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Best Practices for Developing the Engineer's Estimate

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BEST PRACTICES FOR DEVELOPING THE ENGINEER'S ESTIMATE

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ABSTRACT

The research project “Best Practices for Developing the Engineering Estimate” was executed by Clemson University on behalf of the South Carolina Department of Transportation (SCDOT). The primary objective of this research project was to investigate the strengths and weaknesses of two types of estimating methods being utilized today by state department of transportations (DOT) nationwide. These two types of estimating methods are the unit cost line item approach, which the SCDOT utilizes, and the cost-based approach. The unit cost line item approach uses a formulated line item estimate price, based on historical data, multiplied by the anticipated quantity to reach a final unit price. Whereas, the cost-based estimating approach takes into account production rates, crew compositions, fuel cost adjustments, haul distances, and other factors before applying a cost value to a line item estimate.

This research report identifies accuracy obtained, resources expended, and methodologies utilized when implementing either type of estimating approach. Information on both estimating types was found by the research team by reviewing literature on this topic, making site visits to other state DOT’s, and distributing a survey questionnaire. This was done so the research team could gather enough evidence in order to suggest to the SCDOT if a change was needed in their estimating methodologies. The responses to the survey questionnaire from all responding states are included in this report as well. The recommendation to the SCDOT is that there is no compelling evidence to suggest that SCDOT adopt a cost-based/combination estimating approach when preparing the engineer’s estimate.

ACKNOWLEDGMENTS

I would like to thank my advisor, Dr. Bell, for all of his assistance and guidance throughout this research project. I would also like to thank the South Carolina Department of Transportation for their financial support. I would also like to recognize the Research Steering Committee for their thoughts and help. I would also like to thank Dr. Back and Dr. Amirkhanian for their support.

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CHAPTER I

INTRODUCTION

When state estimators formulate an engineer's estimate for transportation projects they may choose from several different approaches to estimate the cost of a specific project. The state DOT's surveyed in this study use two main types of estimating practices The first approach is called the unit cost line item approach. This approach uses a formulated line item estimate price multiplied by the anticipated quantity to get the final unit price. The estimated price used for the line item is often comprised of an average unit price based upon historical bid data. The remaining line items estimated for that particular project are then summed to obtain the final engineer's estimate. This approach is very useful since it incorporates historical information when determining common line items that show up on most DOT estimates.

The second common type of estimating practice is called the cost-based estimating approach. The cost-based estimating approach is nearly identical to the contractor's approach to estimating. This approach defines the labor, material, and equipment costs by taking into account location, production rates, crew sizes, haul times, equipment rates, and other information sources before applying a cost value to a line item. Questions have arisen as to the cost-effectiveness and labor intensiveness of this approach. Practitioner's expressed various opinions regarding these questions (which will be discussed in this study), but no absolutes as apparently most states utilize a combination of both approaches. In particular, the South Carolina Department of

Transportation (SCDOT) currently implements a unit cost line item approach when developing the engineer's estimate, but wanted to investigate the approach taken by other states that utilize the cost-based method. This research project was initiated to gather information from various DOT's in order to explore and to compare the strengths and weakness of these two estimating methods.

Problem Statement

Currently SCDOT implements a unit cost line item approach when developing their engineer's estimate. The primary advantage of this approach is that it requires minimal manpower to compute and is believed to be reasonably accurate. However, there are three basic concerns, or perhaps disadvantages, to the SCDOT unit cost line item estimating approach. The first concern is that unit cost line item estimating relies on historical bid data, and this data includes unbalanced unit prices. The second issue of concern is that unit prices may differ considerably with the quantity of materials required. The final concern with this approach is that the unit prices in the historical database may have been influenced by economic factors that are no longer applicable. Because of these potential disadvantages of using the unit cost line item approach, the SCDOT wanted to explore the cost-based approach to estimating to discover if the potential benefits of a cost-based approach outweigh the perceived cost issues. It is believed that the primary disadvantage of the cost-based approach is that implementation is very manpower intensive. However, this problem could be offset by the possible advantages of this approach that include higher estimate accuracy and a better legal ground when rejecting bids that are more than the engineer's estimate. To discover new information, a survey of state DOT's was necessary to ascertain first what resources were being expended by the

states that felt that they were successful when developing their engineer's estimate, and secondly to determine from this new first hand information if any adjustments to SCDOT's current practice would improve their estimating procedures.

Objectives and Scope of Research

The primary objective for the research project, "Best Practices for Developing the Engineer's Estimate," was to investigate the general advantages and disadvantages of the unit cost line item estimating approach as compared to the cost-based estimating approach and to try and assess the accuracy of each method based upon the data from a survey of DOT's. The secondary objective was to develop specific "best practices" for improving the accuracy of the SCDOT unit cost approach to developing the engineer's estimate based upon a statistical comparison of data provided by SCDOT. This would include examining relationships between the costs of fuel and asphalt bid line items, including the use of subcategories for bid line items such as clearing and grubbing. Alternatives to the bid letting process will be examined including the stipulation of given or maximum lump sum amount for line items such as mobilization, and guidelines for applying engineering judgment and/or database cost adjustment indices to the estimating process will be developed. The research reported herein will focus on the primary objective, and provides the insight that will be reported in a subsequent study that will focus on the second research objective. The emphasis of this research study was to develop and utilize a survey targeting state DOT's nationwide, and to analyze the information received to form conclusions about the two types of estimating methods.

Research Methodology

This research study involved several integrated and ongoing tasks. These tasks included an extensive literature review, site visits to the Georgia (GADOT) and North Carolina (NCDOT) Departments of Transportation, development and distribution of a survey questionnaire, and the interpretation of this data.

The literature review was designed to probe detailed resources that dealt with defining the engineer's estimate, comparing and contrasting alternative approaches to estimate generation, and identifying previous research endeavors relating to the research objectives. Most of this effort focused upon pursuing sources suggested by SCDOT over the internet. As part of this effort the research team attended the annual Transportation Estimator's Association Conference which was held in Daytona Beach, Florida. This conference provided an exceptional opportunity for two graduate students to make contacts with other state DOT's estimators, and gather perspective and suggestions on related literature.

The SCDOT suggested that site visits be pursued to the states that bordered the state of South Carolina because it was believed that both the GADOT and the NCDOT utilized a cost-based estimating approach. The research team contacted both states, and executed site visits. These site visits helped gain insight into the approaches of these DOT's and their perspective on the use of cost-based estimating methodology.

The SCDOT was instrumental in motivating the development of a new survey to be sent to all state departments of transportation in the United States. This research study documents this effort and the responses obtained. The survey was focused to gain a better perspective into what methods and basic assumptions other states were utilizing

and to assess the variations in their approaches to developing engineering estimates. Their responses were grouped together in order to see whether any correlations existed between the two estimating approaches, their methodologies, resources expended, and success rate.

Research Steering Committee

Jim Frick formed and led a Research Steering Committee composed of engineers from the SCDOT. This group provided direction and feedback to the research team on a regular basis. The principal investigator, Dr. Lansford Bell, was instrumental to the success of the progress reports and survey development. Progress reports were forwarded quarterly to the research committee to update the committee on the research team's progress. The Research Steering Committee and the research team met every three months to discuss recent progress and to decide a path forward for future progress reports. The Steering Committee also helped critique the research team's methodology and also helped distribute the survey questionnaire.

CHAPTER II

LITERATURE REVIEW

A comprehensive literature search was executed using the sources cited in the research proposal to the South Carolina Department of Transportation (SCDOT). These included the proceedings of the Transportation Research Board (TRB), the Transportation Research Information Services (TRIS), the South Carolina Department of Transportation (SCDOT), the Federal Highway Administration (FHWA), the Association for Advancement of Cost Engineering (AACE), the American Association of State Highway and Transportation Officials (AASHTO), the Auburn University Archives, and Clemson University Library databases. The purpose of this search was to find background information that would help in defining the scope of the project, and to better understand the workings of the engineer's estimate, types of estimates, and price trends in oil and asphalt in today's marketplace.

Transportation Research Board Website Search

This website was first consulted for information on the best practices for an engineering estimate and fuel and asphalt cost trends and relationships. Several keywords were used: engineer's estimate, cost estimating, unit price estimates, estimators, estimating methods, cost estimators, the engineer's cost estimate, fuel and asphalt trends. Most of these keywords had several links, but many were not related to the project at hand.

Many papers, reports, and research projects were discovered when investigating this website, but very few actually related to the overall topic. Some of these articles included topics such as the cost of estimating vehicles on the road, bridge management (13), cost estimating for underground transit, and others. One article discussed that in the 1980's the FHWA allowed state departments of transportation freedom to investigate innovative contracting approaches (12).

An article identified as a result of this search was *NCHRP Synthesis 331, Statewide Highway Letting Program Management, A Synthesis of Highway Practice* by Stuart Anderson, TTI and Byron Blaschke, College Station, Texas. This report summarizes available information on statewide highway letting programs, which are defined as a set of highway projects in advanced stages of design that have a target date for construction bid. This report contains information from three different sources: a review of the literature pertaining to letting program management conducted with a specific focus on processes and techniques, a survey questionnaire, and selected interviews with five state highway agencies (SHAs) that includes Arkansas, Connecticut, Kansas, New York, and Texas (1).

The NCHRP research survey included questions on contract award considerations including criteria for rejecting bids, analyzing bids that appear unbalanced, identifying collusion, and determining bid responsiveness (1). This report illustrates different states' standards for accepting or rejecting bids. This report states that most SHAs will award the bid to the lowest responsive and responsible bidder. Some 70% of the SHAs claimed that they may not always award the contract the lowest bidder. The selected following approaches were illustrated in NCHRP Synthesis 331.

Maryland's DOT approach:

> Bids 10% over or 15% under the engineer's estimate require a written justification, which must be approved and signed by the procurement officer. If the bid is substantially above the 10% allowance, the design office may write a justification letter, requesting all bids be rejected. The letter, including a detailed explanation of the discrepancy, must be approved by the Assistant Attorney General's Office and the procurement officer. When a bid is rejected, notification is distributed to all bidders.

Kansas's DOT approach:

> Kansas does not automatically reject bids that are over the estimate. If a bid is over the estimate we handle the review on a case by case basis. There may be cases where the estimate was too low due to conditions that were not known at the time the estimate was prepared. There may be other factors. Kansas DOT looks at the bids and if we decide it is to the state's advantage to award rather than reject and relet, we will do that. One bid does not cause that bid to be automatically rejected. Since we have the estimate, we can use that for comparison of the bid.

Texas's DOT approach:

> Texas's DOT has developed a computer program that analyzes certain items in the bid to determine if unbalancing may have occurred. If the program indicates that unbalancing did occur, further analysis is done using [the computer program] Primavera. The schedule developed by the department to estimate the job is used with the contractor's unit bid prices. The net present value of the cash flows is

> calculated. If the cash flows reveal that the second bidder may be lower, we give the low bidder the chance to present their case using their construction schedule. If the cash flows still favor the second bidder, the bid is rejected.

Ohio's DOT approach is following laws that state that the DOT will not award a bid if it is 5% over the engineer's estimate (1).

When the bids appear to be unbalanced most states conduct a bid line item analysis. New York and Pennsylvania use manual calculations when analyzing unbalanced bids. Maryland's DOT uses this approach (1):

> . . . utilizes AASHTO's Trns•port System, DSS Module (Decision Support System). This software is used to create a graph and listing of the bids compared to the engineer's estimate and to each other. The Maryland DOT can also utilize the system to create reports on past bidding history, market prices, price differential in geographical locations, etc. Maryland has a BAMS (Bid Analysis Management System) team, which is made up of individuals from several disciplines, such as, [the] Construction, Bridge, Highway, Design, and Information Technology divisions. The team is to meet on a regular basis to review the graph and listing of pertinent Maryland projects. In addition to the team's review, the administering design office also reviews the same materials. Recommendations are made and documented as needed.

This report illustrates diversity in the fact that some states allow certain percentage criteria above or below the engineer's estimate that bids must meet or the bids

can be rejected immediately. The report also suggests that some states will work with the contractors to find why their bids are either too low or too high. Other states will just reject the bids and readvertise.

TRIS Website Search

The TRIS search could not be considered successful. Information was found, but it really does not relate to the overall objectives of the research project. The keywords used in this search were: engineer's estimate, unit price estimating, construction cost estimating, cost estimating, estimating methods, cost estimators, and fuel and asphalt trends or relationships. Most articles found on this webpage were linked to articles located on other databases such as the TRB.

SCDOT Standard Specifications

The SCDOT Standard Specifications for Highway Construction (2) discusses the bidding process by stating that bidding requirements for construction contracts over $10,000 will be advertised for 3 weeks in at least one newspaper. SCDOT reserves the right to advertise for longer if it is deemed necessary. The basic component of the advertisement states the time and place where bids will be received as well as a description of the work being bid on. Other basic facts in the advertisement include the cost of plans and proposals with prequalification requirements.

Under prequalification requirements all bidders must first be prequalified through SCDOT before they are allowed to submit a bid. Previous performance with contractors who have worked with SCDOT before will be reported to the Director of Construction. Also included are the contents of proposal forms that show the specific quantities of work

to be performed and the time allotted to finish. The dates and the times of the opening bid are also available. Other topics include the pre-bid conference date and times, proposal guarantees stating that a bid bond is required to 5% of the submitted bid. Irregular proposals are also discussed, especially stating that unbalanced bids will be rejected. This section also states that if collusion is discovered among the contractors that those contractors are automatically disqualified.

Section 103 includes the award and execution of the contract. This section states that all bids will be based on bid unit prices. The award of the contract will go to the lowest responsible and qualified bidder. The successful bidder will be notified within thirty days by mail. The remainder of the section goes into bond requirements and insurance and proposal discussions.

Continuing on this subject in the 2004 Code of Regulations State Register Volume 28, Issue 9, Chapter 63 are regulations for the Department of Highway and Public Transportation. Article 8 is for the Disadvantaged Business Enterprise Program which has references to the engineer's estimate. Two sections that deal with the current research topic, Section 63-711 and Section 63-712.

Section 63-711 explains the bid evaluation. The bid evaluation states that if the lowest responsible bidder is within 10 % of the engineer's estimate, that contractor will receive the bid. It also states that preference will be given to a responsible South Carolina contractor over an out of state bid, if it does not exceed the out of state bid by 2.5%. If the department does not wish to award a bid, then the department reserves the right to readvertise the bid.

Section 63-712 discusses negotiations of low bids. This section basically says that if the lowest responsible bidder's bid is over 10% of the engineer's estimate, the department will meet with the bidder to determine why the bid is over and maybe work with the contractor to make the bid within 10%. Also any bids 30% over the engineer's estimate will not be considered unless there was an error in the calculations (2).

Research Previously Executed by Clemson University

This is a summary of a previous project by Dr. Bell and Charles Skipper titled Long Range Program Cost Estimating Methodology for SCDOT, July 2003.

The South Carolina Department of Transportation had in the past used a conceptual or "rule of thumb" approach for estimating the cost of highway improvement projects. The recently completed research executed by Clemson University produced a cost estimating model that is based on historical bid line item data for 58 construction projects that were let to contract between January 1996 and April 2000.

Widening, interstate, and interchange projects from all seven state districts were included in the study. The model is based on historical line item bid data that were entered into a 336 page spreadsheet database that consisted of approximately 17,000 data entries. The data were analyzed and eventually transformed into parametric equations, cost averages and ranges, and estimating guidelines. The model provides estimating guidance for nineteen cost categories: clearing and grubbing, remove and dispose asphalt, remove and dispose concrete, remove and dispose bridges, excavation, mucking, asphalt pavement, concrete pavement, painting, control of intersections, bridge construction, storm drainage, curb and gutter, sidewalks, guardrail, underdrain, erosion control, move items, and mobilization and traffic control.

The model was formulated as an Excel spreadsheet. Basic model input includes project lane miles. For most of the nineteen cost categories the user is given a selection of 4 values (none, low, medium, high) from which to choose a data entry, with a description of what constitutes low, medium, and high. These suggested values were determined from a regression analysis of the bid line item data (3).

Research Previously Executed by Auburn University

Another information source included a thesis written by Phillip Moon at Auburn University in 1972 titled "An Introductory Analysis of the Behavior of the Alabama Highway Industry." The purpose of this thesis was to determine how to minimize instability in the construction industry. One of the most significant instabilities identified was the fluctuation in the number of projects let to bid over a given period of time. The author attempts to explain the reasons for the "feast or famine" concept in the construction industry, and how to eliminate it. Implementing a long range approach to letting a stable number of projects per a year was identified as a possible solution to decreasing instability. The author also produced a function for Alabama that helps give an upper bound on the number of projects to let at certain times based on a given level of capital and labor.

This thesis includes unit price trends in bids for the years from 1950-1970 in Alabama. This research examined cost trends for different types of materials and the number of jobs let. Another trend examined was the number of available projects to the amount of bond financing allowed for construction. Other factors examined were whether the project was a state, federal-aid, or interstate project. The interstate bid prices were significantly higher than the federal-aid or state projects. The author also examined bid

prices in different counties to determine trends. There was a definite difference in the bid prices in different counties. The more affluent counties had higher bid prices than the smaller counties. This factor had more impact on bid price than location or terrain.

One conclusion of the thesis' author was that when the number of projects let to contract increases, bid unit prices increase. Conversely, when fewer projects are let to contract, bid prices lower. The author suggests letting the same volume of work continuously throughout the year. A major problem is that during the winter month's projects seemingly always decrease. The author counters saying that this would allow more time for pre-construction needs like steel fabrication, extended planning, etc. The author concludes that more research would have to be performed to determine whether the costs of winter work versus the costs of continuous letting of projects would be more beneficial. The author makes the claim that future estimates for construction should include project location, project type, and time of year.

FHWA Publications

The Federal Highway Administration (FHWA) provides bidding guidelines in a document entitled "Guidelines on Preparing Engineer's Estimate, Bid Reviews and Evaluation." This document outlines the options an engineer can use when making an estimate. It states that the engineer's estimate is a crucial part of the bidding process because it dictates how much money will be allocated for projects, and everything else will be based off this initial engineer's estimate. Three types of estimating methods are discussed: actual cost approach, historical data approach, and combination approach. Also discussed are the reasons for the engineer's estimate to remain confidential, and why the accuracy of an engineer's estimate is important. The FHWA states that the

engineer's estimate must be within plus or minus ten percent of the low bid fifty percent of the time.

This document discusses the bid analysis and contract award procedures that the states should follow. Assessing competition, considering re-advertisement, comparison of bid prices, and unbalancing of unit bid prices are included under this topic. The FHWA considers the competition excellent if there are six bids within twenty percent of the low bid. Considering re-advertisement may be a good choice if there are no appropriately priced bids because the public interest is always put first. Bid prices should be compared to determine if the contractors are submitting consistent prices on the different projects that they bid. Unbalancing of unit prices should be examined (4).

AACE Publications

A search using the Association for the Advancement of Cost Engineering (AACE) website identified a number of relevant publications. Most of these articles contained information about the cost estimating procedures, but not specifically the engineer's estimate used by public agencies. The articles consisted of estimating technologies including neural networks for cost estimation, cost control articles, defining the scope of estimating procedures, how labor and project locations should be put into a cost estimate, and tools used for cost estimating. These are all good articles, but they do not specifically reference the engineer's estimate or the types of estimating procedures used.

AASHTO Publications

A search of the American Association of State Highway and Transportation Officials (AASHTO) website produced some articles pertaining to the research project. One of the publications, *Project Cost Estimating, A Synthesis of Highway Practice*, related to the research project and discussed cost estimating (5). It examines how several states develop the bid. The publication discusses why states need a strategic approach to estimating, stating that all projects are variable. It also states that there are several stages to the bid with conceptual estimating being the first step; basically it goes through an example and states where improvements in the system are needed in estimating. It claims that in order for the DOT's to be more productive with their resources they need to have specific written guidelines for the engineer to follow when developing the engineer's estimate.

Other articles were found through the AASHTO website linking to the TEA website. This site had documents written by estimating engineers in different DOT's around the country and gives tips on how to get better estimates.

Fuel and Asphalt Trends

Articles were identified relating to the present prices of fuel and how it affects the prices of asphalt. Some articles tracked the increase in asphalt over each decade. There were websites that included the prices of unleaded and diesel gas over the past year. Also there were sites that showed that construction must go on, and how material price increases have affected producer profits and decisions around the globe (6). Basically, projects that were bid just a couple of years ago are seeing their profit disappear due to the unexpected rise in gasoline and asphalt prices. Maintenance of current equipment is

essential in lowering costs in the asphalt industry because with costs rising it is harder to purchase new equipment (6). Some DOT sites show the fuel prices for the past months and have the same thing for asphalt prices. The second research objective includes all of this data and will be addressed in a separate report.

CHAPTER III

GEORGIA DEPARTMENT OF TRANSPORTATION

SITE VISIT

During a meeting with Mr. George Bradfield and Mr. Wade Harris in Atlanta, GA on Monday, January 30, 2006, many questions were posed pertaining to why the Georgia Department of Transportation (GADOT) prefers to use a cost-based estimating approach and how it has improved their letting process. Many explanations were given, but the main driving force behind why the GADOT utilizes a cost-based approach was the fact that they were experiencing problems with contractors unbalancing bids with mistaken quantities and production costs. GADOT wanted to implement an estimating approach that would let the industry know they were carefully monitoring the bid letting process. According to the GADOT, cost-based estimating emulates the procedures contractors use when estimating, which in turn helps to increase accuracy and reduce re-lets. The GADOT foresees a learning curve of anywhere between six months to three years in order to fully implement a cost-based approach, but GADOT's personnel believe that the benefits of a cost-based estimating system greatly outweigh the use of a unit cost line item estimating approach.

Methodology

The GADOT cost-based estimating methodology is straightforward and provides GADOT with an accurate engineer's estimate to use as a benchmark during the letting process. GADOT approaches cost-based estimating in a similar manner to contractors by

first defining labor, material, and equipment costs for items they are pricing. GADOT believes that defining these costs and having accurate production rate costs will increase the accuracy of the engineer's estimate. GADOT generally adheres to the 80-20 rule when estimating projects, stating that eighty percent of the cost can be captured in twenty percent of the bid line items. GADOT uses a cost-based estimating method for the 20%, which make up 80% of the overall bid cost. For the remaining 80% of the items, GADOT utilizes a unit cost line item approach. Once the basic engineer's estimate is developed, using the 80-20 rule, the costs for the labor, materials, and equipment and other factors must be finalized. To finalize these costs and production rates accordingly, the GADOT specifically examines jobsite conditions, historical job production rates, and special restrictions included in the project specifications when creating the engineer's estimate. These factors are then collected and compared to similar projects to check for consistency among the line item estimates. Once these factors are accounted for, the GADOT includes the costs for overhead, profit, bonds, insurance, and contingency factors. The GADOT believes that defining these costs is essential to the accuracy of the overall engineer's estimate.

Production Rates, Material Costs and Asphalt Adjustments

The GADOT believes that maintaining current production rate records helps increase the accuracy of the engineer's estimate. Investigating contractor records from previously completed federal projects is the primary method the GADOT utilizes when determining production rates. Production rates are kept up to date by continually researching these records which GADOT believes can be a big advantage in increasing the accuracy of the engineer's estimate. GADOT also investigates cycle times when

formulating production rates as well. This information assists GADOT in estimating production rates involved with transportation cycles and cyclical labor.

GADOT receives material and equipment cost quotes from rental rate blue books, the Caterpillar Performance Handbook, and from telephone inquiries to manufacturers. The GADOT's main concern when calling the manufacturers directly is that the manufacturers may quote higher prices to the DOT and then provide lower costs to the contractor's. GADOT usually applies a 20% discount rate to the quoted price to account for these discounts when formulating an estimate to account for such costs.

For asphalt adjustments, GADOT generally makes telephone inquiries and talks with distributors when obtaining pricing data. If there are still questions about the validity of the asphalt quotes, GADOT will call other states to make sure the quotes are acceptable. Once the asphalt adjustments are established, the estimating of line items that include asphalt can be adjusted properly. Asphalt adjustments will be discussed further in a second report by Clemson University.

Success Criterion

GADOT does not measure the effectiveness or success of their engineer's estimate by comparing the accuracy of the engineers estimate to the low bid. The GADOT measures estimate effectiveness by examining the total percentages of bids that fall above or below the engineer's estimate depending on the number of bidding parties. GADOT defines success as the ability to fit their data to the curve this method produces. Using a figure like Figure 3.1 or Appendix B, GADOT can quickly examine the bid percentages over or under the engineer's estimate and determine if it is an exorbitant amount. If the bids are too high, GADOT will re-let the projects. Figure 3.1 illustrates

GADOT typical acceptable bid percentages per number of bidders with the 100% line as the engineer's estimate. With only a single bidder, the GADOT deems it acceptable for bids to fall up to 130% or 30% above the engineer's estimate. The reason is that with only one bidder the competition is extremely low, or only a certain contractor can perform that job, so the bid is expected to be higher than the engineer's estimate.

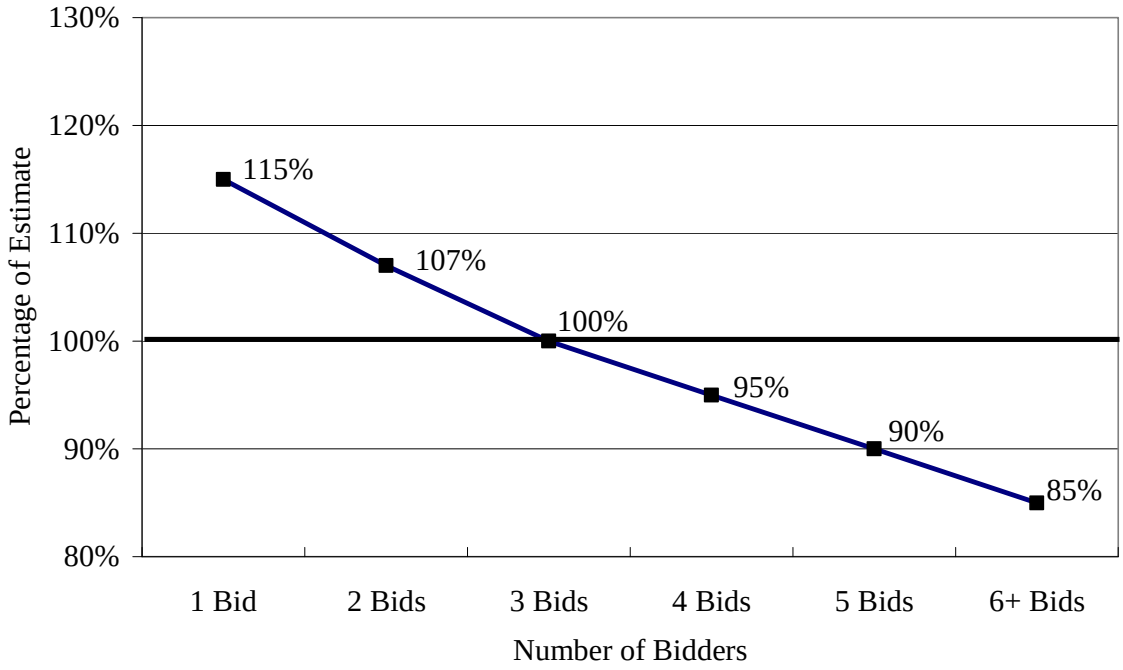


Figure 3.1: GADOT Bid Comparison Graph

The general accepted range of values GADOT uses for two bidders is from 100% to 115% above the engineer's estimate. Adding more bidding competitors lowered the percentage range to half of what is with only one competitor. With three bidders the acceptable range lowers to 95% to 105% of the engineer's estimate. The ranges decrease all the way until there are six or more bidders where the acceptable range should fall

within 80% to 95% of the engineer's estimate. These ranges can be found in Table 3.1. This illustrates the belief that if more competition is present then bids become more competitive becoming more advantageous for the DOT. GADOT feels that these are acceptable values for the bids and if the graph is satisfied, then the estimating method they are using is performing satisfactorily.

Table 3.1: GADOT Range of Accepted Bid Percentages

Number of Bidders	Range (%)
1	100-130
2	100-115
3	95-105
4	90-105
5	85-95
6+	80-95

Due to this method of gauging success, GADOT saved 30 million dollars last year according to their effectiveness standards. It was also noted by GADOT personnel that as the quantities of work increase, the bids should be more evenly distributed. On jobs with smaller quantities, bids should tend to be more dispersed. Also, a major problem noted by the GADOT when comparing the engineer's estimate and the bidder's estimates was errors in estimated bid item quantities. When quantities are stipulated incorrectly, contractors do not hesitate to unbalance their bids.

Perceived Disadvantages of the Unit Bid History Approach

GADOT addressed a number of concerns with employing historical data to create an engineer's estimate. GADOT specifically cited that every individual project contains specifications and plans that are most likely unrelated to most other projects. Historical data is built with information from all projects and an average is taken. That number then becomes the unit price for that particular estimate. GADOT believes that a unit cost line item approach does not take into account restrictions and special conditions of job specific criteria. GADOT also believes that the historical data does not take into account special situations such as lane closures on major roadways or possibly only being able to work at night which can cause the line item to either be under or over estimated. GADOT believes that with each restriction there is an additional cost associated with the estimate. GADOT also believes that unit cost line item historical data is also susceptible to time because state and federal specifications are always changing and older historical data might bring the average up or down. According to the GADOT, the primary problem with unit cost line item estimating is that it attempts to relate an average cost to projects that are not related at all, which can lower the engineer's estimate accuracy because of too much variability between historical data. These perceived inconsistencies are reasons why GADOT believes in using the cost-based approach for estimating projects.

Further Comments

GADOT has employed the cost-based approach for over thirty years. GADOT typically has 360 lettings per year and four estimator's working on these estimates. GADOT does not have any handbooks or reports that they use when cost-based

estimating. GADOT mentioned that Illinois has a manual for cost estimating, but it would only be useful for their state due to the fact that every state has different specifications and regulations. Mr. George Bradfield recently developed a small booklet for the state of Maine on the basic cost-based estimating approach. GADOT firmly believes that the only way to estimate successfully is through some form of cost-based estimating.

CHAPTER IV

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION SITE VISIT

The research team met with Mr. Ron Davenport and Mr. Ray Arnold from the North Carolina Department of Transportation (NCDOT) on February 10, 2006 to discuss the methodology and approaches used by the NCDOT to prepare the engineer's estimate. Many similarities were found to the approaches used by the GADOT. The meeting started with Mr. Davenport and Mr. Arnold answering questions forwarded to them by the research team (Appendix C). Beginning in the early 1980's, cost-based estimating was introduced to the NCDOT to reduce bid-rigging because contractors believed that the DOT engineer's estimate used only bid averages. NCDOT needed a way to show the contractors that their engineer's estimates were not only based on bid averages but included production rates, labor wages, and equipment rates. The answer for the NCDOT was to switch from a pure unit cost line item approach to a cost-based estimating method. The NCDOT began cost-based estimating by first experimenting with earthwork in order to gain accurate production rates. They have now successfully expanded cost-based estimating to mobilization, structural, traffic control, erosion control, signing, and specialty items. NCDOT made it clear that each individual project is specific and must be estimated accordingly. Because of this, the NCDOT uses many forms of the 80-20 rule. Depending on the specific project at hand, the NCDOT could use a cost-based

estimating approach for 30% of the line items to as little as 10% of the line items depending on that individual project.

Perceived Advantages and Disadvantages Of Cost-Based Estimating

Cost-based estimating was adopted by the NCDOT more than 25 years ago and is still in use today due to the numerous benefits the NCDOT believes this approach brings to their engineer's estimate. The biggest advantage in using a cost-based estimating approach, as expressed by NCDOT, is that it allows the DOT to estimate project costs in a manner similar to that used by the bidding contractors. The NCDOT feels this estimating method allows the DOT more legal justification when disputes arise about production rates, material costs, or material quantities with contractors. According to the NCDOT, a cost-based estimate is extremely beneficial in market flux situations because it allows the estimator to reflect current economic conditions by altering certain line items. Also, as would be expected, NCDOT believes that cost-based estimating is more effective when there is minimum job related historical data available in the database.

Although the NCDOT recognizes that a number of benefits are associated with cost-based engineering, some disadvantages of this method were cited by NCDOT personnel. One disadvantage of cost-based estimating is that the estimator must have a working knowledge of construction practices in order to formulate an accurate cost-based estimate. Another drawback viewed is that a 100% cost-based estimate cannot be performed due to the amount of time it would take to complete such an estimate. NCDOT stated that it takes them approximately a half a day to estimate a resurfacing project, one to two days to complete an estimate on a bridge resurfacing project, and

three to five days to complete estimates on larger projects. Even though a cost-based estimate is more time consuming than a unit price estimate, NCDOT believes that the benefits of a cost-based estimate greatly outweigh the unit cost line item approach.

Perceived Disadvantages of the Unit Cost Line Item Price Estimating Approach

NCDOT discussed many reasons why they do not use unit cost line item estimating practices on every line item for their projects. The main reason is that if contractors suspected that NCDOT used historical data, the NCDOT believes that contractors could artificially inflate the market annually. Another reason believed by the NCDOT, is that historical data is often outdated and does not reflect current market considerations. Market rates are always changing, meaning that equipment rates, material rates, and labor rates which are included in the historical database could be inaccurate. Not only are market trends changing, but so are construction indexes and department of transportation specifications. Therefore, the NCDOT believes that line item average prices based on this old information or historical data could be inaccurate. When historical data cannot be found for certain project line items, the NCDOT believes that the unit cost line item approach, in this case, might lead to inaccurate assumptions applied to some line items. NCDOT does utilize a unit cost line item estimating approach, but only on small line items, and uses cost-based estimating for the more significant line items.

Estimating Methodology

NCDOT's estimating methods closely resemble the techniques contractors use to fairly and accurately determine the cost of a project. NCDOT executes its cost-based estimating process by first examining the plans and specifications to determine quantities and procedures. Once the procedures are determined for a specific type of work such as earthwork, the haul times and production rates are determined. A site visit is then conducted to determine any site specific conditions that could constrain the construction process. The quantities are then placed into a spread sheet and material costs, equipment costs, and labor costs are determined. The remaining line items are determined using historical data estimates and using databases in software applications such as Heavy Bid, Transport, and Oman systems software. The cost-based and unit cost estimates are then combined to determine the overall estimate. The resulting engineer's estimate is then compared to historical prices of projects whose size, location, and site conditions are similar to the project being estimated. Finally, if the engineer's estimate is within acceptable DOT standards, that estimate is used as a median when compared to the contractors' bids in order to determine which contractor will be awarded the project.

Production Rates and Material Costs

The production rates for the NCDOT are maintained within a database created by NCDOT personnel a few years ago. The database contains crew compositions and wage rates for certain activities and is updated annually. NCDOT production rate information is gathered from certified payrolls versus present labor rates. NCDOT also uses the project inspector's knowledge of rates on site as well as predetermined crew composition

and equipment databases. All relevant information is then gathered before the final production rate is determined for a certain activity.

Material, aggregate, labor, concrete/concrete component, asphalt mix, and equipment costs are updated semi-annually or annually. To calculate accurate haul distances, NCDOT utilizes maps showing the mileage from every NCDOT project to all asphalt plants, quarries, and sand pits. The NCDOT also keeps in contact with other state DOT's, FHWA, and TEA if questions arise with respect to any costs or issues pertaining to any project. NCDOT obtains aggregate costs by contacting and receiving quotes from all state suppliers every year and updating the database. NCDOT tracks cost fluctuations for concrete/concrete component cost in order to gain a realistic cost estimate. NCDOT also updates all asphalt mix costs through their internal databases for different Super paves used in North Carolina. Equipment costs are gathered by contacting distributors and reviewing Rental Rate Blue Book for Construction Equipment, Contractor's Equipment Cost Guide, Cost Reference Guide, and the Means Heavy Construction Cost Data.

CHAPTER V

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION SITE VISIT

After meeting with the Georgia (GADOT) and North Carolina (NCDOT) Departments of Transportation the research team believed it would be beneficial to more fully clarify the South Carolina Department of Transportation (SCDOT) estimating approach in order to compare and contrast the two estimating methods more effectively. On June 28, 2006 the research team met with Mr. Jim Frick and Mr. Jamie Kendall to discuss how the SCDOT prepares their engineer's estimate. The SCDOT defines the engineer's estimate as "an estimate of the reasonable or fair cost to construct a project used as a benchmark to evaluate the low bid." The SCDOT has four divisions of estimating who prepare the engineer's estimate. The road design division or the estimates and specifications group is the largest with three to four estimators. Of the four divisions, this division handles 90% of the estimating duties. The other three specialty divisions include bridge design, traffic engineering, and bridge maintenance. Last year the SCDOT reported developing 268 engineer's estimates, or about 22 projects per month on average.

Methodology

SCDOT currently uses a unit cost line item estimating approach when preparing their engineer's estimate. Their methodology starts with reviewing plans and specifications for the proposed project. This review allows the estimators to gauge the

types and amounts of quantities required for the project. Once the quantities are determined for the line items, SCDOT tabulates the bids. Historical data is reviewed by looking through Microsoft Access databases to find line item histories that pertain to the project. The three low bidders are shown in the historical data for each line item price with the lowest bid usually being recorded. Using the AASHTO Software PES and LAS the SCDOT can separate out and organize all related historical line item data. Once this data is organized, it is sent into an SCDOT developed program that integrates Microsoft Access and Excel. The DOT estimators using this program can then identify a single line item from the project they are estimating and find historical prices based on job type, length, type of material, by date, county, and many more distinctions. After the estimator defines these job parameters, the computer program will compute an average price for that particular line item. This line item is then checked for accuracy with other line items with similar parameters. The line item quantity is then graphed versus unit price data against historical data. A line is then fit to the curve of the resulting points, and the regression analysis r squared value is checked to see how close it is to one. If that value is close to one, then the estimated price is acceptable, and the estimator moves on to the next line item. Line items pertaining to fuel and asphalt are usually checked against the fuel and asphalt curve as well. The SCDOT also examines the Bureau of Labor Statistics and Federal Highway Administration (FHWA) price trends when estimating to ensure the line item estimates are consistent with current trends in order to enhance the estimate accuracy. Once all items are estimated following this procedure an engineer's estimate is the result.

Estimate Success

SCDOT views a successful engineer's estimate as one that follows the FHWA guidelines stating that the engineer's estimate must be within plus or minus ten percent of the low bid fifty percent of the time (6). SCDOT total engineer's estimate accuracy decreased versus total low bid in the early 2000's but improved in 2003. That year the total low bids were even with the total engineer's estimate. Also during that year the SCDOT received the 2003 Engineer's Estimate Outstanding Achievement Award presented by the FHWA. In 2004, the total low bids were 5.71% higher than the engineer's estimate, and in 2005 the total engineer's estimate was equal to the total low bids. The SCDOT has shown to be exceptionally accurate when preparing the engineer's estimate.

CHAPTER VI

NCDOT, GADOT, AND SCDOT COMPARISON

The NCDOT approach to developing the engineer's estimate is almost identical to the approach used by the GADOT. Both DOT's use a mixture of cost-based and unit cost line item approaches which originated in the early 1980's because of contractor collusion and bid-rigging problems suspected during that time. Both states agree that cost-based estimating illustrates to the contractors the DOT is carefully monitoring the bidding process. The primary difference between NCDOT and the GADOT is that the NCDOT uses more computer software programs to store data such as production rates, material costs, and equipment costs than the GADOT. The GADOT only utilizes computer software when finding historical unit price averages for common line items. When estimating for materials, both agencies utilize maps depicting haul distances from every quarry, asphalt plant, and sand pit in their respective state to the specific project being estimated. NCDOT does not apportion any discount on materials when formulating an engineer's estimate, but the GADOT apportions at least a 20% discount on material costs because they believe the contractor receives this discount from the supplier. These are the main differences between the NCDOT and the GADOT when formulating an engineer's estimate.

NCDOT, GADOT, and SCDOT Comparison

SCDOT uses a unit cost line item approach to estimating while the NCDOT and GADOT utilize a cost-based approach. The NCDOT and the GADOT claim they can use

anywhere from an 80-20 rule approach to a modified 90-10 approach depending on the type of project being estimated. NCDOT uses computer programs such as Heavy Bid and Transport, while GADOT uses Oman Bid Systems (Appendix A) when estimating the 80% of the line items that are common using historical data. The SCDOT uses the Transport programs PES and LAS to filter and organize historical data, but not to finalize their estimate. Production rates are determined by both the NCDOT and the GADOT and are not determined by the SCDOT. For material costs both the NCDOT and GADOT contact suppliers to receive quotes. The SCDOT utilizes historical cost data when estimating these costs.

NCDOT and SCDOT both utilize predetermined fuel/asphalt adjustment factors included in their state DOT specification standards. NCDOT was considering changing the adjustment factors for fuel and asphalt, but they determined that their numbers were still applicable. The factors for diesel and unleaded fuel were the same for the NCDOT and SCDOT. If any questions arose on any of the estimates for fuel/asphalt prices, all states claim to maintain good communication with other state DOT's to check prices.

The DOT's interviewed explained many views of how to compare the engineer's estimate to the bids received for work were explained by the DOT's interviewed. The NCDOT views the engineer's estimate as the median estimate during the bidding process. According to the NCDOT, their engineer's estimate should fall in the middle of the bids, and if this occurs they believe that their estimating methods are performing satisfactorily. The GADOT views the engineer's estimate as a benchmark for bidders and measures engineer's estimate effectiveness by looking at the total percentages of bids that fall above or below the engineer's estimate depending on the number of bidding parties. The

SCDOT views the engineer's estimate as a benchmark to evaluate the low bid. No matter what views are considered by any state DOT, the ultimate goal is to maintain a solid estimating methodology that will assist in developing an accurate engineer's estimate.

CHAPTER VII

SURVEY QUESTIONNAIRE

The primary objective of the survey questionnaire forwarded to each state department of transportation (DOT) was to determine the means and methods utilized by state DOT's when developing their engineer's estimate. This objective is addressed throughout the survey to specifically identify the procedures followed when implementing a cost-based estimating methodology. Defining the estimate accuracy and expected amount of resources expended when estimating with either approach was an objective of the survey as well. Another objective of the survey was to determine how state DOT's implement fuel and asphalt cost adjustments. Gasoline prices have been fluctuating recently, and the survey asks how state DOT's estimate for these kind of market conditions and what methodologies are utilized. The 30 questions included in the survey were designed to interpret these objectives, and the following survey questionnaire analysis extracts these points. Twenty-two state DOT's responded to the survey.

Survey Analysis

Question #1

What is the primary estimating approach performed by your DOT?

- ☐ 10% Cost-based
- ☐ 60% Bid History (Line Item)
- ☐ 30% Combination
- ☐ 0% Other:_____

The estimating approach utilized most often from the questionnaire responses was the bid history approach, as shown by 60% of respondents. The other 40% was made up of cost-based estimating states (10%), and combination approaches (30%).

Question #2

What percentage of projects do you perform with the selected approach from question #1?

%	10	20	30	40	50	60	70	80	90	100
Cost-Based										
Line Item										
Other										

Of the states using bid history, ten states claimed they were 100% bid history, two states responded that they were 90% bid history and 10% other. Of the states responding that they used a cost-based approach; one was 70% bid history and 30% cost-based, and the other was 80% cost-based and 20% bid history. Of the remaining states that use the combination approach two claimed to be 80% cost-based and 20% bid history, one was 90% bid history and 10% cost-based, one was 100% combination, another was 100% bid history, and one was 100% cost-based. These percentages indicate that the states reporting that they use the bid history approach mainly perform 100% line item estimates. But the states using cost-based or the combination approach utilize similar combinations of bid history. For the purpose of this analysis the states responding that they implement a cost-based approach will be grouped together with the states using a combination approach. The reason for this grouping is to form two groups for which a comparative analysis can be performed.

Question #3

Were any of the following methods used when first implementing the cost-based approach to your DOT's methodology to estimating?

- ☐ 5% Starting with one line item to achieve accuracy using the cost-based approach
- ☐ 14% Starting with several line items to achieve accuracy using the cost-based approach
- ☐ 29% Determining production rates
- ☐ 10% Using fuel and asphalt adjustment factors
- ☐ 33% Acquiring supplier quotes for material costs
- ☐ 14% Acquiring information from other state DOT's
- ☐ 48% Other:

After establishing the types of approaches for each DOT, this question was asked to determine when a state DOT first started to implement the cost-based approach, and which specific methods did the DOT's use if any when initiating a new estimating system. The responses from this question indicate that determining production rates and acquiring supplier quotes for material costs are the two most important considerations when implementing a cost-based approach. This result can be broken down further by only including the answers from the states that implement cost-based or combination estimating approaches. Only the state DOT's responding that they used the cost-based or combination approaches are shown in Table 7.1.

Table 7.1: Percentages of the methods used by cost-based/combination states when first implementing the cost-based approach.

Methods used when first implementing the cost-based approach.	
13%	Starting with one line item to achieve accuracy using the cost-based approach
25%	Starting with several line items to achieve accuracy using the cost-based approach
75%	Determining production rates
25%	Using fuel and asphalt adjustment factors
75%	Acquiring supplier quotes for material costs
38%	Acquiring information from other state DOT's
38%	Other

This question illustrates that the DOT's who utilize cost-based/combination approaches believe that determining production rates (75%) and acquiring supplier quotes for material costs (75%) were the most important when first implementing a cost-based approach. It becomes clearer with the high percentages of answers that production rates and material costs are critical components of cost-based estimating. Acquiring information from other state DOT's (38%) was considered an appropriate strategy as well. Using fuel and asphalt adjustments (25%) was considered by some states, but was not one of the two main approaches used when implementing a cost-based approach. Another determination is that instead of initiating a cost-based estimate with one line item (13%), most state DOT's preferred to use estimates from several line items (25%). Georgia and North Carolina stated that starting with one line item should come first in order to obtain accuracy, and then using that same methodology to continue to cost-based estimate using multiple line items. Other responses from DOT's that were not listed as options on the questionnaire included: consulting with field construction engineers and industry representatives, study of similar projects, developing accurate catalogs of labor, equipment, and material prices, and estimator training programs.

Question #4

Are there any perceived advantages or disadvantages for using the cost-based estimating approach that persuaded your DOT to implement it over the bid history approach? (1=Strongly Disagree, 5=Strongly Agree)

This question was asked to obtain insight on what the DOT's believed were advantages and disadvantages of implementing a cost-based approach. Table 7.2 illustrates the answers received from ten states describing their opinions of the cost-based approach. Labeling each statement as a one indicates a low certainty level, while labeling

each statement a five indicates a high certainty level. The numbers in the right column display the average results from DOT's responding to this question.

Table7.2: Perceived advantages and disadvantages of the cost-cased approach.

Perceived Advantages and Disadvantages of the Cost-Based Approach					
	1	2	3	4	5
A) The cost-based approach is more cost effective.	2.8				
B) The cost-based approach improves estimate accuracy.	3.6				
C) The cost-based approach accounts for fluctuating costs of materials.	4.0				
D) The cost-based approach requires additional equivalent man-hours.	3.8				
E) Cost-based estimating should only be utilized for major line items.	3.5				
F) Cost-based estimating approaches estimating similar to the contractor's approach.	3.5				

The DOT's responding to this question indicated that they are indifferent to the statement that the cost-based approach is more cost-effective (2.8). The states responding indicated a higher sense of certainty to the statements that the cost-based approach improves estimate accuracy (3.6), accounts for fluctuating costs of materials (4.0), requires additional equivalent man-hours (3.8), should only be used for major line items (3.5), and that the cost-based approach is similar to the contractor's estimating approach (3.5). The main point that needs to be recognized is the fact that the DOT's responding felt the cost-based approach may not be cost effective and may require more man-hours for execution. This point is important because states considering the transition to a cost-based system, should know a learning curve is involved as indicated by both the GDOT and NCDOT in recent personal interviews.

Question #5

If your DOT has been using a cost-based approach, how long has your DOT been using it?

- ☐ 5% Just Starting
- ☐ 10% Phasing implementation presently
- ☐ 0% 1-5 years
- ☐ 0% 5-10 years
- ☐ 10% 10-20 years
- ☐ 48% Other:

When asked how long state DOT's have been using the cost based approach, it appears that states are either implementing a cost-based approach presently or have been using this approach for more than 10 years, and in some cases over 20 years. This result shows that states usually stay with the estimating procedure they have been using, and are not anxious to change. This also illustrates that the survey responses are from states that have been using this approach for a long period of time and know what the effects of changing to a cost-based approach consist of.

Question #6

In your opinion, regardless of method, how much manpower does it take to obtain an estimate using your DOT's current method?

Approximate annual workload_____
Approximate full-time equivalent estimators_____

The following table indicates the amount of man-power required for each state DOT to estimate projects including the average lettings per year, average full-time estimators, and the average monthly estimates. Table 3 shows that SCDOT averages are in line with the other state DOT's that use a bid history approach. The average full-time

equivalent estimators for the states using the bid history approach are three, and lettings/year and monthly estimates are similar to those of South Carolina.

Table 7.3: Comparisons of resources between South Carolina and other states.

	South Carolina	Bid History	Cost Based/ Combo
Lettings/Year	268	246	448
Full Time Estimators	3	3	4
Monthly Estimates	22	23	36

The cost-based and combination states have more lettings per year on average (Figure 7.1) have, an additional estimator, and have more monthly estimates. This increase indicates that cost-based and combination estimating states have one more resource available to them than states using the bid history approach. This difference appears appropriate considering that more estimates are performed by the states using cost-based/combination techniques. Differences in lettings per year could include the population, state and federal funds, and length of highways in the other states. This could be important when considering whether or not to adopt a cost-based approach. Other answers received from this question involved state DOT's reporting annual workloads in hours per projects, man-hours, dollar amounts, and percentages.

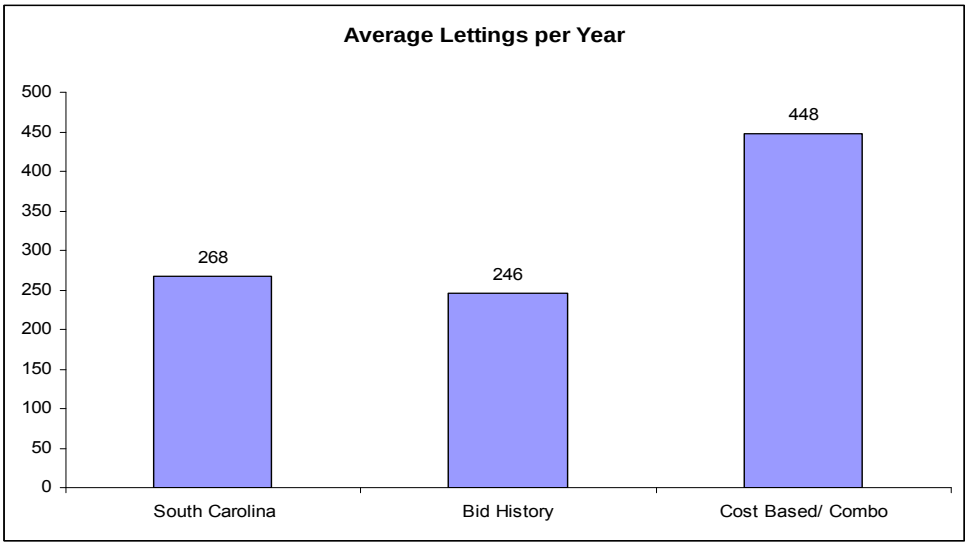


Figure 7.1: Comparison of average lettings per year.

Question #7

If you have recently adopted a cost based approach, what has been the impact on your estimating effort?

On average over a given project:

- ☐ 10% Increased man-hours
- ☐ 0% Reduced man-hours
- ☐ 10% Same man-hours spent

Only a few states responded to this question, but about the same amount (10%) felt that a cost-based approach increased man-hours or kept the man-hours the same. When examining just the cost-based/combination states, 25% indicated increased man-hours, and 13% had same man-hours spent. This response is not definitive, but as indicated from question number four, there was a medium to high certainty level (3.8) for the statement that the cost-based approach requires additional equivalent man-hours. The answers to this question support the answers to question number four, which is that the cost-based approach may increase the number of man-hour resources required.

Question #8

If you have recently adopted a cost-based approach, have additional costs been incurred to execute cost based estimates?

- ☐ 10% Increased cost
- ☐ 0% Reduced cost
- ☐ 5% Same cost

Not many states responded to this question, but about 10% felt that implementing a cost-based estimating approach would increase costs, and 5% believed that cost-based estimating incurred the same costs. This outcome supports the answers reported previously on question four, where the states indicated a lower certainty level (2.8) for the statement that the cost-based approach is more cost effective. Among the cost-based/combination states only, 25% reported an increased cost, 0% reported a reduced cost, and 13% reported the same cost. It is reasonable to assume that a cost-based method could increase your costs.

Question #9

How many estimates does your DOT prepare monthly?

- ☐ 14% 0-10
- ☐ 33% 10-20
- ☐ 10% 20-30
- ☐ 33% 30 or more
- ☐ 10% Other

The same percentage (33%) of states estimated 10-20 and 30 or more estimates per month. The majority of estimates fall within the 10-20 or 30 or more range. Fourteen percent of states reported having between 0 and 10 estimates per month, 10% of states had between 20 and 30 estimates per month, and 10% reported having other estimates that were not among the choice on the survey. The other category consisted of answers including: 5 to 50 per a month, plus or minus 50, and 100 on average.

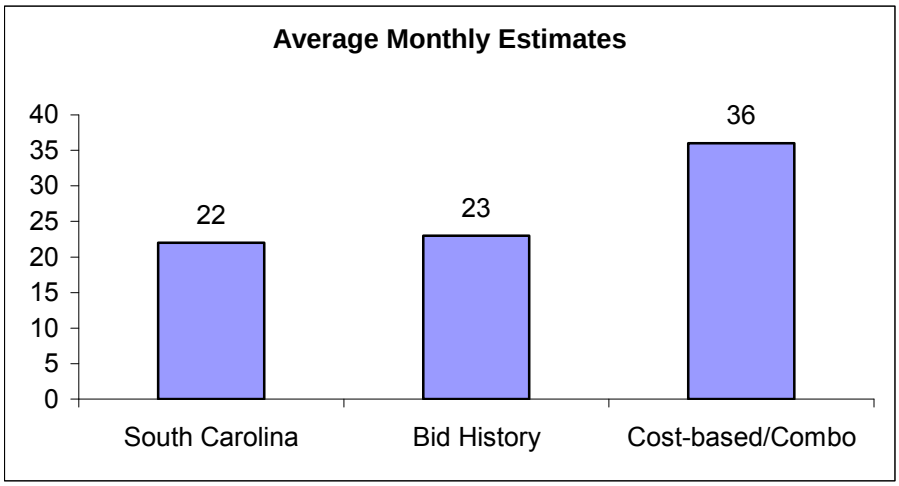


Figure 7.2: Comparisons of average monthly estimates.

Analyzing the data from this question further shows (Figure 7.2) that cost-based/combination estimating states on average, have more monthly estimates than those states who implement a bid history approach.

Question #10

How many equivalent man-hours are expended to prepare those estimates?

- ☐ 14% 0-20
- ☐ 14% 20-30
- ☐ 10% 30-40
- ☐ 33% 40 or more
- ☐ 29% Other

To prepare the monthly estimates the survey data indicates that 33% of the states responding believed that it requires 40 or more man-hours to complete those estimates. Other responses received from responding states included: not currently tracking, 8-12 hours per estimate, 2-16 hours per estimate, and 10-20 hours per estimate. There was no clear pattern to why some states require more resources than others.

Fifty percent of the states using the cost-based approach required 40 or more man-hours to complete the estimates, as compared to the 23% of the bid history states that required the same man-hours. Table 7.4 illustrates that bid history appears to require less man-hours to complete their estimates, but the previous question indicates that cost-based estimating states tend to have more estimates per month.

Table 7.4: Comparisons of man-hours used to perform an estimate between bid history and cost-based/combination states.

Man-hours	Bid History	Cost-based/Combo
0-20	15%	13%
20-30	15%	13%
30-40	8%	13%
40 or more	23%	50%
Other	31%	25%

Question #11

Does your DOT employ any form of the 80-20 rule for estimating?

- ☐ 38% Yes
- ☐ 57% No
- ☐ 38% Other

When asked which states implement an 80-20 rule when estimating the results, the results indicated that 38 % implemented the rule, while 75% did not. This rule describes the amount of line items that are estimated using the different estimating approaches. The 80-20 rule is another way of expressing to what extent the DOT expects to cost-base estimate, meaning that 80% of the cost is in 20% of the line items, and those items will be cost-based estimated. Thirty-eight percent of the states checking the other

tab reported: that they rationally estimate 65% of projects, earthwork, paving and bridge work are majority of estimate cost, using a cost-based approach to earthwork and paving and using bid history for remainder of estimate.

Question #12

What percentage of the time, when utilizing a cost-based estimating approach does the low bid fall within plus or minus 10% of the engineer's estimate?

- ☐ 5% 30 -40%
- ☐ 10% 40-50%
- ☐ 10% 50-75%
- ☐ 43% Other

Question twelve responses indicate that 10% of the responding states receive low bids falling within plus or minus 10% of the engineer's estimate 50-75% of the time when cost-based estimating. The FHWA states that 50% of the time the low bid must fall within plus or minus 10% of the engineer's estimate; in this case it does not. Forty-three percent of the states responded with the other tab. One state reported that 75-85% of the bids that they receive fall within plus or minus 10% of the engineer's estimate; another state said that it does not track this statistic. When just tracking the cost-based/combination states responses, the survey showed that 25% had 50-75%, and that 38% were below 50%.

Question #13

What percentage of the time, when using the bid history approach, does the low bid fall within plus or minus 10% of the engineer's estimate?

- ☐ 14% 30 -40%
- ☐ 24% 40-50%
- ☐ 48% 50-75%
- ☐ 14% Other

When using bid history the low bid falls within plus or minus 10% of the engineer's estimate 50-75% of the time for 48% of the states responding to this survey. Twenty-four percent of the states receive low bids within these parameters 40-50% of the time. There seems to be a major improvement from the states using a cost-based approach as opposed to the states using the bid history approach when examining this statistic. When just examining the bid history states, 75% had bids falling within 10% of the engineer's estimate 50-75% of the time. This is a big difference compared to the 25% of cost-based/combination states.

The purpose of posing this question was to determine if the states receive low bids within plus or minus 10% of the engineer's estimate. This outcome can be used as a success criterion as stated in the FHWA "Guidelines on Preparing the Engineer's Estimate." For the purpose of this research, the state DOT's expressing that the low bids they receive that fall within 10% of the engineer's estimate 50-75% of the time, will be considered "successful", and those that state that they fall below this criteria will be looked at as "average" performers. Any trends or comparisons have been identified when comparing these two groups.

Figure 7.3 represents the state DOT's where the low bid falls within 10% of the engineer's estimate 50-75% of the time. These states are shown as either implementing a cost-based approach (CB) or a bid history approach (BH) to estimating. Also illustrated in this figure are the numbers of lettings per year versus the number of full time equivalent estimators these DOT's employ. There does not seem to be any relationship between the type of estimating each DOT's utilized and the number of lettings and full time estimators. It is apparent from the figure that cost-based states definitely have more

lettings per year than the bid history states, but they do not have more estimators. This figure also indicates that, regardless of estimating approach, there seems to be no relationships when comparing lettings per year and number of full time estimators.

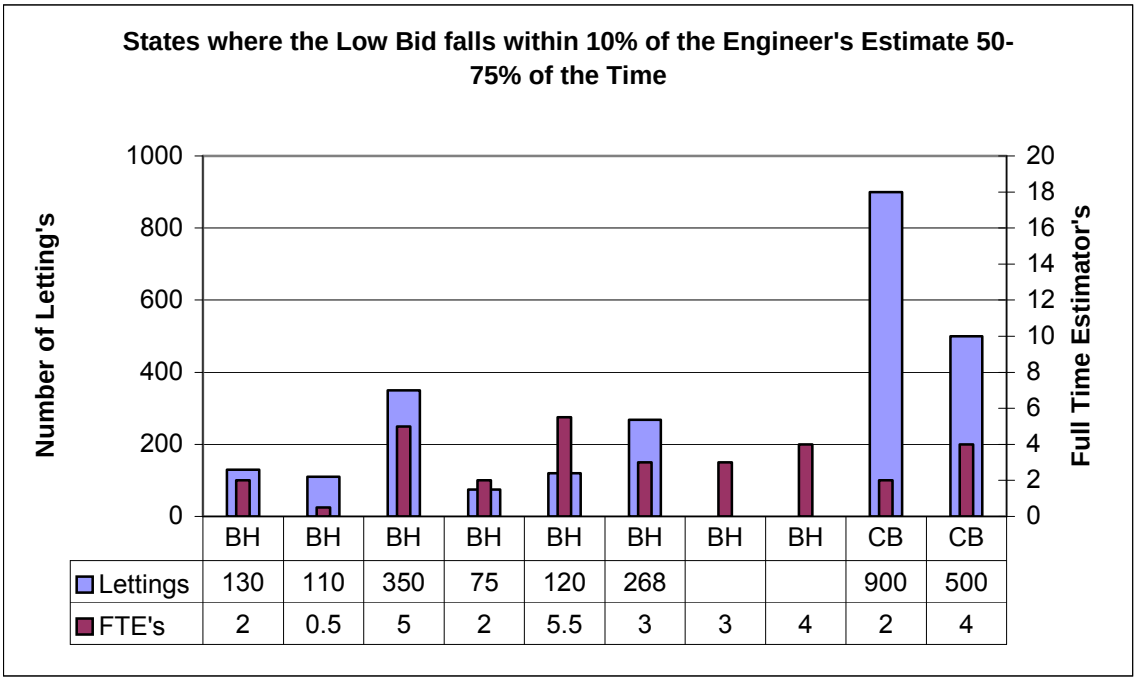


Figure 7.3: States DOT's where the low bid falls within 10% of the engineer's estimate 50-75% of the time.

Figure 7.4 illustrates the state DOT's where the low bid falls within 10% of the engineer's estimate 40-50% of the time. These states are shown as either implementing a cost-based/combination approach (CB) or a bid history approach (BH) to estimating. These particular states are perceived to be average performers when estimating their engineer's estimate. There appears to be no relationship with these states when comparing the number of lettings versus number of full time estimators. Figure 7.4 also

illustrates that 25% of the BH states are average performers while 38% of the CB states are average performers.

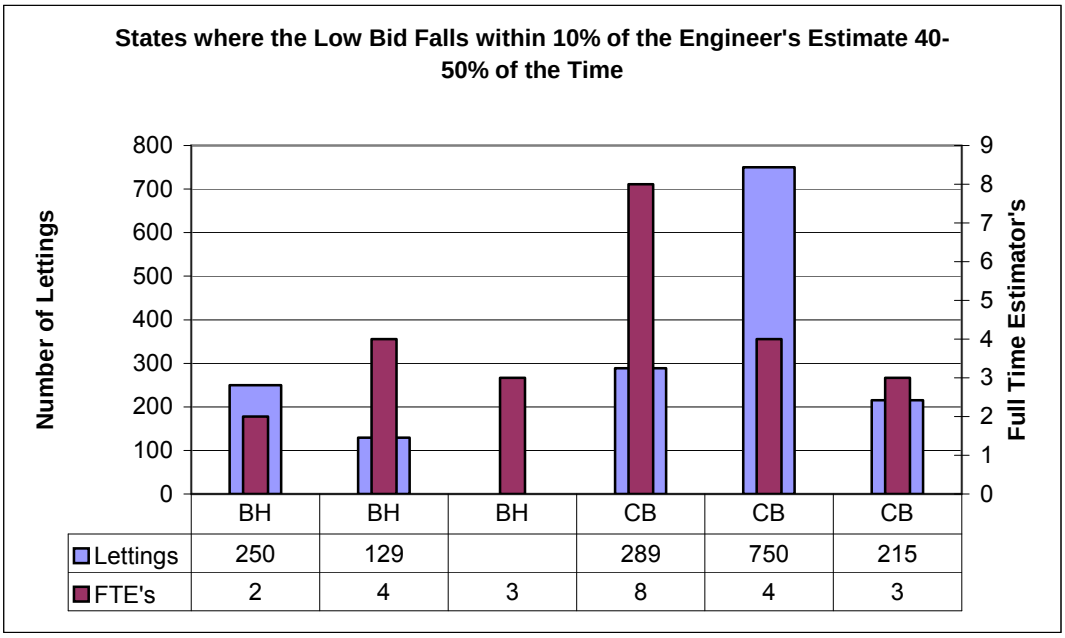


Figure 7.4: States DOT's where the low bid falls within 10% of the engineer's estimate 40-50% of the time.

Question # 14

Does your DOT follow the FHWA Guidelines on Preparing the Engineer's Estimate?

- ☐ 52% Yes
- ☐ 19% No
- ☐ 14% Sometimes
- ☐ 14% Other

When asked which states follows the FHWA guidelines, responses indicated that 52% say they follow the FHWA guidelines, 19% stated they do not, 14% sometimes, and 15% giving explanations. One state DOT reported that the FHWA guidelines are not sufficiently clear and decisive. Another state DOT reported that their award criteria is that the low bid must fall within 7% of the engineer's estimate, and that awards made

outside of this range require justification. Another state has developed its own estimating manual. Overall 52% follow the guidelines presented by the FHWA when estimating. Fifty percent of the cost-based/combination states and 58% of the bid history states follow these guidelines.

Question # 15

Does your DOT utilize production rates when determining an estimate?

- ☐ 43% Yes
- ☐ 57% No

The answers were almost even, but 43% of the responding state DOT's use production rates, and 57% do not. This statistic clearly illustrates the importance of production rates to each estimating method. Of the states using the cost-based/combination approach, 100% said they utilize production rates when performing an estimate, as compared to 8% of states using the bid history approach. One state reported that they are just beginning to implement cost-based estimating on selected items for which production rates would be a consideration.

Question #16

Are any of the following methods used when determining production rates?

- ☐ 39% Crew compositions
- ☐ 38% Haul distances
- ☐ 14% Contractor Payroll Data
- ☐ 33% Inspector's Logs
- ☐ 38% Contacting material suppliers
- ☐ 10% Fuel price indexes
- ☐ 33% Rental Rate Blue Book for Construction Equipment
- ☐ 14% Contractor's Equipment Cost Guide
- ☐ 5% Cost Reference Guide
- ☐ 19% Means Heavy Construction Cost Data
- ☐ 52% Other

This question examines how states obtain production rate statistics. This information is important given that production rates were one of the key factors associated with cost-based approach in questions three and fifteen. Crew compositions, haul distances, inspector's logs, contacting material suppliers, and the use of the Rental Rate Blue Book all were selected by about 40% of the responding states as important criteria when estimating production rates. Fifty-two percent of the states selected the "other" tab which included: reference guides and means are last resort, contacting department's construction personnel, estimator's experience from work as an inspector, and the designer's experience. All of these are different ways that were unlisted as methods that state DOT's use when obtaining production rates. Table 7.5 lists the cost-based/combination states separately to identify how they prepare production rates.

Table 7.5: Methods used by cost-based/combination states when determining production rates.

Methods Used When Determining Production Rates	
	Cost-Based/Combo
Crew Compositions	75%
Haul Distances	88%
Contractors Payroll	38%
Inspectors Logs	75%
Contacting Material Suppliers	100%
Fuel Price Indexes	25%
Rental Rate Blue Book	88%
Contractor's Equipment Cost Guide	38%
Cost Reference Guide	13%
Means Heavy Construction Cost Data	50%

As indicated in Table 7.5 cost-based/combination states utilize crew compositions, haul distances, inspector's logs, contacting material suppliers, and rental rate blue books when determining production rates. The states responding felt that these measures were the most important when estimating production rates. These items need to be addressed when converting to a cost-based approach and a database should be developed to track of the actual attained production rates.

Question #17

How often does your DOT update production rates?

- ☐ 10% Annually
- ☐ 5% Bi-Annually
- ☐ 0% Monthly
- ☐ 62% Other

When states were asked how often they updated production rates, 10% responded updates annually, 5% biannually, and 62% updated production rates differently. Most states responded that it varied and depended on the project or as needed, and there was no set time period for updating these costs. Seven states do not update these rates at all.

Question # 18

How does your DOT obtain material costs from suppliers?

- ☐ 62% Contacting material supplier by telephone
- ☐ 5% Contacting material supplier in person
- ☐ 5% Contacting other DOT's
- ☐ 48% Other

Another important question to ask addressed was how state DOT's obtain material costs for estimates. Sixty-two percent of the states responding said they contacted the material suppliers by telephone, 5% contacted material suppliers in person, and 5% contacted other DOT's. Other methods (48%) being used among the states

responding was the use of bid history, review trade magazines, newspapers, investment literature, Poten and Partners, discussions with field personnel, email, subcontractors, and examining previous invoices. Telephone was the best way for the respondents to gain material cost prices from the suppliers; some states assumed that contractors are given discounts and included or excluded this information from the bid.

Question #19

How often do you update these costs?

- ☐ 0% Annually
- ☐ 0% Bi-Annually
- ☐ 19% Monthly
- ☐ 62% Other

When asked how often the DOT's updated material costs, the most common answer was as needed by the project being estimated. There was no real update time other than 20% of the states stated that they update material costs every month. While 62% of the states responding reported that they used other methods. Six states said they updated these costs by project or as needed, four states do not update these costs, checking historical data instead, and one state updates after every letting. States update costs in many ways, but the most common answer was as needed or by project.

Question #20

Does your DOT quantify lump sum items such as traffic control, mobilization, and clearing and grubbing?

- ☐ 38% Yes
- ☐ 24% No
- ☐ 19% Sometimes
- ☐ 24% Other

It was found that 38% of the DOT's claimed that they do quantify these items, 24% said they do not, and 19% said that they do sometimes.

Table 7.6 suggests that bid history states have a higher variation in their approach. Cost-based/combination states consistently quantify these items or they do not. This outcome shows that each state DOT quantifies these items differently, and that there is no uniform approach. When just identifying the cost-based/combination group, 50% of the state DOT's responding quantified these lump sum items as compared to 33% of bid history approach states. Clearly the cost-based/combination group believes that quantifying these items is important.

Other responses included:

- Traffic control is quantified.
- Mobilization and maintenance and traffic are lump sum, but not clearing and grubbing.
- Clearing and grubbing acres are quantified, but removal items are not.
- Clearing and grubbing are quantified, and traffic control is quantified sometimes.
- The DOT rationally estimates these items if they are a major cost on the project.
- Mobilization is calculated as a percentage of construction item costs.
- Clearing and grubbing is lump sum, traffic control can be lump sum or unit prices, mobilization are always lump sum.

Table 7.6: Percentages of DOT's who quantify lump sum items.

Does the DOT Quantify Lump Sum Items		
	Bid History	Cost-based/Combo
Yes	31%	50%
No	23%	25%
Sometimes	31%	0%
Other	8%	50%

Question #21

If so, how does your DOT quantifying traffic control, mobilization, and clearing and grubbing?

- ☐ 48% Acreage
- ☐ 5% Land use classifications
- ☐ 29% Lane closure setups
- ☐ 38% Number of cones, barrels, or barriers
- ☐ 48% Other

Of the state DOT's responding how they specifically quantify these items, 50% stated that they quantify lump sum items using acreage, 40% quantify using number of cones, barrels, or barriers, and 30% quantify lane closure setups.

Table 7.7 illustrates the differences in the two approaches and what methods each approach uses when quantifying lump sum items. Acreage (63%), lane closures (50%), and number of cones, barrels, or barriers (63%) are utilized by the cost-based/combination states. The bid history approach states primarily utilize acreage when quantifying lump sum items. Other responses included the following:

- Pre-cast barriers are separate pay items along with message boards and cones, barrels, flagging, etc are not.
- Mobilization is a lump sum item. Traffic Control is paid for by the unit (square footage of signs), by other quantities (linear foot of barricades,

number of raised pavement markers, etc) and by lump sum (includes barrels, movement of signs, etc.).

- Traffic items are required by the FHWA to split out.
- Clearing and grubbing are by the acre. Traffic control is based on quantifiable items such as barrels and barrier plus contract duration, mobilization is based solely as a percentage of the total contract value depending on the type and complexity of the work being performed
- Sometimes acreage is used for clearing and grubbing only.

Table 7.7: Comparison of DOT methods used when quantifying lump sum items.

Methods of Quantifying Lump Sum Items		
	Bid History	Cost-based/Combo
Acreage	38%	63%
Land use classifications	0%	13%
Lane closure setups	15%	50%
Number of cones, barrels, or barriers	23%	63%
Other	54%	38%

Question #22

How often do your estimators perform site visits prior to estimate development?

- ☐ 38% Every project
- ☐ 14% Major projects
- ☐ 14% Special condition projects
- ☐ 5% Owner required projects
- ☐ 33% Other

This question addressed the amount of time the state's estimators perform site visits. Interestingly 38% of the states polled said that their estimators perform site visits

for every project, and the next highest response was for major and special condition projects.

When examining the different approaches it is apparent that the states utilizing the bid history approach perform site visits 46% of the time (Table 7.8). Overall the bid history states perform more site visits than the states utilizing the cost-based approach. Other responses from responding states were as follows:

- 3 States: never
- Site visits are on an "as needed basis".
- Rarely done.
- It is extremely rare that there would be time to visit a project site during the estimating process. We do have a video log of our roadways and we do have discussions about the project with the designers, the construction engineers and the materials engineers. During the summer we visit.
- Very few.
- Designer's preference and complexity of the project.
- Project estimates are prepared by the design team who are intimately familiar with the project and make multiple site visits throughout the design process.

Table 7.8: Percentage of state estimators that perform site visits.

State Estimators Performing Site Visits		
	Bid History	Cost-based/Combo
Every project	46%	25%
Major projects	8%	25%
Special condition projects	15%	13%
Owner required projects	8%	0%
Other	23%	50%

Question #23

Does your DOT publish their engineer's estimate?

- ☐ 0% Prior to the letting date
- ☐ 10% After the letting date
- ☐ 5% State mandated
- ☐ 62% No
- ☐ 24% Other

The survey indicated that 60% of states responded that they do not publish the engineer's estimate. Five percent responded that it was state mandated, and 10% noted that they published the engineer's estimate after the letting date.

The majority of state DOT's do not publish their engineer's estimate, as is indicated in Table 7.9. Other responses by state DOT's included:

- At the time bids are opened as required by Kentucky Statute.
- After award.
- State law not to reveal.
- Only bottom line numbers are provided. Unit prices are not released.
- At time of advertisement.
- State Law requires it to be kept confidential even post award.

Table 7.9: Percentages of how state DOT's publishing their engineer's estimate.

How States Publish their Engineer's Estimate		
	Bid History	Cost-based/Combo
Prior to the letting date	0%	0%
After the letting date	15%	0%
State mandated	0%	13%
No	62%	63%
Other	8%	50%

Question #24

How does your DOT implement fuel adjustments?

- ☐ 14% When preparing the estimate
- ☐ 62% At payout to contractor's

When the state DOT's were asked how they implement fuel cost adjustments, 60% of the states polled said that they implement fuel cost adjustments at contractor payout, and 15% said they include this factor when preparing the estimate. Seven states replied that they did not use fuel adjustments. Other responses included:

- Currently only during construction.
- Based on similar projects in area which recently let (2-3) months.
- Fuel adjustments are not currently included in the estimate. After prerequisites are met, and at contractor's request, fuel cost adjustments are calculated and paid at payout.
- Contractor has the option to participate in fuel cost provisions. At time of signing contract, the contractor must indicate if they wish to participate, and if so, how much of bid is fuel. If participating, each progress payment is modified to the market value vs. the market at the time the project was bid.
- Fuel factors are not used; however we try to account for higher fuel costs when preparing the estimate. The anticipated length of the project with reference to time, scope of work, asphalt plant quotes, etc influence estimates in reference to fuel prices.
- When preparing the estimate and at payout to contractor's, at estimate—we use the blue book rental rate for our equipment costs. Fuel is included in the

operating cost. At payout—a fuel escalation clause is included in our contracts.

- When the change in the fuel adjustment varies over $0.15 from the index at the time of the letting.
- Fuel risk is not estimated since the contractors risk is mitigated by our special provision, payments are made or credits collected based on the index change over the life of the contract.
- Also adjusted at project completion.

Question #25

If your state DOT implements fuel adjustments, how does your DOT obtain the specific adjustment factors?

- ☐ 0% Through AGC contacts or resources*
- ☐ 14% Use of quoted FHWA adjustment factors (http://www.fhwa.dot.gov/programadmin/contracts/ta50803.htm)
- ☐ 5% Use of USDOT resources
- ☐ 29% Use of state DOT factors developed through self determined investigation*
- ☐ 38% Other

An interesting survey indication was that no state DOT obtained fuel adjustment factors through the Association of General Contractors resources. Ten percent of the DOT's polled said that they obtained the adjustment factors through use of quoted FHWA adjustment factors, 5% said they used USDOT resources, 30% of the DOT's have in-house methods for determining fuel adjustments, and 40% said they used some of the previous methods or other methods. Other methods of obtaining fuel cost information included: past projects, ENR-20 city average, formulas, Platts Diagram, Poten and Partners, industry, and investigating other state DOT's.

Table 7.10 illustrates that bid history approaches (23%) use quoted FHWA adjustment factors when obtaining a fuel adjustment and no cost-based/combination states did. Some cost-based/combination states (13%) utilized USDOT resources when obtaining fuel adjustments and 0% of bid history states did. More bid history states used state DOT factors developed through self determined investigation (38%) than cost-based/combination states (13%). Most states used other methods that are described in the previous paragraph. Appendixes E and F examples of adjustment factors.

Table 7.10: Percentages of how states obtain fuel cost adjustments.

How States Obtain Fuel Cost Adjustments	Bid History	Cost-based/Combo
Through AGC contacts or resources	0%	0%
Use of quoted FHWA adjustment factors	23%	0%
Use of USDOT resources	0%	13%
Use of state DOT factors developed through self determined investigation	38%	13%
Other	38%	38%

Question #26

How does your DOT implement asphalt related cost adjustments?

- ☐ 24% When preparing the estimate
- ☐ 48% At payout to contractor's

Asphalt adjustments were said to be adjusted by 45% of the state DOT's at payout to contractors, and 25% of the states responded that they consider asphalt cost adjustments when preparing the estimate. Other state DOT responses included the following:

- Based on similar projects in area which recently let (2-3) months.

- Estimated asphalt adjustments are included in the estimate, but actual cost adjustments are calculated and paid at payout.
- Costs are modified at time of Engineer's Estimate, but are not modified on the contract.
- Fuel factors are not used; however we try to account for higher fuel costs when preparing the estimate. The anticipated length of the project with reference to time, scope of work, asphalt plant quotes, etc influence estimates in reference to fuel prices.
- Supplier quotes.
- Special provision allows for payments or credits for AC based on index from bid date to when material is placed. The risk is not estimated since contractor is protected if AC rises.
- 4 States: Not currently adjusting asphalts.
- We publish a monthly asphalt price with each contract and make adjustments to the contractors bid price for asphalt items if the base price increases or decreases throughout the project.
- A line item is contained in the bid proposal titled "Asphalt Adjustment Cost". At time of Construction the constructor must provide documentation of his costs to the department.

Question #27

If your state DOT implements asphalt related cost adjustments, how does your DOT obtain the specific adjustment factors?

- ☐ 0% Through AGC contacts or resources*
- ☐ 10% Use of quoted FHWA adjustment factors (http://www.fhwa.dot.gov/programadmin/contracts/ta50803.htm)
- ☐ 0% Use of USDOT resources
- ☐ 24% Use of state DOT factors developed through self determined investigation*
- ☐ 33% Other

None of the states consult with the AGC when obtaining asphalt adjustments. Ten percent of the DOT's polled said that they obtained the adjustment factors through use of quoted FHWA adjustment factors, 20% of the DOT's have in-house methods for determining fuel adjustments, and 35% said they used some of the previous methods or other methods. Other methods of obtaining asphalt cost information included: past projects, ENR-20 city average, Asphalt Weekly Monitor, refineries, Poten and Partners, industry, and investigating other state DOT's.

Table 7.11 illustrates the percentages of cost-based/combination states relying on their own in-house factors (25%) and other methods (13%) when obtaining asphalt adjustments. Bid history states used quoted FHWA adjustment factors (15%), state in-house factors (23%), and other methods (46%). These are almost exactly the same percentages that were recorded for fuel adjustments.

Table 7.11: Percentages of how states obtain asphalt cost adjustments.

How States Obtain Asphalt Cost Adjustments	Bid History	Cost-based/Combo
Through AGC contacts or resources	0%	0%
Use of quoted FHWA adjustment factors	15%	0%
Use of USDOT resources	0%	0%
Use of state DOT factors developed through self determined investigation	23%	25%
Other	46%	13%

Question #28

Are there any other cost categories or line items, other than those that are asphalt or gasoline related, for which you make adjustments when preparing the estimate, or at contractor payout?

- ☐ 43% Yes
- ☐ 48% No

When asked if any other adjustments were implemented by the DOT's 43% indicated no, and 48% indicated yes. Adjusting for steel costs was the answer most DOT's cited. Other adjustments that the state DOT's responded with included: concrete, asphalt cement, and water pollution control. Comments included for this question are listed below:

- 4 States: Steel Adjustment.
- Steel; at estimate—supplier quotes, at payout—a steel escalation clause is included in our contracts. We use data from the Engineering News Record—20 city average.
- Concrete and Steel prices.
- No, we did have a steel adjustment, but have discontinued it.
- Earthwork, concrete pipe, concrete pavement, structural concrete, stone base

- Price adjustments for fuel, steel, and asphalt cement. Risk is not estimated, since owner has mitigated this risk by using the special provision for price adjustment. Payments or credits are handled over the life of the contact.
- "Water Pollution Control" is a line item which allocates money for the purpose which is paid to the contractor during presentation of the work. It is a cost plus item.

Question #29

Would you be willing to share any specific procedures, reports, fuels and asphalt adjustment factors, or handbooks for the method that your DOT uses as guidelines for estimating?

Most state DOT's were willing to share information on request.

Question #30

Please provide the following information:

Name:_____
Title:_____
Telephone #:_____
E-mail: _____

Table 7.12: Listing of respondents to the survey questionnaire.

	Evaluator	State	E-mail
1	Jim Frick	South Carolina	frickjh@scdot.org
2	Charles Clements	Arkansas	charles.clements@arkansashighways.com
3	Roger Bierbaum	Iowa	Roger.Bierbaum@DOT.Iowa.gov
4	Steven Anderson	Utah	StevenAnderson@utah.gov
5	Kevin Hanlon	Maine	Kevin.Hanlon@maine.gov
6	Larry Felsing	Michigan	FelsingL@michigan.gov
7	John Miller	Nebraska	jmiller@dor.state.ne.us
8	John Riedl	Oregon	John.J.Riedl@odot.state.or.us
9	Maria Burke	Texas	mburke@dot.state.tx.us
10	George Bradfield	Georgia	georgefbradfield@bellsouth.net
11	Harry Rankin	Mississippi	hrankin@mdot.state.ms.us
12	Paul Knofczynski	South Dakota	paul.knofczynski@state.sd.us
13	Kevin McCulley	Idaho	Kevin.McCulley@itd.idaho.gov
14	Robert Neville	Connecticut	Robert.Neville@po.state.ct.us
15	Jerry Cameron	Illinois	Jerry.Cameron@dot.il.gov
16	Norie Calvert	Maryland	ncalvert@sha.state.md.us
17	Richard Kiefer	Virginia	richard.kiefer@vdot.virginia.gov
18	Ryan Griffith	Kentucky	ryan.griffith@ky.gov
19	Nancy Sannes	Minnesota	nancy.sannes@dot.state.mn.us
20	John Koster	Nevada	jkoster@dot.state.nv.us
21	Dennis O' Shea	Delaware	dennis.oshea@state.de.us
22	Mike Fowler	Vermont	mike.fowler@state.vt.us

CHAPTER VIII

CONCLUSIONS

Literature Review

The comprehensive literature review conducted by the author identified a number of useful background publications. However, the literature review did not specifically identify publications that examine why a state agency would adopt one estimating approach to developing the engineer's estimate in favor of another. Bidding procedures used by the various states are well documented in the literature. Clemson University executed a research project that focused on long range cost estimating that was unit price as opposed to crew, cost, and labor productivity based. Most state agencies account for fluctuations in fuel and asphalt prices through provisions in their standard specifications. No references were identified that stated how a state agency should modify the engineer's estimate to take recent price fluctuations into account. Recent national events indicate that significant fluctuations in fuel prices can occur within a relatively short period of time.

Site Visits

The primary objective of the research project was to examine two types of estimating approaches, and to identify their individual strengths and weaknesses. The site visits to Georgia (GADOT) and North Carolina (NCDOT) Departments of Transportations enabled the research team to personally investigate states that implement a different estimating approach than the SCDOT. The research team discovered that

some of the cost-based estimating approaches used by the GADOT and NCDOT appeared to have merit, and might be useful for the SCDOT. The GADOT and NCDOT believe that their estimating approach is effective, and should be implemented by all state estimators. The methodology seems straightforward, but the GADOT discussed that a learning curve of half a year to three years was needed to become accurate at cost-based estimating. Both states felt that once this method is established, it will help increase the accuracy of the engineer's estimate. The site visits gave the perspective that a cost-based estimating approach is a good fit for the states visited, but the research team remained unconvinced that a switch by the SCDOT would be beneficial. Further analysis was needed to verify these methodologies of cost-based estimating, so a survey questionnaire was forwarded to all state departments of transportation nationwide.

Survey Analysis

The goal of the survey questionnaire was to gain knowledge and insights into the cost-based and unit cost line item estimating approaches, and to extract any pertinent information that could possibly sway a DOT to switch estimating methods. The survey questions were asked to determine means and methods associated with a cost-based approach, and to discern the actual accuracy and resources expended for this approach.

It was discovered that 60% of the states responding utilized the unit cost line item (bid history) approach, whereas 40% performed a combination of either methods or a cost-based approach.

When first implementing a cost-based estimating approach some additional procedures must be implemented. The data from Table 7.1 in the survey questionnaire suggests that when employing a cost-based estimating approach, production rates and

material costs should be determined. Table 7.5 illustrates that crew composition, haul distances, inspector's logs, contacting material suppliers, and the use of the Rental Rate Blue Book were most commonly used by cost-based/combination states when determining their production rates. The reporting states also suggested that these production rates are typically updated by project or updated as needed. Determining material cost quotes was also deemed important by the responding states. Data shows that material cost quotes were normally found by contacting the material suppliers by telephone, with a small portion of respondents suggesting that they received the material cost quotes from other sources such as magazines, television, and other medias.

Knowing what kind of resource expenditures can be expected when first managing a cost-based estimate is very important. Table 7.4 suggests that more man-hours expended could be expected when developing an estimate using the cost-based approach rather than a unit cost line item approach to estimating. Question seven reiterates this finding when 25% of cost-based/combination states answered that they had experienced increased man-hours spent when first implementing a cost-based approach. Table 7.4 illustrates another important finding. States answered with a low certainty that the cost-based approach is more cost-effective. Also 25% of the cost-based/combination states in question eight responded that increased costs were identified per project when implementing a cost-based approach. This correlation is a small, but few states responded to these questions. This low response could be interpreted as respondents not wanting to identify this information because of fear that their states would be associated with any response given, their method may be secretive, or they did not know. It can be

ascertained form the data that implementing a cost-based estimating approach might increase costs and labor.

The research team felt that since SCDOT compares their engineer's estimate success to how well their engineer's estimate follows the guidelines set forth by the FHWA, that a success or accuracy criterion would be the states whose bids fell within the engineer's estimate 10% of the time, over 50% of the time. Figure 7.3 illustrates a surprising statistic that 75% of unit cost line item states obtained accuracy 50%, whereas only 25% of cost-based states obtained acceptable accuracy. This statistic suggests that a unit cost line item approach to estimating is more accurate than utilizing a cost-based approach. Another interesting statistic that can be formed from Figures 7.3 and 7.4 is that states who obtain better accuracy utilize 0.98 estimators per one-hundred lettings, and the states attaining less accuracy utilize 1.29 estimators per one-hundred lettings. In this instance states who employ fewer estimators achieve higher accuracy. It also appears that, from very limited data from these figures, that cost-based states utilize 0.79 estimators per one-hundred lettings, whereas unit cost line item states utilize 1.68 estimators per one-hundred lettings. This result could indicate that some states have inexperienced staff members. Examining Table 7.3, cost-based estimating states had one more estimator on staff, and an average of about two-hundred more lettings per year than unit cost line item states.

The remainder of the survey analysis examined quantifying lump sum items, and gathering information into how states implement adjustments for fuel and asphalt costs. This information will be analyzed in the form of a parallel second research report being prepared by Clemson University.

Recommendations

When the research proposal was initially established there was recognition by the SCDOT that their estimating method contained a few disadvantages, and they were willing to address their concerns by investigating an alternative approach to estimating. This alternative approach was the cost-based estimating approach. The surrounding states of Georgia and North Carolina utilized this approach, and it would be convenient for a research team to investigate alternate methodologies. SCDOT's intent was to understand more completely the strengths and weaknesses of this approach compared to their estimating approach. The site visits were executed to determine whether a cost-based estimating approach was more accurate, and to find out the amount of resources that would need to be expended to implement this method if it was deemed more acceptable

After site visits with the GADOT and the NCDOT, the research team believed that implementing some sort of a cost-based estimating approach, with respect to the 80-20 rule, should be addressed by the SCDOT. But after reviewing the results from the survey questionnaire, it became clear that the SCDOT should not try and implement a cost-based estimating approach when developing the engineer's estimate. Table 7.3 indicates that the number of resources available to SCDOT was comparable to other state DOT's who utilize a unit cost line item estimating approach that were surveyed. It was found that 75% of the unit cost line item states obtained accuracy as opposed to 25% of the states utilizing a cost-based approach. It was also found that implementing a cost-based estimating approach could require more monetary risk and increased labor. There are many perceived advantages to cost-based estimating, but most of the states who are

implementing this method have been using it for over ten years and can be considered experts with this type of estimating. These states have readily available data and solid methodologies already established. For a state DOT to implement this type of method would require a steep learning curve. Considering the success of SCDOT's methodology this type of change seems unnecessary. Since SCDOT, GADOT, and NCDOT view the accuracy and success of the engineer's estimate differently, comparing their accuracy or success is not viable. In conclusion, there is no compelling evidence from the survey questionnaire to suggest that SCDOT adopt a cost-based or cost-based/combination approach, to preparing the engineer's estimate.

APPENDICES

Appendix A

Oman Bid Tabs Professional Plus

GADOT uses this computer software developed by Oman Services Inc., www.omanco.com, which has the capability to link GADOT historical data to a spreadsheet. Since GADOT uses a an 80-20 approach on most projects they are able to tell the program to retrieve line item prices for select time periods, locations, and project sizes. The program then retrieves a price for that line item which is an average price for the selected variables. These average prices are used for 80% of the line items which account for only 20% of the cost, enabling the estimator to spend the majority of the time on cost-based estimates for the more significant line items.

OVERVIEW

A companion product to BidTabs Professional, BidTabs PLUS is add-on module (program) allowing you to set up a spreadsheet of pay items with multiple columns of prices. You can import the pay item data for an upcoming job from an electronic format such as Expedite or Excel and then load pay item prices (averages) from BidTabs Professional in four different columns.

The pay item averages are based on parameters defined by the user, such as state average prices in a county or region, a competitor's prices and many others. By viewing what past prices have been for pay items, a user can very quickly determine approximate project size and get a feel for average prices or competitors prices for an upcoming job.

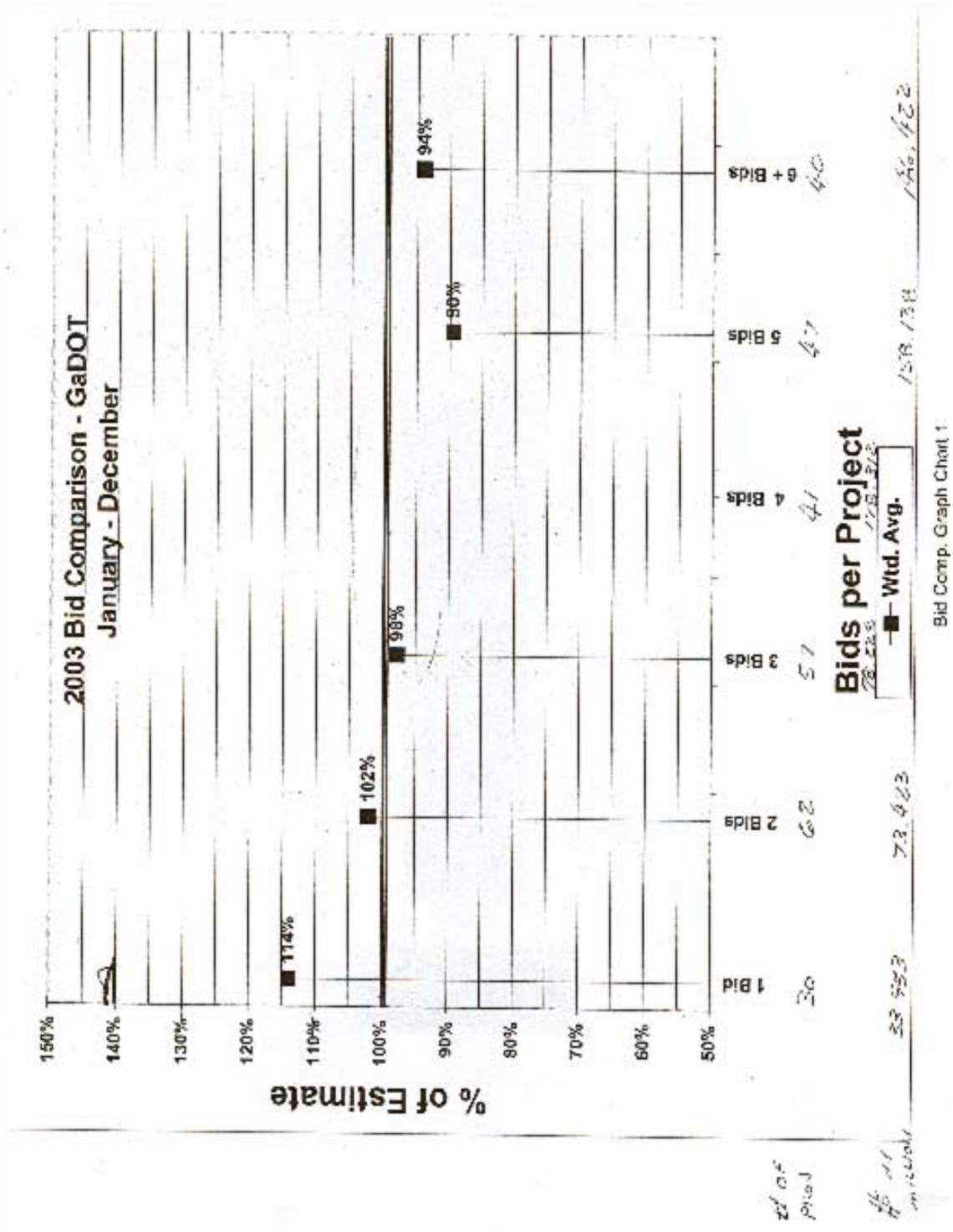
Program Highlights
Import Data – Easily import pay item data from a DOT bid disk or from a spreadsheet file, or pick pay items (batch load) from a master database or add pay items one at a time.
Quantity Parameters – When loading averages for *all* pay items you can enter a quantity percentage over/under the current project quantity that the system will use when calculating pay item averages. You can also enter project size ranges to calculate lump sum items.
Specific Pay Item - When loading averages for specific pay items you can quickly view all items that make up the average price for a pay item. You then have the ability to "dial in" the weighted average by excluding specific prices that you feel are too low or too high and may skew the price.
Category Totals - Easily create and display subtotals for each category of work. Quickly break down and review each category of work for a more in-depth understanding of work to be performed..
Reports – Compare different pricing scenarios for any project or print a listing of pay items falling outside user-defined parameters.
Show Records Found - Display the number of records that were found when calculating the average price for each pay item based on the criteria that you set
Import/Export - Import and export pay item data from and to other programs and files including Expedite and spreadsheet files.
Metric Conversion – Easily switch between English and Metric units of measure at any time

Appendix B

Bid Comparison Graphs

GADOT defines success as the ability to fit their data to the curve produced by the bid comparison method. The bid comparison is set up with percentage of Engineer's Estimate on the y-axis and number of bids per project on the x-axis (Figure B). The Engineer's Estimate is used as the benchmark meaning that it is 100%. The percentages show are the maximum, average, and minimum accepted bids compared to the Engineer's Estimate. This is done from one bidder to 6 plus bidders using all let projects per year. Underneath the bids per project is the number of projects that was let that had only one bidder and how much they accounted for in millions. GADOT then looks at the graphs curve and compares it to the acceptable values that are predetermined. These acceptable values are; for one bidder ranging from 100% to 130% of the Engineer's Estimate, 2 bidders ranging from 100% to 115%, 3 bidders ranging from 95% to 105%, 4 bidders ranging from 90% to 105%, 5 bidders ranging from 85% to 95%, and 6+ bidders ranging from 80% to 95%. They feel that these are acceptable values for the bids and if the graph is satisfied then the estimating method they are using is working accurately.

Figure B



Bid Comp. Graph Chart 1

Appendix C

Site Visit Questionnaire

1. Why does GA DOT use the cost estimating approach?
2. Advantages, Benefits of this approach as opposed to historical data method (line item)?
3. Disadvantages?
4. History, how long has GA DOT used this method?
5. How has it influenced time (man-hours)? More or less time spent?
6. Explain the methodology of the cost estimating approach? Any diagrams, flowcharts that we could look at?
7. Procedures, reports, or handbooks for this method that GA DOT uses?
8. Thoughts on 80-20, 70-30 approaches used by other states.
9. Any extra costs associated with this method?
10. Is this method more cost effective?
11. Are GA DOT engineer estimates usually on target with bids? Over/under.
12. Fuel adjustments?
13. Asphalt related cost adjustments?
14. Any specific data pertaining with exact percentages with respect to estimate accuracy?
15. The number of estimates prepared monthly and the man-hours expended to prepare those estimates?
16. How are production rates determined?

17. How do you update databases?

18. Do you have any example databases that we could look at?

Appendix D

Engineer's Estimate Questionnaire

South Carolina Department of Transportation

INTRODUCTION

The South Carolina Department of Transportation (SCDOT) currently uses a unit price line item (or "bid history") approach for developing the engineer's estimate. In an effort to improve our estimating procedures, a research project was initiated with the Department of Civil Engineering, Clemson University, to examine alternative approaches to preparing the engineer's estimate, including what is termed the "cost-based" estimating approach whereby the agency essentially replicates the labor crew approach taken by the contractor.

As part of this research project, this brief survey was developed. All responses to this questionnaire will remain confidential. A summary of responses will be prepared and distributed to those participating; however, agencies will not be identified.

Please return the completed survey by mail or e-mail to Dr. Lansford Bell at Clemson University. Contact Dr. Bell if you have any questions related to survey execution. A response by July 14, 2006 will be greatly appreciated.

Lansford Bell
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DEFINITIONS

Described below are definitions of terminology used in the questionnaire survey.

Cost-based estimate: Using this approach the transportation agency essentially replicates the estimating process utilized by the bidding contractor. Labor, materials, and equipment costs are determined using crew designations, wage rates, internal equipment rental/ownership rates, labor productivity, and equipment productivity data.

Unit Cost Line Item Estimate (Bid History): Under this approach the agency inserts estimated unit costs for the bid line items into a spreadsheet that includes item description and estimated work quantities for each line item, and line item costs are summed to compute the estimated project cost. The unit price estimates are derived from a large database of historical unit price bid items.

The 80-20 Rule: For most projects 80 percent of the costs are found in 20% of the line items. Cost-based estimating is done on that 20%, and bid history data is utilized for the remaining 80%.

Low Bid: Lowest qualified bid that is accepted by the DOT.

Production rates: The amount of work that can be completed in a single labor hour, based on crew composition, equipment ratings, and other conditions.

Engineer's Estimate: The estimate produced by the state DOT engineers.

FHWA Guidelines: Guidelines that state the engineer's estimate should be within +/- 10 percent of the low bid for at least 50 percent of the projects.

SURVEY QUESTIONNAIRE

Directions: Please place an X in any box that applies to your state DOT, if other is chosen please expand on your answer.

1. What is the primary estimating approach performed by your DOT?
   - ☐ Cost-based
   - ☐ Bid History (Line Item)
   - ☐ Combination
   - ☐ Other:_____

2. What percentage of projects do you perform with the selected approach from question #1?

%	10	20	30	40	50	60	70	80	90	100
Cost-Based										
Line Item										
Other										

3. Were any of the following methods used when first implementing the cost-based approach to your DOT's methodology to estimating?
   - ☐ Starting with one line item to achieve accuracy using the cost-based approach
   - ☐ Starting with several line items to achieve accuracy using the cost-based approach
   - ☐ Determining production rates
   - ☐ Using fuel and asphalt adjustment factors
   - ☐ Acquiring supplier quotes for material costs
   - ☐ Acquiring information from other state DOT's
   - ☐ Other:_____
     _____
     _____

4. Are there any perceived advantages or disadvantages for using the cost-based estimating approach that persuaded your DOT to implement it over the bid history approach? (1=Strongly disagree, 5=Strongly Agree)

	1	2	3	4	5
The cost-based approach is more cost effective.					
The cost-based approach improves estimate accuracy.					
The cost-based approach accounts for fluctuating costs of materials.					
The cost-based approach requires additional equivalent man-hours.					
Cost-based estimating should only be utilized for major line items.					
Cost-based estimating approaches estimating similar to the contractors approach.					

Other: _____
_____

5. If your DOT has been using a cost-based approach, how long has your DOT been using it?
   - ☐ Just Starting
   - ☐ Phasing implementation presently
   - ☐ 1-5 years
   - ☐ 5-10 years
   - ☐ 10-20 years
   - ☐ Other: _____

6. In your opinion, regardless of method, how much manpower does it take to obtain an estimate using your DOT's current method?

   Approximate annual workload_____
   Approximate full-time equivalent estimators_____

7. If you have recently adopted a cost based approach, what has been the impact on your estimating effort?
   On average over a given project:
   - ☐ Increased man-hours
   - ☐ Reduced man-hours
   - ☐ Same man-hours spent

8. If you have recently adopted a cost based approach, have additional costs been incurred to execute cost based estimates?
   - ☐ Increased cost
   - ☐ Reduced cost
   - ☐ Same cost

9. How many estimates does your DOT prepare monthly?
   - ☐ 0-10
   - ☐ 10-20
   - ☐ 20-30
   - ☐ 30 or more
   - ☐ Other:_____

10. How many equivalent man-hours are expended to prepare those estimates?
    - ☐ 0-20
    - ☐ 20-30
    - ☐ 30-40
    - ☐ 40 or more:_____
    - ☐ Other:_____

11. Does your DOT employ any form of the 80-20 rule for estimating?
    - ☐ Yes
    - ☐ No

    Explain:_____
    _____
    _____

12. What percentage of the time, when utilizing a cost-based estimating does the low bid fall within plus or minus 10% of the engineer's estimate?
    - ☐ 30 -40%
    - ☐ 40-50%
    - ☐ 50-75%
    - ☐ Other:_____

13. What percentage of the time, when using the bid history approach, does the low bid fall within plus or minus 10% of the engineer's estimate?
    - ☐ 30 -40%
    - ☐ 40-50%
    - ☐ 50-75%
    - ☐ Other:_____

14. Does your DOT follow the FHWA Guidelines on Preparing the Engineer's Estimate?
    - ☐ Yes
    - ☐ No
    - ☐ Sometimes
    - ☐ Other:_____

15. Does your DOT utilize production rates when determining an estimate?
    - ☐ Yes
    - ☐ No

16. Are any of the following methods used when determining production rates?
    - ☐ Crew compositions
    - ☐ Haul distances
    - ☐ Contractor Payroll Data
    - ☐ Inspector's Logs
    - ☐ Contacting material suppliers
    - ☐ Fuel price indexes
    - ☐ Rental Rate Blue Book for Construction Equipment
    - ☐ Contractor's Equipment Cost Guide
    - ☐ Cost Reference Guide
    - ☐ Means Heavy Construction Cost Data
    - ☐ Other:_____
      _____

17. How often does your DOT update production rates?
    - ☐ Annually
    - ☐ Bi-Annually
    - ☐ Monthly
    - ☐ Other:_____

18. How does your DOT obtain material costs from suppliers?
    - ☐ Contacting material supplier by telephone
    - ☐ Contacting material supplier in person
    - ☐ Contacting other DOT's
    - ☐ Other:_____
      _____

19. How often do you update these costs?
    - ☐ Annually
    - ☐ Bi-Annually
    - ☐ Monthly
    - ☐ Other:_____

20. Does your DOT quantify lump sum items such as traffic control, mobilization, and clearing and grubbing?
    - ☐ Yes
    - ☐ No
    - ☐ Sometimes
    - ☐ Other:_____

21. If so, how does your DOT quantifying traffic control, mobilization, and clearing and grubbing?
    - ☐ Acreage
    - ☐ Land use classifications
    - ☐ Lane closure setups
    - ☐ Number of cones, barrels, or barriers
    - ☐ Other:_____
      _____

22. How often do your estimators perform site visits prior to estimate development?
    - ☐ Every project
    - ☐ Major projects
    - ☐ Special condition projects
    - ☐ Owner required projects
    - ☐ Other:_____
      _____

23. Does your DOT publish their engineer's estimate?
    - ☐ Prior to the letting date
    - ☐ After the letting date
    - ☐ State mandated
    - ☐ No
    - ☐ Other:_____
      _____

24. How does your DOT implement fuel adjustments?
    - ☐ When preparing the estimate
    - ☐ At payout to contractor's

    Explain:_____
    _____
    _____

25. If your state DOT implements fuel adjustments, how does your DOT obtain the specific adjustment factors?
    - ☐ Through AGC contacts or resources*
    - ☐ Use of quoted FHWA adjustment factors (http://www.fhwa.dot.gov/programadmin/contracts/ta50803.htm)
    - ☐ Use of USDOT resources
    - ☐ Use of state DOT factors developed through self determined investigation*
    - ☐ Other:_____
      _____

    *Explain:_____
    _____
    _____

26. How does your DOT implement asphalt related cost adjustments?
    - ☐ When preparing the estimate
    - ☐ At payout to contractor's

    Explain:_____
    _____
    _____

27. If your state DOT implements asphalt related cost adjustments, how does your DOT obtain the specific adjustment factors?
    - ☐ Through AGC contacts or resources*
    - ☐ Use of quoted FHWA adjustment factors (http://www.fhwa.dot.gov/programadmin/contracts/ta50803.htm)
    - ☐ Use of USDOT resources
    - ☐ Use of state DOT factors developed through self determined investigation*
    - ☐ Other:_____
      _____

    *Explain:_____
    _____
    _____

28. Are there any other cost categories or line items, other than those that are asphalt or gasoline related, for which you make adjustments when preparing the estimate, or at contractor payout?
    - ☐ Yes
    - ☐ No

    Explain:_____
    _____
    _____

29. Would you be willing to share any specific procedures, reports, fuels and asphalt adjustment factors, or handbooks for the method that your DOT uses as guidelines for estimating?

    _____
    _____
    _____
    _____
    _____
    _____
    _____
    _____
    _____
    _____

30. Please provide the following information:

    Name:_____
    Title:_____
    Telephone #:_____
    E-mail: _____

Appendix E

Adjustment Index

Idaho Fuel Price Adjustment 7/06

A. Description. Fuel Price Adjustments will be applied to partial and final payments for contract items categorized in Section B, as a payment to the Contractor or a credit to the Department. Work performed by the Contractor at its own expense will not be eligible for fuel price adjustments.

B. Categories of Bid Items. The following fuel usage rates for the applicable items, as determined, will be used to determine fuel price adjustments:

Item Description Categories	**Fuel Usage Rate English Gal/Unit**	**Fuel Usage Rate Metric Gal/Unit**
Excavation including topsoil	0.29 CY	0.38 m^3
Excavation – Rock (must be specifically identified as such in contract)	0.39 CY	0.51 m^3
Borrow	0.29 CY	0.38 m^3
Base	0.63 Ton	0.69 t
Surface treatments including sealcoats	0.02 SY; 1.47 Ton	0.0167 m^2; 1.62 t
Concrete Pavements	0.03 SY per inch of depth	0.025 m^2 per 25mm. of depth
Concrete (all concrete paid by the CY or m^3)	0.98 CY	1.27 m^3
Plantmix pavements	2.6 Ton	2.86 t
Piledriving	0.12 gal per ft	0.39 gal per m
Rotomilling / Pulverizing / Mixing	0.02 SY per inch of depth	0.0167 m^2 per 25mm of depth
Pilot / Pace Car, pipe, guardrail	19.0 / $1000	19.0 / $1000
MSE Retaining Wall	19.0 / $1000	19.0 / $1000

C. Fuel Index. A current fuel index (CFI) will be established by the Department for each month. The CFI will be the price of No. 2 diesel fuel, as reported in Oil Price Information Services for the first Monday of the month.

The base fuel index (BFI) will be the CFI for the month the contract was awarded.

D. Computing the Fuel Price Adjustment. If the ratio of CFI/BFI falls between 0.80 and 1.20 inclusive, no fuel adjustment will be made for that pay estimate. If the ratio is less than 0.80 a credit to the Department will be computed. If the ratio is greater than 1.20,

additional payment to the Contractor will be computed. Credits and payments are computed as follows:

a. The quantity of work done for each pay estimate for the contract items identified in Section B is identified from the pay estimate.
b. The gallons of fuel used for that pay estimate are computed for each of the contract items identified in Section B by applying the unit fuel usage factors categorized in Section B to the quantity of work performed.
c. The total gallons (Q) of fuel used for that pay estimate will be summed for the applicable contract items, as determined, in Section B.
d. The Fuel Price Adjustment credit or payment is computed from the following formulas:

Contractor Payment: FA = ((CFI/BFI)-1.20) x Q x BFI

Department Credit: FA = ((CFI/BFI)-0.80) x Q x BFI

Where: FA = Fuel Price Adjustment
CFI = Current Fuel Index
BFI = Base Fuel Index
Q = Total gallons of fuel used for the pay estimate

E. Basis of Payment. A Fuel Price Adjustment payment to the Contractor will be made as a dollar amount for each pay estimate. A Fuel Price Adjustment credit to the Department will be deducted as a dollar amount for each pay estimate from any sums due to the Contractor.

F. Final Fuel Price Adjustment: Upon completion of the work under the contract, any difference between the estimated quantities and the final quantities will be determined. An average CFI, calculated from the CFI for all the pay estimates that the fuel price adjustment was applied, is used in accordance with the procedure set forth in Section D. A final fuel price adjustment will be made on the final estimate.

Appendix F

Excerpt from NDOTs' 2001 Standard Specifications

The following is an excerpt from NDOTs' 2001 Standard Specifications for Road and Bridge Construction describing our specifications for fuel escalation:

109.05 Fuel Escalation. The Fuel Escalation Clause, as described herein, may be enacted when requested by the Contractor or deemed necessary by the Department. Enactment of the Fuel Escalation Clause will only be considered when the increase or decrease of the "Contract Price" for fuel as defined herein exceeds 25%.

The use of the price adjustment provisions developed for the Fuel Escalation Clause are intended to minimize the cost effects of price uncertainty to the Contractor and the Department, for fuel used in the construction of this contract. The price adjustment provisions are not intended to compensate the Contractor for what would be considered normal day-to-day fluctuations or seasonal changes. The price adjustment provisions are not intended to serve as a guarantee for full compensation for fuel price fluctuations but are intended to provide for a sharing, by the Department, in a portion of the Contractor's risk which could result from unusual price fluctuations. The price adjustment provisions do not serve to relieve the Contractor of risks associated with fluctuation in prices beyond the amount adjusted by the provisions.

If the Fuel Escalation Clause is activated, the clause will apply from the period of time the unusual price for fuel began, until the end of the contract.

Fuel Escalation Clause
Contract fuel costs will be adjusted upward or downward on a bi-weekly basis. To accomplish this adjustment the Department will determine, for each contract, a "Fuel Factor Percentage" that represents an estimated percent of fuel cost by type of construction. The "Fuel Factor Percentage" will be applied to each bi-weekly progress payment balance due (excluding payments for stockpiled materials) to determine a "Bi-weekly Fuel Cost."

The bi-weekly fuel adjustment shall be calculated by comparing a "Contract Price" to an "Adjustment Price" to determine a percent of increase or decrease. The adjustment will be determined by the Department using the average diesel (No. 2 fuel oil) price postings for Reno and Las Vegas as provided by Oil Price Information Services. The method for calculating the "Bi-weekly Fuel Adjustment" will be as described in the following paragraphs:

(a) Fuel Factor Percentage (Ffp). The "Fuel Factor Percentage" (Ffp) will be an estimated fuel factor as a percentage of cost by type of construction as determined by the Department. The "Fuel Factor Percentage" will be specified in the Special Provisions.

(b) Bi-Weekly Fuel Cost (Bfc). The "Bi-Weekly Fuel Cost" (Bfc) will be the contract bi-weekly progress payment balance due (excluding payments for stockpiled materials) multiplied by the "Fuel Factor Percentage."

(c) Base Price (Bp). The “Base Price” (Bp) for fuel will be determined weekly using the prices posted on Monday of each week.

(d) Contract Price (Cp). The “Contract Price” (Cp) for fuel will be established for the week during which the bid opening is held. The “Contract Price” will be determined using the “Base Price” of fuel for the week of the bid opening averaged with the “Base Price” of fuel recorded for the previous three weeks.

(e) Adjustment Price (Ap). The “Adjustment Price” (Ap) will be the average of the “Base Prices” recorded during the bi-weekly progress payment period.

(f) Compensation Formula. The compensation payable as part of each bi-weekly progress payment will be subject to increase or decrease in accordance with the following provisions for fuel price fluctuations exceeding 25%. The bi-weekly fuel adjustment will be determined in accordance with the following formula:

For an increase in fuel adjustment prices that exceed 25% of the “Contract Price” (Cp):

$$A = (Ap/Cp - 1.25)* Bfc$$

For a decrease in fuel adjustment prices that exceed 25% of the “Contract Price” (Cp):

$$A = (0.75 - Ap/Cp)* Bfc$$

Where: A=Bi-weekly fuel adjustment in dollars rounded to the nearest dollar.
Ap=“Adjustment Price”
Cp=“Contract Price”
Bfc=“Bi-Weekly Fuel Cost”

(g) Compensation Adjustment. The adjustment in compensation for fuel shall also be subject to the following:

1. Payment of compensation provided herein will be made as part of the progress payment. The Contractor shall be liable to the state for decreased compensation adjustments and the Department may deduct the amount thereof from any monies due or that may become due the Contractor.

1. The maximum adjustment allowed under the terms of this specification occurs when the “Adjusted Price” exceeds the “Contract Price” by 75%.

The Department reserves the right to cancel the contract whenever the adjustment exceeds 75%. The contract may be canceled in part or in whole by the Department. If the Department elects to cancel the contract, in part or in whole, price adjustments shall not be allowed for other than major bid items. Adjustments to major bid items shall be in accordance with Subsection 104.02.

The following is an excerpt from NDOTs’ Standard Specifications pull sheets that modify our specifications for <u>fuel</u> escalation described above.

109.05 Fuel Escalation. The Fuel Escalation Clause is not in effect for this contract, therefore this Subsection of the Standard Specifications is hereby deleted. Delete for construction estimate greater than $250,000

(a) Fuel Factor Percentage (Ffp). The Department has established a Fuel Factor Percentage@ of % for this contract.

The following is an excerpt from NDOTs' 2001 Standard Specifications for Road and Bridge Construction describing our specifications for <u>asphalt</u> escalation:

401.05.02 Asphalt Escalation. The use of the price adjustment provisions as developed and implemented herein are intended to minimize the cost effects of price uncertainty to the Contractor and the Department for "Asphalt Cement" used in the construction of the contract. The price adjustment provisions are not intended to serve as a guarantee for full compensation for "Asphalt Cement" price fluctuations but are intended to be a sharing, by the Department, in a portion of the Contractor's risk which could result from potentially volatile price fluctuations that might occur throughout the duration of the contract.

The price adjustment provisions do not serve to relieve the Contractor of risks associated with fluctuation in prices beyond the amount adjusted by the provisions. This adjustment shall be full compensation for any and all price fluctuations, including but not limited to taxes, transportation, and delays.

The price adjustment provisions are only applicable to "Asphalt Cement"; they are not applicable to liquid asphalt or emulsified asphalt. The term "Asphalt Cement" as used herein is applicable to AC grades, AC-20P, and PG grades as specified in Subsection 703.03.02.

The progress payment will be adjusted upward or downward, as calculated by the "Total Bi-Weekly Adjustment." These adjustments will be determined by the Department using price posting for crude oil provided by Oil Price Information Services and AMOCO Crude Oil Price Bulletins. The sources used by the Department to determine the crude oil price at any given time will be the average of the price postings for Midway Sunset Crude, Buena Vista Crude, Utah Black Wax and West Texas & New Mexico Sour. The adjustment will be made by comparing a "Basic Materials Index" to a "Bi-Weekly Materials Adjustment Index." The method for making this comparison is described in the following paragraphs:

(a) A "Basic Materials Index" will be determined by the Department on a weekly basis. The "Basic Materials Index" in effect for the week a contract bid opening occurs will be the "Basic Materials Index" for that contract.

The "Basic Materials Index" shall be arrived at by averaging the Monday posting of the current week and the Monday posting of the three previous weeks.

The "Basic Material Index" price for "Asphalt Cement" will be available on an informational basis to interested parties but said prices shall not be available prior to the first regular business day of the week of the bid opening. The price may be obtained by contacting the Construction Division in the Department's General Headquarters, 1263 S. Stewart Street, Carson City, Nevada 89712, phone (775) 888-7460.

(b) During the time that the “Asphalt Cement” is paid for on this contract, the Department shall maintain crude oil price postings to be used to obtain a “Bi-Weekly Materials Adjustment Index.” The “Bi-Weekly Materials Adjustment Index” shall be arrived at by averaging the Monday posting of the current week and the Monday posting of the three previous weeks and shall be compared with the “Basic Materials Index” price to determine a “Bi-Weekly Material Price Adjustment.”

(c) The compensation payable for said “Asphalt Cement” will be subject to increase or decrease in accordance with the following provisions for “Asphalt Cement” price fluctuations exceeding 20%. The adjustment in compensation will be determined in accordance with the following formula for “Asphalt Cement” included in the progress payment:

Total Bi-Weekly Adjustment = AQ

For an increase in the Bi-Weekly Materials Adjustment Index exceeding 20% of the Basic Materials Index:

A = [Bp—Bi (1.20)]* F

For a decrease in the Bi-Weekly Materials Adjustment Index exceeding 20% of the Basic Materials Index:

A = [Bi (.80)—Bp]* F

Where: A =“Bi-Weekly Material Price Adjustment” in dollars per metric ton (ton) of “Asphalt Cement” rounded to the nearest dollar.

Bi =“Basic Materials Index” for the week in which the bid opening for the contract occurred (Dollars per barrel of crude oil). This is calculated as noted in paragraph (a) above.

Bp =“The Bi-Weekly Materials Adjustment Index” which pertains to the period during which the quantity subject to adjustment is included in the progress payment (Dollars per barrel of crude oil). This is calculated as noted in paragraph (b) above.

F =6.2 barrels of crude oil per metric ton (5.6 barrels of crude oil per ton) of “Asphalt Cement.”

Q =Quantity in metric tons (tons) of “Asphalt Cement” included in the progress payment.

(d) The adjustment in compensation shall also be subject to the following:

1. The compensation adjustments provided herein, will be shown separately on the progress payment. The Contractor shall be liable to the State for decreased compensation adjustments and the Department may deduct the amount thereof from any monies due or that may become due the Contractor.

2. The maximum adjustment allowed under the terms of this specification occurs when the "Bi-Weekly Materials Adjustment Index" exceeds the "Basic Materials Index" by 75%.
The Department reserves the right to cancel the contract whenever the 75% adjustment is exceeded. The contract may be canceled in part or in whole by the Department. If the Department elects to cancel the contract, in part or in whole, price adjustments shall not be allowed for other than major bid items. Adjustments to major bid items shall be in accordance with Subsection 104.02

(e) The contract unit price for "Asphalt Cement" will be considered to include the initial cost of the "Asphalt Cement" and all costs for furnishing, hauling, handling, spreading, and mixing of the material as required. Changes in the cost of "Asphalt Cement" that occur between the date of bid opening and the date the material is paid for will be addressed using the adjustment provisions previously described.

The following is an excerpt from NDOTs' Standard Specifications pull sheets that modify our specifications for <u>asphalt</u> escalation described above.

401.05.02 Asphalt Escalation. The Asphalt Escalation Clause is not in effect for this contract, therefore this Subsection of the Standard Specifications is hereby deleted. In if less than 450 metric tons (500 tons) of total asphalt cement on contract

This Subsection of the Standard Specifications is in effect for this contract with the following modifications: Delete if no asphalt escalation

Asphalt Cement@ is not a bid item on this contract and is not included in the progress payment, however, compensation or deduction will be made for Asphalt Cement@ price fluctuations as specified therein.

The value for AQ@ in subparagraph (c) is hereby deleted and the following substituted therefore:

Q = Quantity in metric tons (tons) of Asphalt Cement@ that were used on the project during the progress payment period. The quantity, in metric tons (tons), of Asphalt Cement@ will be calculated using the approved mix design and the following formula:

$$Q = \frac{\text{Wet tons used} \times \% \text{ Asphalt} / 100}{[1 + (\% \text{ Asphalt} + \% \text{ Mineral Filler}) / 100]}$$

The following is an excerpt from NDOTs' Standard Specifications pull sheets that define NDOTs' <u>steel</u> escalation clause, which was established in 2004.

109.09 Steel Escalation. The Steel Escalation Clause, as described herein, may be enacted when requested by the Contractor or deemed necessary by the Department. Enactment of the Steel Escalation Clause will only be considered when the

"Adjustment Price" is more than a 10% increase or decrease from the ABenchmark Price@ for steel as defined herein.

The use of the price adjustment provisions developed for the Steel Escalation Clause are intended to minimize the cost effects of price uncertainty to the Contractor and the Department, for most steel used in the construction of this contract. The price adjustment provisions are not intended to compensate the Contractor for what would be considered normal day-to-day fluctuations or seasonal changes. The price adjustment provisions are not intended to serve as a guarantee for full compensation for steel price fluctuations but are intended to provide for a sharing, by the Department, in a portion of the Contractor's risk which could result from unusual price fluctuations. The price adjustment provisions do not serve to relieve the Contractor of risks associated with fluctuation in prices beyond the amount adjusted by the provisions.

If the Steel Escalation Clause is activated, the clause will apply from the period of time the unusual price for steel began, until the end of the contract.

The price adjustment provisions will only apply to reinforcing steel, structural steel, overhead sign structures, steel piling, steel poles for luminaires and traffic signals, dowel bars and tie bars for concrete pavement, and beam elements and metal posts for guardrail. No other steel materials are covered by this price adjustment provision. Edit items per contract

Steel Escalation Clause

The progress payment will be adjusted upward or downward as calculated by the "Steel Cost Adjustment." The adjustment will be determined by the Department using the average of the 20-City Average for Grade 60, #4 Reinforcing Bars@ and Hot-Rolled Carbon Steel Plate@ from Engineering News-Record, published in the fourth weekly publication of the month. The adjustment will be calculated by comparing the "Benchmark Price" to the "Adjustment Price."

The method for calculating the "Steel Cost Adjustment" will be as described in the following paragraphs:

(a) Benchmark Price (BP). The Benchmark Price@ (BP) will be the current published price at the time bids are opened.

The "Benchmark Price" for steel will be available on an informational basis to interested parties. The price may be obtained by contacting the Construction Division in the Department's Headquarters, 1263 South Stewart Street, Carson City, NV 89712, Phone No. (775) 888-7460.

(b) Adjustment Price (AP). The Adjustment Price@ (AP) will be the published price for the month that the steel is shipped from the mill.

The Contractor shall submit copies of the mill or warehouse invoices, showing the shipping dates and quantity shipped, for all steel referenced above. These invoices shall cover all steel materials to be placed. The Contractor shall also submit documentation showing where the steel will

be placed and the theoretical waste of the material in the fabrication process.

(c) Compensation Formula. The compensation payable as part of each bi-weekly progress payment will be subject to increase or decrease in accordance with the following provisions for steel price fluctuations exceeding 10%. The bi-weekly steel adjustment will be determined in accordance with the following formula:

For an increase in steel adjustment prices that exceed 10% of the "Benchmark Price" (BP):

$$A = BP(1.10)] * Q/100[AP -$$

For a decrease in steel adjustment prices that exceed 10% of the "Benchmark Price" (BP):

$$A = - AP] * Q/100[(0.90)BP$$

Where:
- A = "Steel Cost Adjustment" in dollars rounded to the nearest dollar
- AP = "Adjustment Price" in dollars per 100 pounds
- BP = "Benchmark Price" in dollars per 100 pounds
- Q = Quantity of steel material in pounds

(d) Compensation Adjustment. The adjustment in compensation for steel shall also be subject to the following:

1. Payment of compensation provided herein will be made as part of the progress payment. The Contractor shall be liable to the state for decreased compensation adjustments and the Department may deduct the amount thereof from any monies due or that may become due the Contractor.

2. The maximum adjustment allowed under the terms of this specification occurs when the "Adjustment Price" exceeds the "Benchmark Price" by 75%.

   The Department reserves the right to cancel the contract whenever the adjustment exceeds 75%. The contract may be canceled in part or in whole by the Department. If the Department elects to cancel the contract, in part or in whole, price adjustments will not be allowed for other than major bid items. Adjustments to major bid items will be in accordance with Subsection 104.02.

3. The contract unit prices will be considered to include the initial cost of the steel used and all costs for furnishing, hauling, manufacturing, fabrication, shipping, storage, etc. of the material as required. Changes in the cost of steel that occur between the date of bid opening and the date the material is shipped from the

mill will be addressed using the adjustment provisions previously described.

4. No steel cost adjustments will be made for any items manufactured from steel having a mill shipping date prior to the bid date of the contract. The maximum quantity of steel material that this provision will apply to will be theoretical plan quantity shown in the plans or as determined.

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