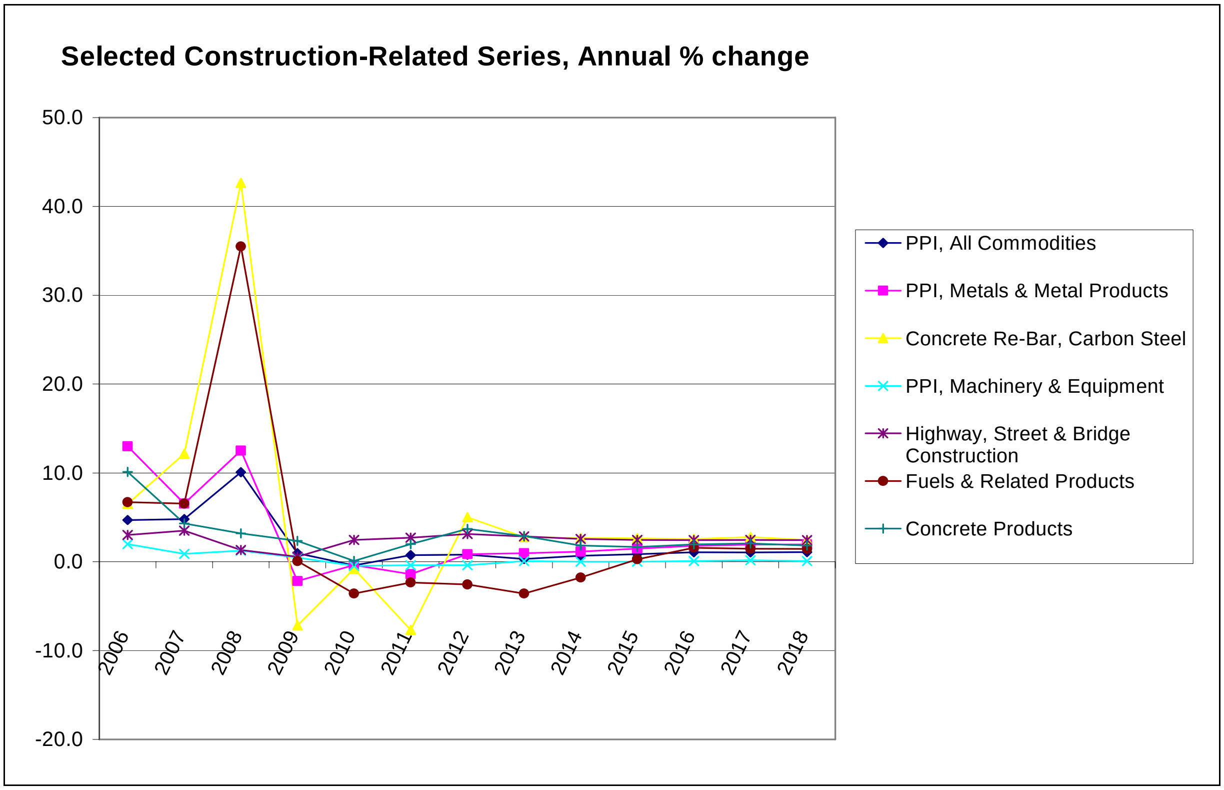


Figure A shows that Concrete Reinforcing Bar (Carbon Steel) is predicted to increase considerably more than the other indices. While the costs for carbon steel are expected to decline substantially in 2009 and 2011, the cost increase in 2008 is sufficient for this cost increase to be the greatest over the period 2006 to 2018. Conversely, PPI, Machinery & Equipment is predicted to be very stable over the next 10 years.

The annual change in these same construction series is shown in **Figure B**. This Graph shows the forecast large increase in process for both Fuels and Related Products and Concrete Reinforcing Bar (Carbon Steel).

Figure B also shows that the selected index series tend to move together in the long-run. In the short-run, they are predicted to be more variable, but in the longer term, many are predicted to converge.

Figure B



Labor costs are expected to increase faster than general construction costs according to the Global Insight forecast indices. Labor costs for both Professional & Related and Construction & Extraction are predicted to move together fairly closely in the long-run, although the short-run shows the labor costs for Construction & Extraction decreasing and then increasing sharply in the next year or two. Productivity is expected to increase relatively steadily in the long-run, with slight volatility in the short-run as presented in **Figure C** and **Figure D**.

Figure C

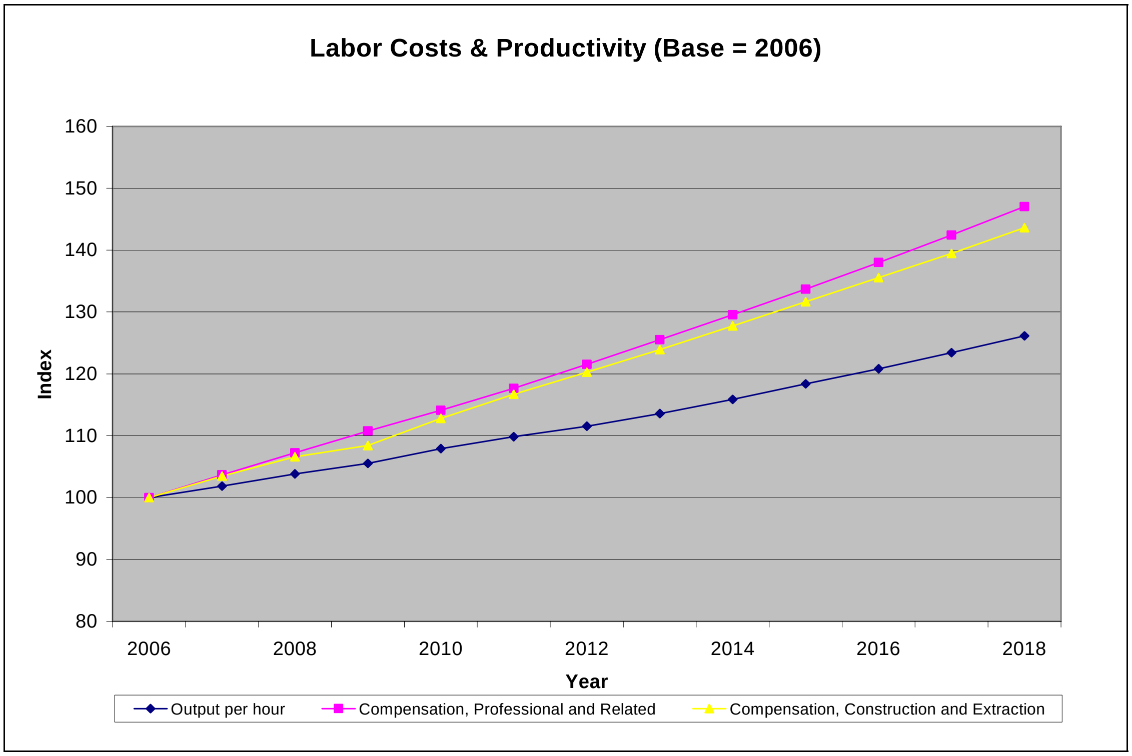
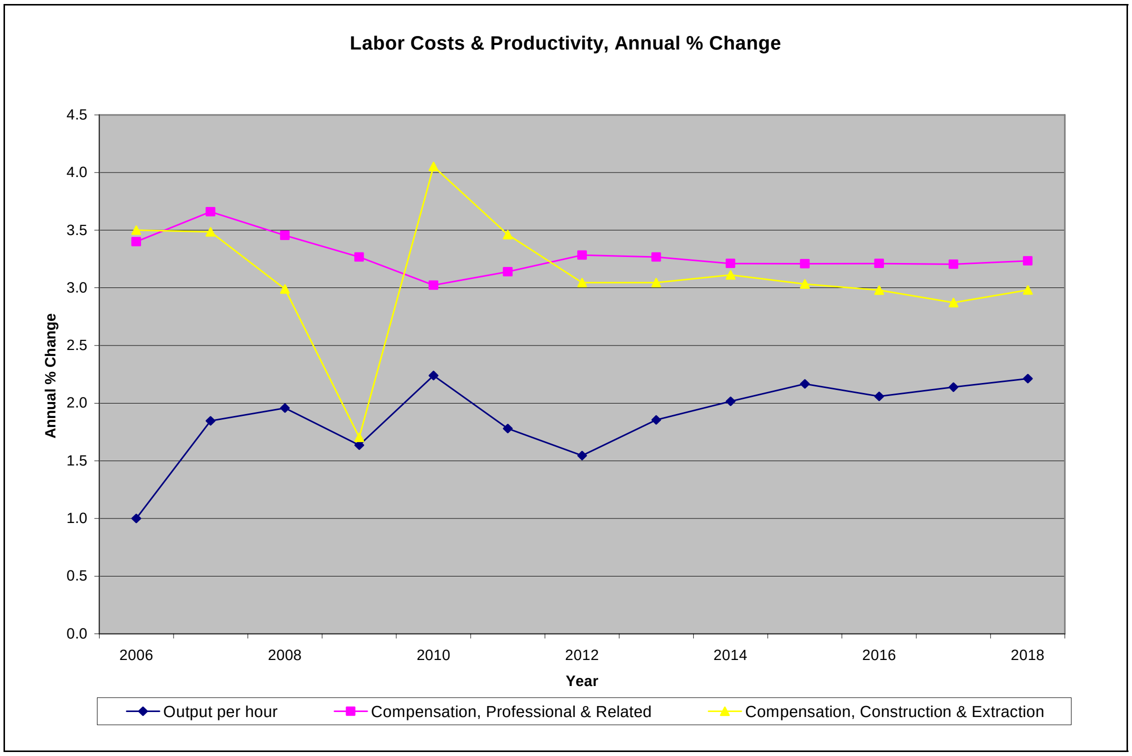


Figure D



Competition

A major determinant of costs in the construction industry is competition. If competition is low, then there tends to be fewer bids, which generally results in higher bid prices and thus over construction costs. If competition is high, there tends to be more bids, which drives down the bid prices and could lead to lower construction costs. While there is no index predicting future competition, several explanatory variables exist that could be used to forecast competition, such as:

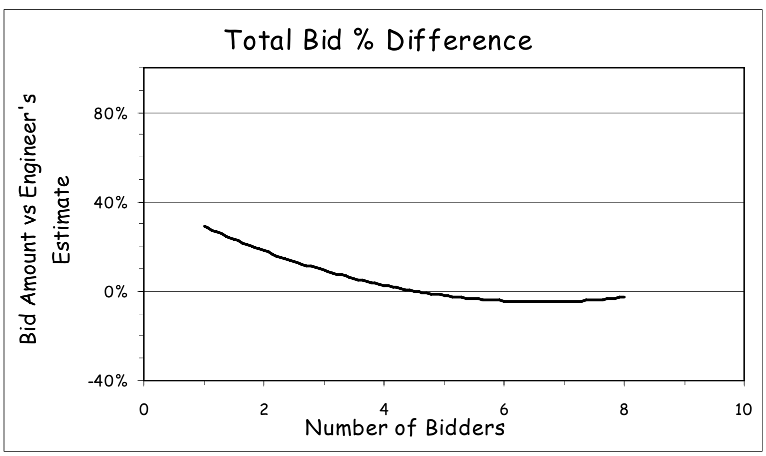
* Value of Construction
* Non-residential investment
* Housing starts
* Construction machinery
* Gross Domestic Product Construction employment

Others may include the Caltrans District 4 Construction budget forecast, number of projects during a given season, and/or the average size of the projects being bid. These measures can be useful in determining the "demand" for contractor services; for example, an increase in the number of projects put out to bid, and an increase in the average size of projects being let, will both place a greater demand on contractor services and result in price increases.

The level of competition in the infrastructure construction industry is influenced by the competition in other construction industries, and by the number of project offerings that are made by a District. In addition, the construction industry faces an on-going trend of industry concentration, i.e., fewer contractors taking more and more of the overall industry pie. These big contractors have high fixed costs which create pressures for firms to fill capacity which leads to price cutting when excess capacity is present. In addition, the nature of the industry (low bid from a pool of firms) means that competition is based entirely on price, potentially resulting in extreme price competition.

Consider **Figure E**, which shows how lack of competition can substantially increase the bid price. The graph, based on data from the California Department of Transportation, Division of Engineering Services (DES), shows how the bid amount versus the engineer's estimate increases substantially when the number of bidders falls below four.

Figure E: Bid price As Percentage of Engineer's Estimate vs. Number of Bidders



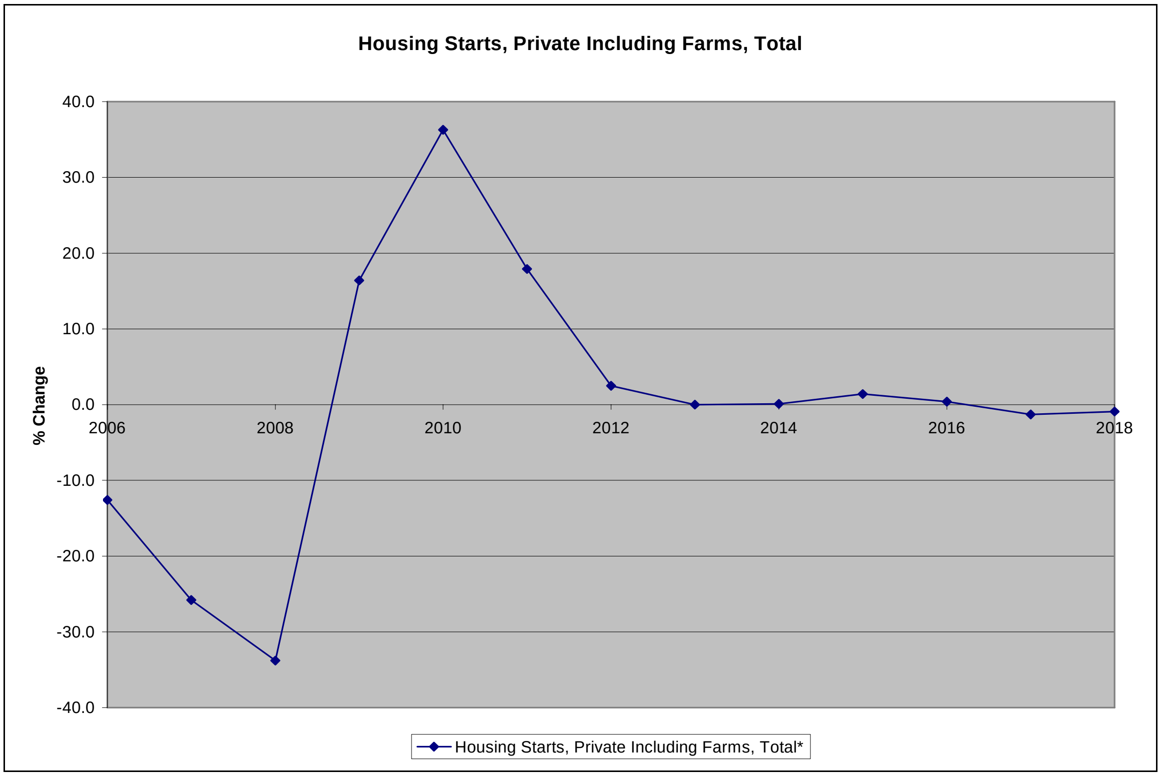
Source: Caltrans, Powerpoint Presentation, Transportation Building Facilities: Design, Estimating and Bidding (http://www.dot.ca.gov/hq/oppd/costest/BLDG_Design_Pres_to_DMB-PMB_050306.ppt#256, 1, Transportation Building Facilities)

Where competition is high (demand is low), the bid price reduces slightly (less than 10%) below the Engineer's Estimate. Conversely, low competition (high demand) can result in bid prices up to 30 percent (30%) higher than the Engineer's Estimate.

Housing can be used to represent the construction in the economy in general, and tends to be a leading indicator of national output. Thus, if future housing starts are expected to be high, then competition for road construction is likely to be low, and vice versa.

The Global Insight's housing start forecast index shows that housing starts are expected to keep decreasing through 2008, but increase in 2009 and remain stable at about 95% of 2006 levels until 2018 (see **Figure F**).

Figure F: Global Insight Housing Starts Index for the US (seasonally adjusted)



Using this explanatory variable to forecast competition would suggest that competition will start decreasing next year and will level off in 2011.

The Global Insight construction employment index for the US shows a similar cycle as that shown for Housing Starts (see **Figure G**). The key difference is that Employment in Construction lags Housing Starts by approximately one year. See for example how Housing starts are already declining in 2006, while Employment in Construction is still increasing, and how Housing Starts peak in 2008, while Employment in Construction does not peak until 2009.

Figure G: Global Insight Employment in Construction Index for the US (Seasonally adjusted)

An assessment would need to be undertaken using bid prices, engineer's estimates, and each of the explanatory variables discussed above to see which provide the better measure of competition.

Funding Availability & District Projects Advertised

The number of projects advertised annually affects competition and ultimately the bid prices received. Data provided by Caltrans shows that for the 21 projects that were advertised between September and December in 2005, the average number of bids was 2.5 bids per project. However, between January and March 2006, the average number of bids for the 7 projects advertised was 4.1. Thus, with fewer projects offered, the number of bids per project increased.

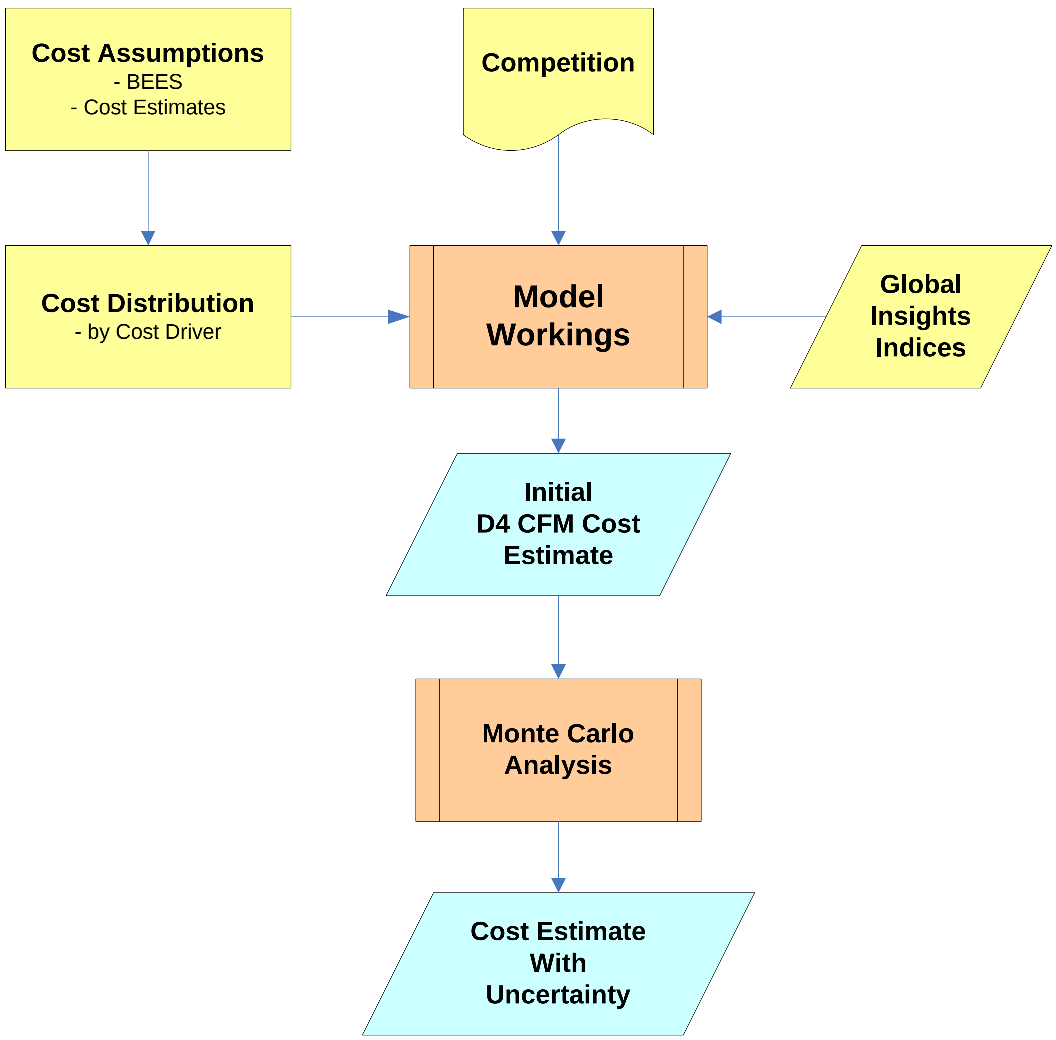
Over these two consecutive time periods, the average total average bid price was 43 percent over the Engineer's Estimate during late 2005, but only 17 percent over the Engineer's Estimate in early 2006. This suggests that the number of projects advertised does influence the number of project bidders and bid price. It also indicates that competition was becoming greater in 2006.

Note that no information was available to suggest whether the projects advertised during these two time periods were of a similar size. It is typically found that the smaller the project size, the more project bids that will be received.

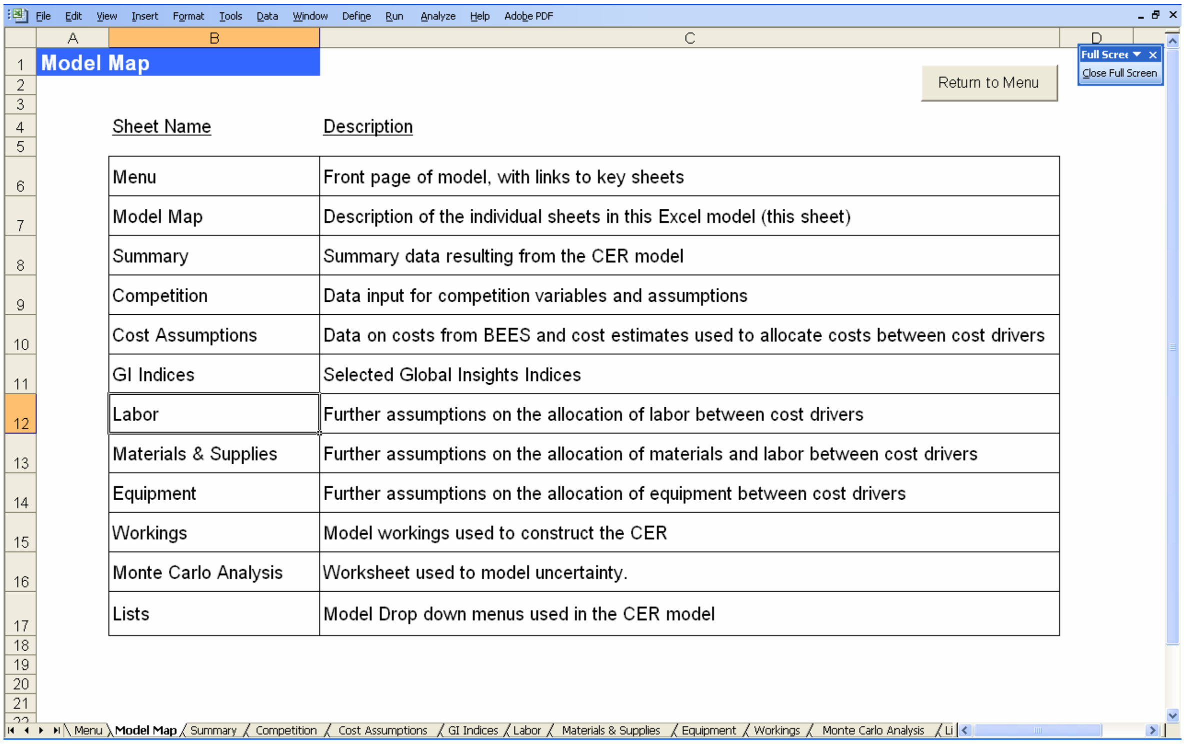
APPENDIX D
Model Output (Results)

Introduction

The CER Model modeling framework is shown diagrammatically below.



The CER Model is comprised of twelve (12) Excel worksheets as shown in the following screen capture of the Model map.



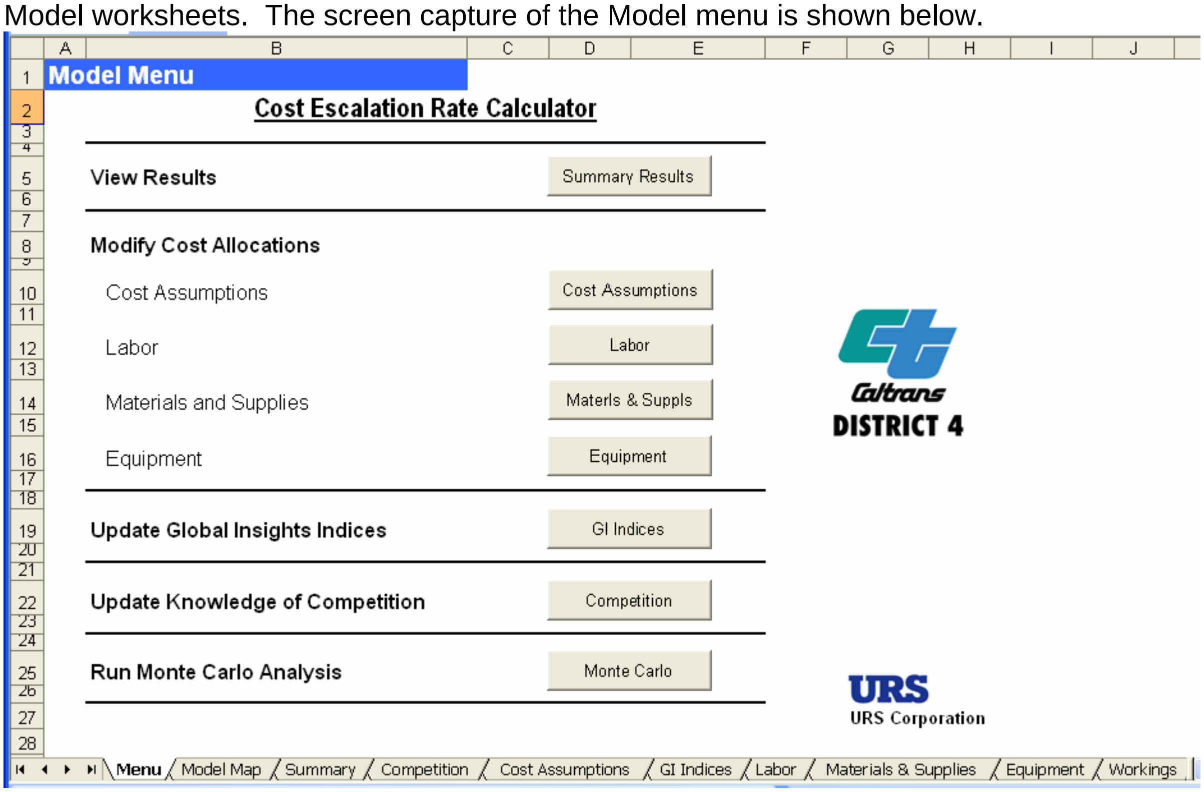
Model Map

Return to Menu

Sheet Name	Description
Menu	Front page of model, with links to key sheets
Model Map	Description of the individual sheets in this Excel model (this sheet)
Summary	Summary data resulting from the CER model
Competition	Data input for competition variables and assumptions
Cost Assumptions	Data on costs from BEES and cost estimates used to allocate costs between cost drivers
GI Indices	Selected Global Insights Indices
Labor	Further assumptions on the allocation of labor between cost drivers
Materials & Supplies	Further assumptions on the allocation of materials and labor between cost drivers
Equipment	Further assumptions on the allocation of equipment between cost drivers
Workings	Model workings used to construct the CER
Monte Carlo Analysis	Worksheet used to model uncertainty.
Lists	Model Drop down menus used in the CER model

Model Menu

The CER Model has been developed with Visual Basic macros to enable easy navigation of the Model worksheets. The screen capture of the Model menu is shown below.



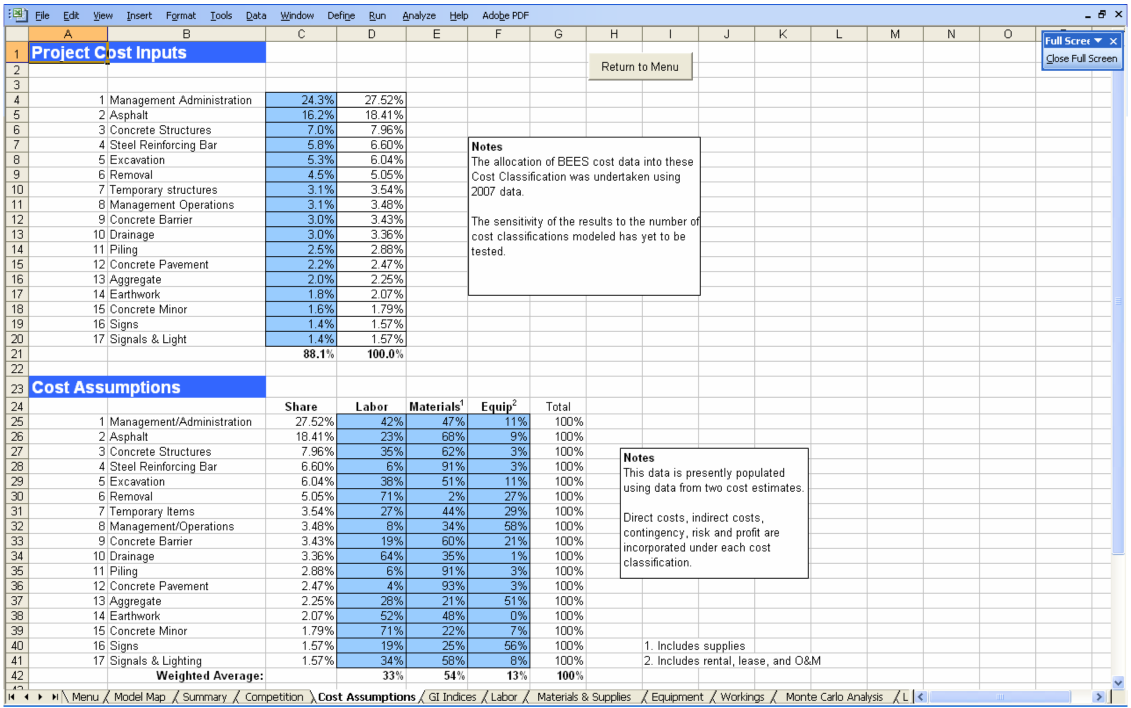
Model Menu

Cost Escalation Rate Calculator

View Results	Summary Results
Modify Cost Allocations	
Cost Assumptions	Cost Assumptions
Labor	Labor
Materials and Supplies	Materls & Suppls
Equipment	Equipment
Update Global Insights Indices	GI Indices
Update Knowledge of Competition	Competition
Run Monte Carlo Analysis	Monte Carlo

Model Assumptions

Most of the cost assumptions used to develop the CER Model have come from analyzing BEES data and two cost estimates that were made available to URS. These data sources were used to populate the Model on four separate worksheets. This data should only be modifies where improved data is made available to modify the assumptions presented. Screen captures of these worksheets are shown on the following two pages.



Project Cost Inputs

Return to Menu

1	Management Administration	24.3%	27.52%
2	Asphalt	16.2%	18.41%
3	Concrete Structures	7.0%	7.96%
4	Steel Reinforcing Bar	5.8%	6.60%
5	Excavation	5.3%	6.04%
6	Removal	4.5%	5.05%
7	Temporary structures	3.1%	3.54%
8	Management Operations	3.1%	3.48%
9	Concrete Barrier	3.0%	3.43%
10	Drainage	3.0%	3.36%
11	Piling	2.5%	2.88%
12	Concrete Pavement	2.2%	2.47%
13	Aggregate	2.0%	2.25%
14	Earthwork	1.8%	2.07%
15	Concrete Minor	1.6%	1.79%
16	Signs	1.4%	1.57%
17	Signals & Light	1.4%	1.57%
		88.1%	100.0%

Notes
The allocation of BEES cost data into these Cost Classification was undertaken using 2007 data.

The sensitivity of the results to the number of cost classifications modeled has yet to be tested.

Cost Assumptions

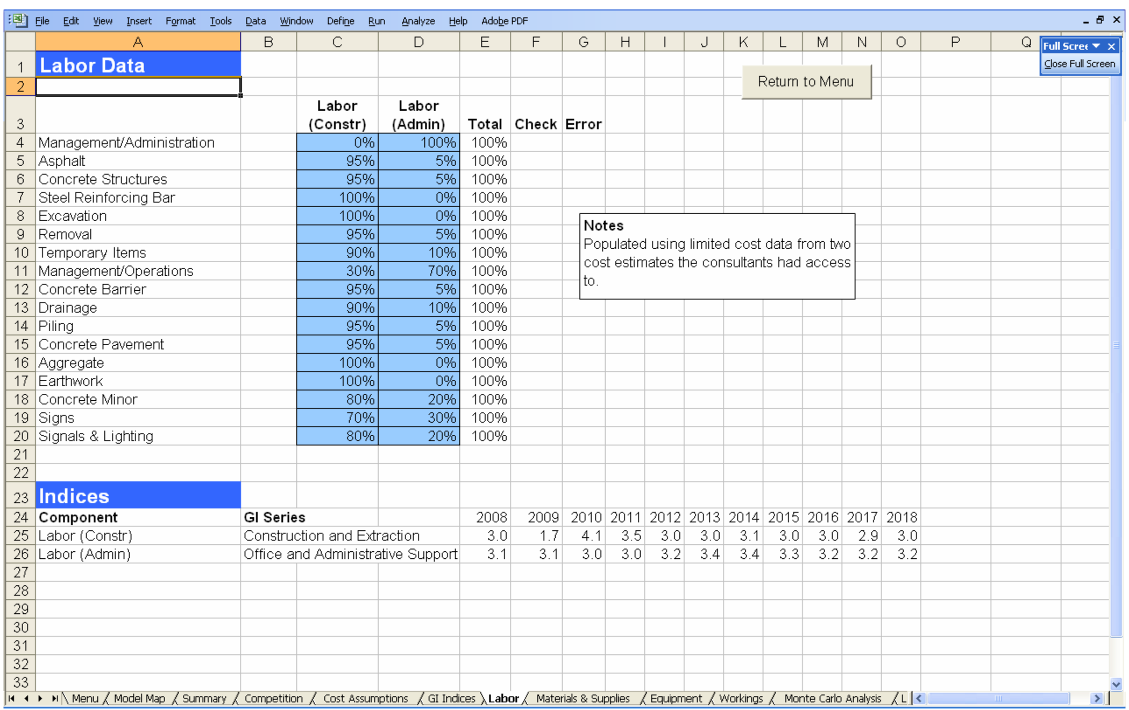
		Share	Labor	Materials[1]	Equip[2]	Total
1	Management/Administration	27.52%	42%	47%	11%	100%
2	Asphalt	18.41%	23%	68%	9%	100%
3	Concrete Structures	7.96%	35%	62%	3%	100%
4	Steel Reinforcing Bar	6.60%	6%	91%	3%	100%
5	Excavation	6.04%	38%	51%	11%	100%
6	Removal	5.05%	71%	2%	27%	100%
7	Temporary Items	3.54%	27%	44%	29%	100%
8	Management/Operations	3.48%	8%	34%	58%	100%
9	Concrete Barrier	3.43%	19%	60%	21%	100%
10	Drainage	3.36%	64%	35%	1%	100%
11	Piling	2.88%	6%	91%	3%	100%
12	Concrete Pavement	2.47%	4%	93%	3%	100%
13	Aggregate	2.25%	28%	21%	51%	100%
14	Earthwork	2.07%	52%	48%	0%	100%
15	Concrete Minor	1.79%	71%	22%	7%	100%
16	Signs	1.57%	19%	25%	56%	100%
17	Signals & Lighting	1.57%	34%	58%	8%	100%
	Weighted Average:		33%	54%	13%	100%

Notes
This data is presently populated using data from two cost estimates.

Direct costs, indirect costs, contingency, risk and profit are incorporated under each cost classification.

1. Includes supplies
2. Includes rental, lease, and O&M

Menu / Model Map / Summary / Competition / Cost Assumptions / GI Indices / Labor / Materials & Supplies / Equipment / Workings / Monte Carlo Analysis



Labor Data

Return to Menu

	Labor (Constr)	Labor (Admin)	Total	Check	Error
Management/Administration	0%	100%	100%		
Asphalt	95%	5%	100%		
Concrete Structures	95%	5%	100%		
Steel Reinforcing Bar	100%	0%	100%		
Excavation	100%	0%	100%		
Removal	95%	5%	100%		
Temporary Items	90%	10%	100%		
Management/Operations	30%	70%	100%		
Concrete Barrier	95%	5%	100%		
Drainage	90%	10%	100%		
Piling	95%	5%	100%		
Concrete Pavement	95%	5%	100%		
Aggregate	100%	0%	100%		
Earthwork	100%	0%	100%		
Concrete Minor	80%	20%	100%		
Signs	70%	30%	100%		
Signals & Lighting	80%	20%	100%		

Notes
Populated using limited cost data from two cost estimates the consultants had access to.

Indices

Component	GI Series	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Labor (Constr)	Construction and Extraction	3.0	1.7	4.1	3.5	3.0	3.0	3.1	3.0	3.0	2.9	3.0
Labor (Admin)	Office and Administrative Support	3.1	3.1	3.0	3.0	3.2	3.4	3.4	3.3	3.2	3.2	3.2

Menu / Model Map / Summary / Competition / Cost Assumptions / GI Indices / Labor / Materials & Supplies / Equipment / Workings / Monte Carlo Analysis

Materials & Supplies Data

Return to Menu

	Aggregate Base	Asphalt Concrete	Concrete/ Structural & Pavement	Concrete/ Misc	Steel Rebar	Structural Steel	Misc Hardware	Plastics and Composites	Electrical Equipment	Total	Check	Error
Management/Administration							50%	50%		**100%**		
Asphalt		100%								**100%**		
Concrete Structures			100%							**100%**		
Steel Reinforcing Bar					100%					**100%**		
Excavation							100%			**100%**		
Removal							100%			**100%**		
Temporary Items	15%	15%		15%			20%	15%	20%	**100%**		
Management/Operations							30%	20%	50%	**100%**		
Concrete Barrier			100%							**100%**		
Drainage				30%			30%	30%	10%	**100%**		
Piling			50%			50%				**100%**		
Concrete Pavement			100%							**100%**		
Aggregate	100%									**100%**		
Earthwork	100%									**100%**		
Concrete Minor				100%						**100%**		
Signs								100%		**100%**		
Signals & Lighting									100%	**100%**		

Notes
Populated using limited cost data from two cost estimates the consultants had access to.

Indices

Component	GI Series	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Aggregate Base	Sand, Gravel, & Crushed Stone	6.5	3.0	0.3	1.5	2.4	2.3	1.9	2.0	2.3	2.3	2.2
Asphalt Concrete	Asphalt Paving Mixtures & Blocks	6.5	7.3	0.0	0.4	1.8	1.3	0.5	0.6	1.0	1.2	1.0
Concrete/ Structural & Pavem	Ready-Mixed Concrete	2.1	0.9	0.9	5.1	3.2	2.0	2.0	2.1	2.2	2.2	2.2
Concrete/ Misc	Concrete Products	3.2	2.3	0.1	2.0	3.7	2.9	1.8	1.7	1.9	2.1	1.8
Steel Rebar	Concrete Reinforcing Bar, Carbon Steel	42.6	-7.2	-0.8	-7.7	5.0	2.8	2.7	2.6	2.6	2.8	2.4
Structural Steel	Hot Rolled Sheet, Carbon Steel	78.4	-21.5	-7.6	-8.7	8.6	1.6	2.4	-1.9	2.6	3.6	3.3
Misc Hardware	Fabricated Structural Metal Products	9.5	3.4	-0.1	0.3	2.7	1.9	1.4	1.5	1.7	1.8	1.7
Plastics and Composites	Plastic Construction Products	1.9	1.0	-1.1	-0.2	1.6	1.9	1.7	1.7	1.9	2.0	2.2
Electrical Equipment	Electrical Lighting Equipment	1.8	0.5	-0.7	-0.4	0.5	0.5	0.2	0.4	0.5	0.6	0.7

Menu / Model Map / Summary / Competition / Cost Assumptions / GI Indices / Labor / **Materials & Supplies** / Equipment / Workings / Monte Carlo Analysis

Equipment Data

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	Equipment Rent/Depr 1	Equipment Rent/Depr 2	Equipment Rent/Depr 3	Fuel 1	Fuel 2	Maint	Total	Check	Err
		45%			55%				
	33%	33%	33%	30%	30%	40%			
Management/Administration	15%	15%	15%	17%	17%	22%	**100%**		
Asphalt	15%	15%	15%	17%	17%	22%	**100%**		
Concrete Structures	15%	15%	15%	17%	17%	22%	**100%**		
Steel Reinforcing Bar	15%	15%	15%	17%	17%	22%	**100%**		
Excavation	15%	15%	15%	17%	17%	22%	**100%**		
Removal	15%	15%	15%	17%	17%	22%	**100%**		
Temporary Items	15%	15%	15%	17%	17%	22%	**100%**		
Management/Operations	15%	15%	15%	17%	17%	22%	**100%**		
Concrete Barrier	15%	15%	15%	17%	17%	22%	**100%**		
Drainage	15%	15%	15%	17%	17%	22%	**100%**		
Piling	15%	15%	15%	17%	17%	22%	**100%**		
Concrete Pavement	15%	15%	15%	17%	17%	22%	**100%**		
Aggregate	15%	15%	15%	17%	17%	22%	**100%**		
Earthwork	15%	15%	15%	17%	17%	22%	**100%**		
Concrete Minor	15%	15%	15%	17%	17%	22%	**100%**		
Signs	15%	15%	15%	17%	17%	22%	**100%**		
Signals & Lighting	15%	15%	15%	17%	17%	22%	**100%**		

Notes
Populated using limited cost data from two cost estimates the consultants had access to.

Indices

Component	GI Series	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Equipment Rent/Depr 1	Transportation Equipment	2.3	2.0	0.4	0.8	0.9	1.4	1.3	1.3	1.4	1.4	1.4
Equipment Rent/Depr 2	Construction Machinery	2.5	4.5	2.3	3.7	0.4	0.2	0.2	1.4	2.2	2.3	2.1
Equipment Rent/Depr 3	Trucks, Over 10,000 LBS, GVW	2.0	4.5	1.7	1.9	2.4	1.9	1.9	1.9	1.9	1.9	1.9
Fuel 1	Gasoline	29.1	-2.2	-5.8	-4.0	-4.2	-6.2	-4.9	-1.2	0.4	0.4	0.4
Fuel 2	Diesel Fuel	56.9	-3.9	-7.4	-2.6	-2.4	-3.3	-3.5	-0.4	0.9	0.8	0.8
Maintenance	Motor Vehicle Parts and Access	0.5	0.3	-1.1	-0.4	-0.1	0.3	0.2	0.1	0.1	0.1	0.1

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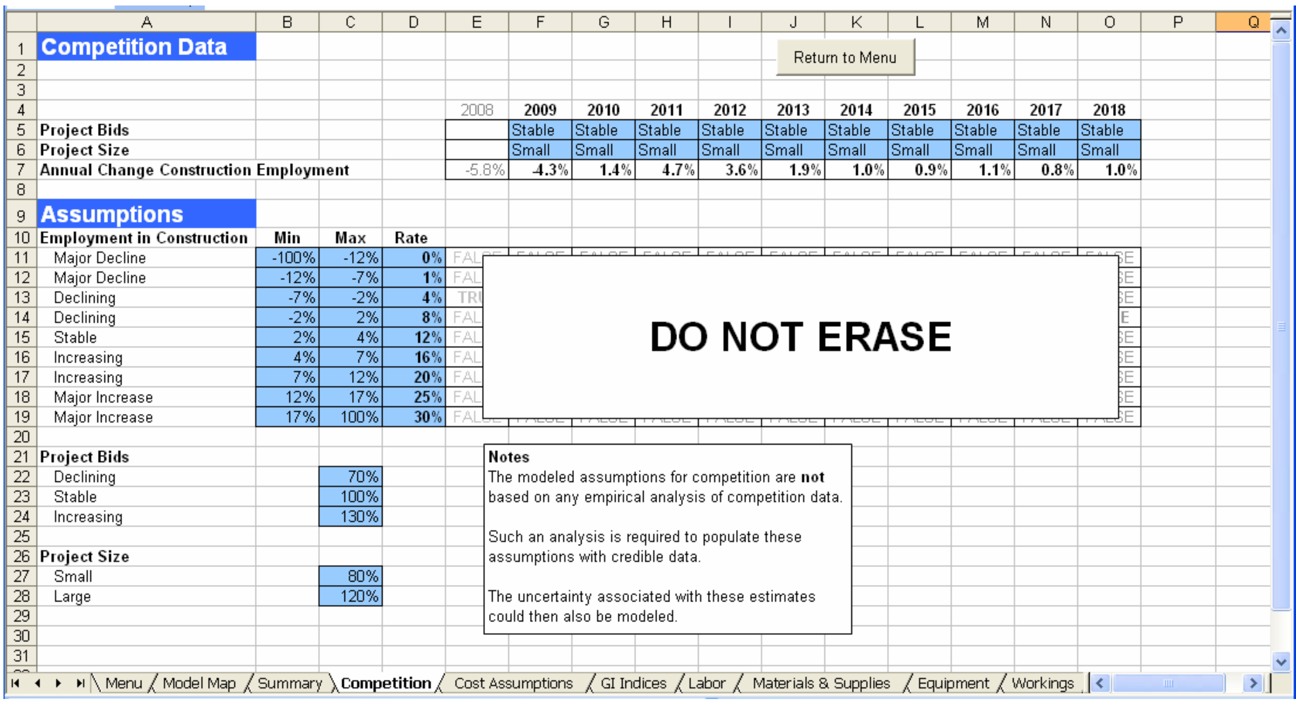
Running the Model

In running the Model, the two main areas which need to be regularly updated are the chosen Indices used to escalate prices (presently Global Insights indices are used), and information on the competitiveness of the industry. These two worksheets are “GI Indices” and “Competition.” The screen captures of these worksheets are shown below and the following page.



Competition Data

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	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Project Bids		Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable
Project Size		Small	Small	Small	Small	Small	Small	Small	Small	Small	Small
Annual Change Construction Employment	-5.8%	-4.3%	1.4%	4.7%	3.6%	1.9%	1.0%	0.9%	1.1%	0.8%	1.0%

Assumptions

Employment in Construction	**Min**	**Max**	**Rate**
Major Decline	-100%	-12%	0%
Major Decline	-12%	-7%	1%
Declining	-7%	-2%	4%
Declining	-2%	2%	8%
Stable	2%	4%	12%
Increasing	4%	7%	16%
Increasing	7%	12%	20%
Major Increase	12%	17%	25%
Major Increase	17%	100%	30%

DO NOT ERASE

Project Bids	
Declining	70%
Stable	100%
Increasing	130%

Project Size	
Small	80%
Large	120%

Notes
The modeled assumptions for competition are **not** based on any empirical analysis of competition data.

Such an analysis is required to populate these assumptions with credible data.

The uncertainty associated with these estimates could then also be modeled.

Menu / Model Map / Summary / Competition / Cost Assumptions / GI Indices / Labor / Materials & Supplies / Equipment / Workings

Global Insight Series Used

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	Used	Model Location	GI Seri	GI Seri	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
					5	6	7	8	9	10	11	12	13	14	15
1	Construction and Extraction	Labor	ECI(A)	ECIPCCE	3.0	1.7	4.1	3.5	3.0	3.0	3.1	3.0	3.0	2.9	3.0
2	Office and Administrative Support	Labor	ECI(A)	ECIPCO.	3.1	3.1	3.0	3.0	3.2	3.4	3.4	3.3	3.2	3.2	3.2
3	Highway, Street, & Bridge Construction	Labor	AHE(A)	CEU202	1.3	0.6	2.5	2.7	3.1	2.8	2.6	2.4	2.5	2.5	2.4
4	Construction	Labor	ECI(A)	ECIPCC(	3.0	1.4	1.7	4.3	4.5	3.8	3.2	3.1	3.1	3.0	3.0
5	Sand, Gravel, & Crushed Stone	Materials and Supplies	Building	WPIP13	6.5	3.0	0.3	1.5	2.4	2.3	1.9	2.0	2.3	2.3	2.2
6	Asphalt Paving Mixtures & Blocks	Materials and Supplies	Building	PPI3241	6.5	7.3	0.0	0.4	1.8	1.3	0.5	0.6	1.0	1.2	1.0
7	Ready-Mixed Concrete	Materials and Supplies	Building	PPI3273	2.1	0.9	0.9	5.1	3.2	2.0	2.0	2.1	2.2	2.2	2.2
8	Concrete Products	Materials and Supplies	Building	WPIWP1	3.2	2.3	0.1	2.0	3.7	2.9	1.8	1.7	1.9	2.1	1.8
9	Concrete Reinforcing Bar, Carbon Steel	Materials and Supplies	Steel(A	PREBAF	42.6	-7.2	-0.8	-7.7	5.0	2.8	2.7	2.6	2.6	2.8	2.4
10	Hot Rolled Sheet, Carbon Steel	Materials and Supplies	Steel(A	PHRCSH	78.4	-21.5	-7.6	-8.7	8.6	1.6	2.4	-1.9	2.6	3.6	3.3
11	Fabricated Structural Metal Products	Materials and Supplies	Fabrica	WPIP10	9.5	3.4	-0.1	0.3	2.7	1.9	1.4	1.5	1.7	1.8	1.7
12	Plastic Construction Products	Materials and Supplies	Building	WPIP07	1.9	1.0	-1.1	-0.2	1.6	1.9	1.7	1.7	1.9	2.0	2.2
13	Electrical Lighting Equipment	Materials and Supplies	Electric	PPI3351	1.8	0.5	-0.7	-0.4	0.5	0.5	0.2	0.4	0.5	0.6	0.7
14	Transportation Equipment	Equipment	Transpo	WPIWP1	2.3	2.0	0.4	0.8	0.9	1.4	1.3	1.3	1.4	1.4	1.4
15	Construction Machinery	Equipment	Non-Ele	PPI3331	2.5	4.5	2.3	3.7	0.4	0.2	0.2	1.4	2.2	2.3	2.1
16	Trucks, Over 10,000 LBS, GVW	Equipment	Transpo	WPIP14	2.0	4.5	1.7	1.9	2.4	1.9	1.9	1.9	1.9	1.9	1.9
17	Gasoline	Equipment	Energy(	PPI3241	29.1	-2.2	-5.8	-4.0	-4.2	-6.2	-4.9	-1.2	0.4	0.4	0.4
18	Diesel Fuel	Equipment	Energy(	PPI3241	56.9	-3.9	-7.4	-2.6	-2.4	-3.3	-3.5	-0.4	0.9	0.8	0.8
19	Motor Vehicle Parts and Access	Equipment	MRO(A)	WPIP14	0.5	0.3	-1.1	-0.4	-0.1	0.3	0.2	0.1	0.1	0.1	0.1
	Construction Employment	Competition	Macro_I	ECON	-5.8	-4.3	1.4	4.7	3.6	1.9	1.0	0.9	1.1	0.8	1.0

Table Included in Report

Cost Types	GI Indices	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
		Percentage Change (%)										
Equipment												
Equipment Rent/Depr 1	Transportation Equipment	2.3	2	0.4	0.8	0.9	1.4	1.3	1.3	1.4	1.4	1.4
Equipment Rent/Depr 2	Construction Machinery	2.5	4.5	2.3	3.7	0.4	0.2	0.2	1.4	2.2	2.3	2.1
Equipment Rent/Depr 3	Trucks, Over 10,000 LBS, GVW	2	4.5	1.7	1.9	2.4	1.9	1.9	1.9	1.9	1.9	1.9
Fuel 1	Gasoline	29.1	-2.2	-5.8	-4	-4.2	-6.2	-4.9	-1.2	0.4	0.4	0.4
Fuel 2	Diesel Fuel	56.9	-3.9	-7.4	-2.6	-2.4	-3.3	-3.5	-0.4	0.9	0.8	0.8
Maintenance	Motor Vehicle Parts and Access	0.5	0.3	-1.1	-0.4	-0.1	0.3	0.2	0.1	0.1	0.1	0.1
Materials												
Aggregate Base	Sand, Gravel, & Crushed Stone	6.5	3	0.3	1.5	2.4	2.3	1.9	2	2.3	2.3	2.2
Asphalt Concrete	Asphalt Paving Mixtures & Blocks	6.5	7.3	0	0.4	1.8	1.3	0.5	0.6	1	1.2	1
Concrete/ Structural & Pavement	Ready-Mixed Concrete	2.1	0.9	0.9	5.1	3.2	2	2	2.1	2.2	2.2	2.2
Concrete/ Misc	Concrete Products	3.2	2.3	0.1	2	3.7	2.9	1.8	1.7	1.9	2.1	1.8
Steel Rebar	Concrete Reinforcing Bar, Carbon Ste	42.6	-7.2	-0.8	-7.7	5	2.8	2.7	2.6	2.6	2.8	2.4
Structural Steel	Hot Rolled Sheet, Carbon Steel	78.4	-21.5	-7.6	-8.7	8.6	1.6	2.4	-1.9	2.6	3.6	3.3
Misc Hardware	Fabricated Structural Metal Products	9.5	3.4	-0.1	0.3	2.7	1.9	1.4	1.5	1.7	1.8	1.7
Plastics and Composites	Plastic Construction Products	1.9	1	-1.1	-0.2	1.6	1.9	1.7	1.7	1.9	2	2.2
Electrical Equipment	Electrical Lighting Equipment	1.8	0.5	-0.7	-0.4	0.5	0.5	0.2	0.4	0.5	0.6	0.7
Labor												
Labor (Constr)	Construction and Extraction	3	1.7	4.1	3.5	3	3	3.1	3	3	2.9	3
Labor (Admin)	Office and Administrative Support	3.1	3.1	3	3	3.2	3.4	3.4	3.3	3.2	3.2	3.2
Competition												
Construction Employment	Competition	-5.8	-4.3	1.4	4.7	3.6	1.9	1	0.9	1.1	0.8	1

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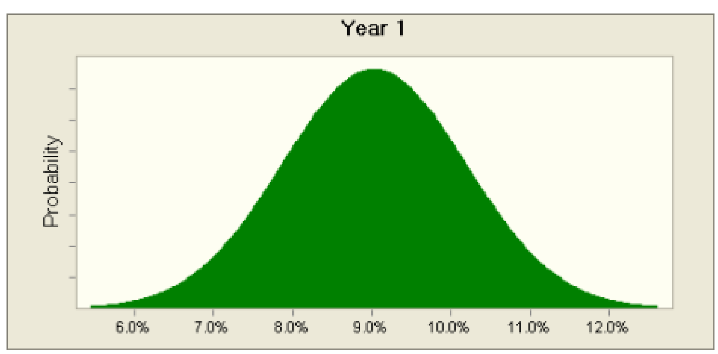
Modeling Uncertainty

The CER Model was developed using Crystal Ball software to enable the uncertainty associated with cost indices (and potentially competition) to be modeled explicitly.



For selected assumptions, the software enables the user to specify the type of distribution, and other data (mean, standard deviation, 95th percentile etc), such that a curve can be constructed. We used normal distributions, the estimated mean CER from the Model and guesstimated 20% and 80% values to construct uncertainty distributions in the Model. The Year 2008 curve is shown to the right, which was based on the mean CER (prices only) of 9%. No correlation was assumed between each year.

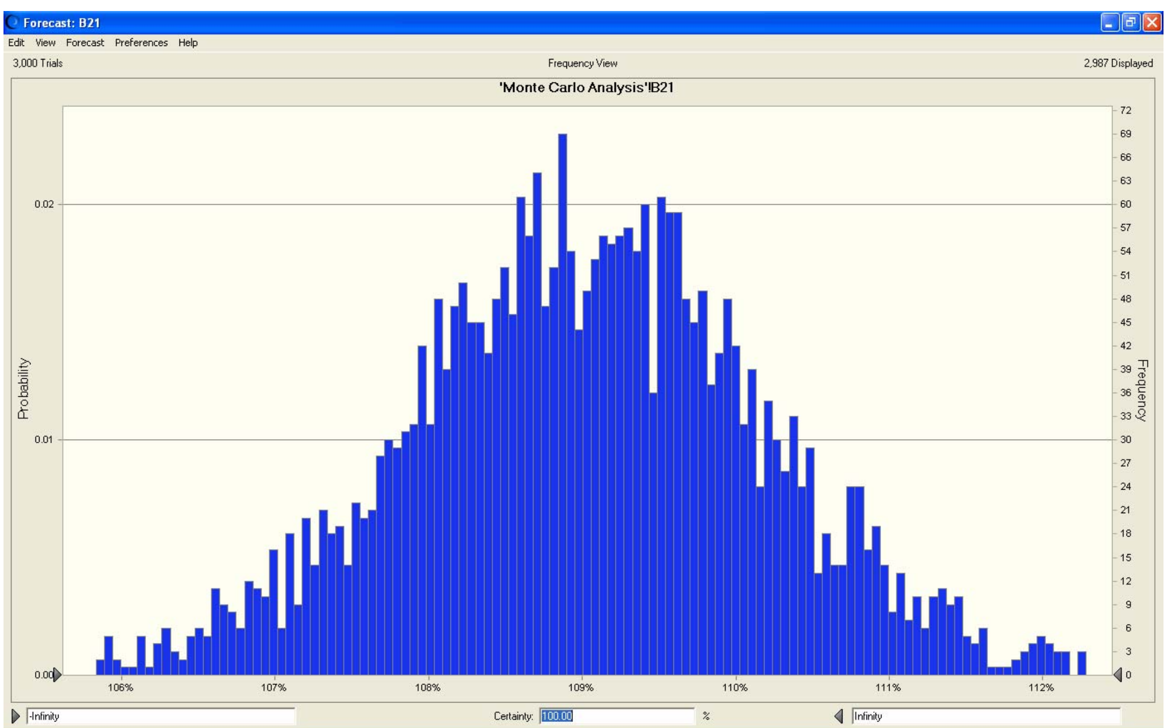
The screen capture for this worksheet is provided below.

	A	B	C	D	E	F	G	H	I	J	K
1	**Monte Carlo Analysis**										
2								Return to Menu			
3	**With Modeled Uncertainty**										
4	(prices only)		**Probability of Exceedence**								
5	* **Preliminary Data**		50.0%	90.0%	10.0%						
6			**Mean**	**Low**	**High**						
7	Year 1	1.7%	1.7%	-2.0%	4.0%						
8	Year 2	0.9%	0.9%	-3.0%	3.0%						
9	Year 3	1.3%	1.3%	-3.0%	3.0%						
10	Year 4	2.4%	2.4%	-2.0%	5.0%						
11	Year 5	2.0%	2.0%	-2.0%	4.0%						
12	Year 6	1.8%	1.8%	-2.0%	4.0%						
13	Year 7	2.0%	2.0%	-2.0%	4.0%						
14	Year 8	2.2%	2.2%	-2.0%	5.0%						
15	Year 9	2.2%	2.2%	-2.0%	5.0%						
16	Year 10	2.2%	2.2%	-2.0%	5.0%						
17											
18		**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
19	**Forecast Cells**	102%	103%	104%	106%	108%	110%	113%	115%	118%	120%
20	**Probability of Exceedence**										
21	50%	102%	102%	102%	104%	106%	107%	109%	111%	113%	115%
22	90%	99%	98%	97%	97%	98%	98%	98%	99%	100%	101%
23	10%	104%	106%	109%	113%	116%	119%	122%	125%	129%	133%
24	**Annual**										
25	50%	1.7%	0.3%	0.2%	2.0%	1.5%	1.3%	1.5%	2.0%	2.0%	1.8%
26	90%	-0.5%	-1.5%	-1.1%	0.5%	0.3%	0.4%	0.3%	1.0%	1.1%	0.8%
27	10%	4.1%	2.3%	2.3%	3.7%	2.7%	2.6%	2.3%	3.0%	2.8%	3.4%
28											
29											

Notes
We can use a retrospective look at how actual price changes have varied with forecast changes to produce a probability distribution.

GI Indices / Labor / Materials & Supplies / Equipment / Workings / Monte Carlo Analysis / Lists / Projec

When the Model is run using 3000 trial events, a curve such as the one below is produced for each of the assumptions. Once that is complete, values for the 20% and 80% events are selected to represent an above average result and a below average result.



Results

The final screen snapshot is of the summary results worksheet. This worksheet summarizes the results of the CER Model both with and without uncertainty. The results are presented as annual escalation and as cumulative escalation rates. It is important to note that no uncertainty has been modeled for the competition variables.

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URS Corporation

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Caltrans DISTRICT 4

Cost Escalation Rate Results (CER)

(Percent Change from Prior Year)

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Project Bids	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable
Project Size	Small	Small	Small	Small	Small	Small	Small	Small	Small	Small
1. Contractor Input Costs CER										
Base Estimate	1.7%	0.9%	1.3%	2.4%	2.0%	1.8%	2.0%	2.2%	2.2%	2.2%
With Uncertainty*										
90%	-0.5%	-1.5%	-1.1%	0.5%	0.3%	0.4%	0.3%	1.0%	1.1%	0.8%
50%	1.7%	0.3%	0.2%	2.0%	1.5%	1.3%	1.5%	2.0%	2.0%	1.8%
10%	4.1%	2.3%	2.3%	3.7%	2.7%	2.6%	2.3%	3.0%	2.8%	3.4%
2. Profit CER	0.0%	3.1%	5.9%	-4.1%	-4.3%	0.0%	0.0%	0.0%	0.0%	0.0%
3. Combined CER	1.7%	4.0%	7.3%	-1.8%	-2.4%	1.8%	2.0%	2.2%	2.2%	2.2%

*Probability of exceeding value shown

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The uncertainty results can be interpreted as providing a likely range for the estimated CER rates. For example in 2009, there is a 90% likelihood that the escalation rate is greater than -0.5%. Also, there is a 90% likelihood the rate is less than 4.1%, which is equivalent to a 10% likelihood it is greater than 4.1%. As discussed above, assumptions were made to generate this likelihood and future refinement is necessary to better identify the proper distributions of the CER rates.

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