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FINAL REPORT
Project Number: 930-656

DEVELOPMENT OF A PROCEDURE FOR UPDATING LIQUIDATED DAMAGE RATES USED IN ALDOT CONSTRUCTION CONTRACTS

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October 2008

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Sponsored by:
Alabama Department of Transportation
Montgomery, AL

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ABSTRACT

This research effort sought to develop statistically justifiable means for developing a schedule of liquidated damage (LD) rates to be adopted by the Alabama Department of Transportation (ALDOT). The procedure outlined is to be used to review and update the LD rates found in ALDOTs standard specifications for highway construction contracts, since their current schedule and review procedure has come under legal scrutiny. After a review of pertinent literature on the subject, it was determined that there was lack of documentation concerning State Highway Agencies (SHAs) use of LDs. As a result, an electronic survey was created and sent out to all SHAs to determine the state-of-the-practice regarding the use of LDs by SHAs in construction contracts. This survey experienced a 100% response rate. Using the knowledge obtained from the survey, two statistically justifiable methodologies were developed to calculate LD rates using historical project cost accounting data including: (1) a traditional LDs provision based on FHWA guidelines with the LD rates stipulated in a table as a function of contract value, and (2) a more complex table in which the LDs rates are categorized by contract value as well as by project type (i.e. bridge, road, building, etc.). These methods were then compared to the current ALDOT procedure. The first methodology which stipulates LD rates in a table by contract value was determined to be the most robust method. The project type method successfully stipulated LDs by both contract value and project type, but assumptions were made concerning the project type designations due to lack of information in the historical project data, introducing bias to the procedure weakening its objectivity. The final product of this research effort is a set of stepwise guidelines for practitioners to reference when reviewing and updating their schedule of LD rates.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Contract time is an essential element in construction contracts, and a contracting agency must ensure the work is completed accordingly. Through administering a contract the contracting agency incurs costs associated with engineering, inspection, and supervision of the work being performed. If the work extends beyond the allotted contract time the owner will endure additional administrative costs that were not anticipated at the time of contract formation. Failure to meet a contract completion date constitutes a breach of contract that entitles the contracting agency to incurred damages (Allen, 1995). The contracting agency may be in a legal position to recover damages and additional costs, from the contractor, associated with late completion. A liquidated damages (LDs) clause may be stipulated in the contract to avoid the litigation related to the recovery of actual damages caused by a delay.

1.2 LIQUIDATED DAMAGES

Several activities may occur on construction projects to delay any given activity or the overall project. These delays increase both the contract completion time and the costs for many parties involved. A contractor is only liable for the time and costs associated with a non-excusable delay. A *non-excusable* delay is caused by the contractor or its subcontractor that affects the project completion and additional time is not granted by the owner. In the case of a non-excusable delay, the contactor assumes the risk of cost and consequences; not only his own but possibly of all the parties involved as well. Non-

excusable delays may be due to subcontractor's actions, inadequate supervision, failure to provide materials and equipments on time, and so forth. These non-excusable delays may constitute a breach of contract by the contractor and can result in termination of the contract (Bramble & Callahan, 1987).

LDs are a daily monetary rate stipulated in a contract to compensate the owning agency for additional costs incurred as a result of a project extending beyond its completion date due to a non-excusable delay. LDs may be based upon a reasonable forecast of loss of actual damages to the owning agency if the project is not completed on time. The purpose and intent of the LDs clause is to compensate the owning agency for additional cost associated with the late completion, and not "financial castigation" of the contractor for breach of contract. Subsequently, a contractor has the option to extend a project beyond a completion date by reimbursing the owner through LDs. Historically, LDs that are disproportional to actual damages have been deemed as a penalty and unenforceable by the court of law (Jensen, 2000).

Based upon our review of practices nationwide, the calculation associated with computing LD rates may include additional costs associated with lost revenue, rental value, user costs, engineering and inspection, administrative costs, additional wages, and overhead fees. However, costs related to the impact on follow-on contracts are generally not considered. A follow-on contract is one that relies on the completion of a previous contract in order to begin; therefore, if the preceding contract is delayed it will result in the delay of any succeeding (i.e. follow-on) contract. Typically, LDs are calculated at the time of contract formation and are included as a provision in the contract. According to

Thomas et al. (1995), a LDs provision is a less expensive and time saving option than proving actual damages in court.

In the United States, it is the responsibility of each State Highway Agency (SHA) to build and maintain the transportation infrastructure in that state. The Federal Highway Administration (FHWA) distributes the majority of the funds associated with this work. As a result, the FHWA places many requirements on SHAs for the way they develop contracts associated with Federal-aid projects. One such requirement is the incorporation of a LDs clause into the contract. As a minimum, the liquidated damage (LD) rate stipulated as a contract provision to recover damages attributable to contract schedule overrun must include the SHA's average daily construction engineering costs (23 CFR 635.127).

1.3 RESEARCH OBJECTIVES

The focus of this research project is to review and evaluate the Alabama Department of Transportation's (ALDOT) current LDs provision used in construction contracts. ALDOT's 2002 LDs rates (*§108.10* and *§108.11* of ALDOT's 2002 Standard Specifications) are outdated and have come under legal scrutiny. A need exists for the development of a statistically justifiable means of establishing appropriate LD rates. As a result, the primary goal of this research is to develop such a methodology for calculating LD rates to be included in ALDOT's Standard Specifications for Highway Construction that represent an accurate estimate of actual damages. To develop such a methodology, two methods for calculating LDs using historical project cost accounting data were investigated including: (1) a traditional LDs provision based on FHWA guidelines with

the rates stipulated in a table as a function of the contract value, and (2) a more complex table in which the LDs rates are categorized by contract value as well as by project type (i.e. bridge, road, building, etc.). The first step in developing the methodologies is to determine if this was an ALDOT specific problem or a problem being experienced nationwide. This would be accomplished by conducting a review of the current state-of-the-practice of SHAs' experiences with LD provisions in construction contracts through an online survey, polling each SHA on their LD practices.

The specific objectives of this research are as follows:

1. Administer a survey to determine the state-of-the-practice of SHAs' use of LD clauses.

2. Develop two methodologies to compute LDs that are statistically justifiable and entirely objective.

3. Compare the two methodologies to the current ALDOT method to identify the most appropriate method for computing LDs.

4. Develop guidelines for practitioners to use for updating LDs on a biennial basis.

The specific tasks to satisfy the abovementioned research objectives are as follows:

1. Identify, describe, evaluate, and critically assess pertinent literature on the use, applicability, and enforceability issues along with lessons learned with respect to LDs provisions in construction contracts.

2. Conduct a survey of other SHAs to determine the current provisions and policies utilized by SHAs nationwide, concerning the use and experiences with LDs on construction contracts, and determine the state-of-the-practice regarding LDs provisions on a national scale.

3. Acquire historical ALDOT specific accounting data (i.e. engineering and inspection costs) for completed projects, and additional data on the type of work the project encompassed.

4. Analyze the collected data and develop methodologies to determine LD rates and determine which methodology more accurately models the actual damages experienced.

5. Develop guidelines for applying the selected methodology, as well as clear instructions on how to update the LDs rates.

1.4 ORGANIZATION OF FINAL REPORT

This report is divided into five chapters that organize, illustrate, and describe the steps taken to meet the defined research objectives throughout the duration of this project. Immediately following this chapter, Chapter 2: *Literature Review*, summarizes the body of knowledge pertaining to this study and synthesizes previous research efforts. The focus of the literature review is centered on the federal regulations governing SHAs' application of LD provisions, the application of LDs in the State of Alabama, the current body of knowledge concerning the development, implementation, and enforcement of LDs, and the current legal precedence of LDs set forth by court rulings throughout the nation and abroad. Chapter 3: *Survey Deployment and Procedures*, outlines the steps

taken to develop and administer an online survey of SHAs' LDs practices. The information obtained from the survey is discussed to determine and synthesize best practices used among SHAs. Chapter 4: *Data Collection and Analysis*, discussed the effort in obtaining historical project data from ALDOT, the organization of this data, and the statistical analyses used to analyze this data. Chapter 5: *LDs Methodology Development and Guidelines*, describes ALDOT's current methodology for developing LDs and two objective and justifiable methods for determining LDs using the project data obtained from ALDOT. Finally, Chapter 6: *Conclusions and Recommendations*, provides input as to the best methodology for use by ALDOT to calculate future LD rates. Additionally, this chapter identifies the potential for further research that can be conducted expand on this research effort.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

A contractor's timely performance in the construction arena is of essential importance on both public and private projects to an owner. When a contractor caused delay occurs, and the project extends beyond the specified contract completion date, the owning agency suffers damages associated with loss of revenue as well as additional administrative, engineering and inspection costs. The contractual mechanism of damage liquidation is used by owners in dealing with the event of inexcusable contractor delay in order to recover costs attributed to contract schedule overrun. An effective LDs clause will offer an estimate of damages that closely resembles actual damages. If a court finds that the LDs rate represents an arbitrary or unreasonable approximation of damages, the courts will strike it down, deeming it a penalty and unenforceable.

In order to satisfy the research objectives identified in Section 1.3, the first critical task involved conducting a thorough literature review on several pertinent subjects. The literature review focused on examining: (1) the federal regulations governing how SHAs implement LDs within their construction contracts, (2) the status of LDs in the state of Alabama, (3) a summary of past court cases involving the application of LDs in contracts, and (4) the existing body of knowledge concerning the development, implementation, and enforcement of LDs. Each of these individual topics will be covered in more depth in subsequent sections.

2.2 FEDERAL REGULATION (23 CFR 635.127)

The FHWA provides SHAs with guidance on developing LD rates. In federal regulation 23 CFR 635.127, liquidated damages are defined as,

> "The daily amount set forth in the contract to be deducted from the contract price to cover additional costs incurred by a state transportation department because of contractor's failure to complete the contract work within the number of calendar days or workdays specified. The term may also mean total of all daily amounts deducted under the terms of a particular contract." (23 CFR 635.127)

This federal regulation requires each SHA to establish LD rates for projects contracted in that state. States may develop their rates either on a project specific basis or in the form of a table or schedule categorized for a range of project costs and/or project types. These rates, as a minimum should cover the estimated average daily construction engineering (CE) costs associated with the type and size of work encountered on the project.

SHAs are required to have their LD rates approved by the FHWA. Project specific rates must be approved on a project-by-project basis. In developing or maintaining their rates for a table or schedule, SHAs are required to review their rates a minimum of every two years and rates are to be updated, when deemed necessary. This biennial evaluation requires the SHA to verify that their LD rates closely approximate the actual average daily CE costs being experienced and submit these findings to FHWA for review.

SHAs may include additional amounts in LDs to cover the anticipated costs associated with project-related delays that result in inconveniences to either the SHAs or the public. (e.g. road-user costs, cost of retaining detours for an extended time, etc.). The federal regulation permits the use of an incentive/disincentive (I/D) provision for early

completion concurrently with the LD rates as long as they are assessed separately. I/Ds differ from LDs in that they offer a motivation for early completion as well as a disincentive for late completion. The I/D rate and the LD amounts both have to be presented in justifiable, non-arbitrary amount.

2.3 LIQUIDATED DAMAGES IN THE STATE OF ALABAMA

The ALDOT Standard Specifications for Highway Construction, 2002 edition, contains the following LDs provision (*§108.10*) and a schedule of LDs (*§108.11*) based on a range of contract dollar amounts as shown in Figure 2.1.

The rates used in the 2002 ALDOT Standard Specifications by ALDOT for the assessment of LDs (*§108.10* and *§108.11*) underestimated actual engineering and inspection costs incurred. These LDs rates have been challenged in court in the recent past, deeming ALDOT's LD rates arbitrary and thus unenforceable. Therefore, a need exists for a detailed investigation and analysis of the LD rates utilized by ALDOT in construction contracts. Furthermore, the need for development of a statistically justifiable means for calculating LD rates in Alabama exists as well. This methodology must be robust enough to stand up to the scrutiny of the courts. In Alabama, legal precedence has established that LD provisions are ruled unenforceable unless ALDOT can prove that: (1) the damages incurred, caused by a breach of nonperformance, are difficult or impossible to accurately estimate, (2) the intentions of the contracting parties was to provide for damages rather than a penalty, and (3) the LDs amount stipulated is a reasonable pre-estimate of the probable anticipated loss determined during contract

formation. The Alabama courts look to see if the stipulated sum bears a rational relationship to the injury.

"§108.10 Failure to Complete Work Within Contract Time.
Should the Contractor, or in case of default, the surety, fail to complete the work within the time stipulated in the contract or the adjusted time as granted under the provisions of Article 108.09, a deduction for each calendar day or work day that any work shall remain uncompleted, an amount indicated by the Liquidated Damages Schedule shown in Article 108.11 or provided in the contract documents shall be deducted from any monies due to the Contractor on monthly estimates. Any adjustments due to approved time extensions or overruns in the contract amount will be made on the monthly, semi-final or final estimate as may be appropriate.

Liquidated damages assessed as provided in these Specifications is not a penalty, but is intended to compensate the State for increased time in administering the contract, supervision, inspection and engineering, particularly that engineering and inspection which requires maintaining normal field project engineering forces for a longer time on any construction operation or phase than originally contemplated when the contract period was agreed upon in the contract.

Permitting the Contractor to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time for completion may be extended, will in no way operate as a wavier on the part of the Department of any of its rights under contract.

§108.11 Schedule of Liquidated Damages.

Original Contract Amount		Liquidated Damages Daily Charge	
More Than	To and including	Calendar Day or Fixed Date	Work Day
$ 0	$ 100,000	$ 120	$ 200
100,000	200,000	180	300
200,000	500,000	300	500
500,000	1,000,000	480	800
1,000,000	2,000,000	660	1,100
2,000,000	5,000,000	840	1,400
5,000,000	10,000,000	1,020	1,700
10,000,000	- - - - - - -	1,200	2,000

When the contract time is on the calendar day or date basis, the schedule for calendar days shall be used. When the contract time is on a work day basis, the schedule for work days shall be used."

Figure 2.1 LDs Provision in ALDOT's Standard Specifications (ALDOT, 2002)

2.4 TYPES OF DELAY

Construction delays are categorized as (1) non-excusable, (2) compensable, and/or (3) excusable. As mentioned in section 1.2, non-excusable delays result from a contractor's

untimely performance. A *compensable delay* is the delay caused by the owner or its representative in which additional time and costs should be granted to the contractor to complete the project. For example, design related delays are caused by the Architect/Engineer who acts as an owner's representative. For compensable delays, the contractor is typically entitled to a time extension and damages for additional cost incurred due to the delay (Kraiem & Diekmann, 1987). An *excusable delay* is defined as the delay caused by factors beyond the control of the contractor or owner. Delays caused due to severe weather, labor disputes, acts of God, war, and so forth are classified as excusable delays since these delays excuse the contractor from meeting a contract completion date (Bramble & Callahan, 1987). Thus, in the event of excusable delay, additional time is granted to the contractor.

Concurrent delays involve a combination of any of the three above cases. In the event of a concurrent delay, care must be taken in order to fairly determine the amount of time to extend the contract as well as the amount of time in which damages are applicable. For instance, if concurrent delays occur where both the owner (compensable delays) and contractor (non-excusable delays) are responsible for delays in completing the work, there are two different approaches to resolve the issue. In the first, less complicated resolution, LDs are not allowed; instead the court settles on providing a time extension to the contractor, extending the contract completion date. The second resolution involves the apportionment of LDs. It is crucial for records to explicitly establish the extent of fault attributable to each party involved in the delay (Kraiem & Diekmann, 1987).

2.5 CALCULATING LDs

Allen (1995) compared methods of calculating LDs rates for the Boston Harbor Project, and the Central Artery/Third Harbor Tunnel Project (CA/T). Each of these projects were composed of multiple contracts being carried out simultaneously. For the Boston Harbor Project, the Massachusetts Water Resources Authority (MWRA) used a linear function that applied engineering and inspection (E&I) costs based on contract amount and duration. The linear function did not take into consideration the interdependence between a contractor's performance, the nature of contract work, and schedule logic. For example, inspection costs on complicated work would be more than inspection costs accrued during typical construction. Also, longer duration contracts may require more daily expenses than the shorter duration contracts of equal cost. As a result, MWRA's method used for calculating LDs was challenged in court. However, the case was settled before trial leaving these issues unanswered.

For CA/T, the Massachusetts Highway Department (MHD) determined LDs rates on a case-by-case basis. MHD reviewed the scope of each individual contract with respect to entire project schedule, extent of additional costs that would be required if the project is delayed, costs associated with permits, licenses, fees, and impact of delayed milestones or contract completion on other contractors. By adjusting historical data for the probability of affecting other works as well as individual estimates of E&I costs, MHD computed LDs for each individual contract. MHD also took into consideration project postponement and the cost of financing the project by applying cost escalation factors. MHD's systematic analysis of impacts on a contract-by-contract basis eliminates chances of LDs being challenged in court (Allen, 1995).

McCormick (2003) studied past legal cases involving LDs, identified common "pitfalls", and proposed guidelines for formation and calculation of LDs. The author states that if the damages are difficult to measure, the owner should assess LDs and if damages are easy to measure, the owner should assess actual damages. In the event LDs are ruled unenforceable, the owner can always pursue actual damages. Along with LDs, I/D provisions may be incorporated in the contract. When intentions of the owner are explicitly stated in the contract along with the method of calculation, I/D provisions are enforceable. However, the author maintains that the safest and infallible method is to provide a LDs clause without incorporating actual or I/D provisions.

Multi-prime projects are typically large projects consisting of multiple contracts. Many of these contracts, called follow-on contracts, are dependent on the completion of a previous contract in order to proceed. According to McCormick (2003), forming a LDs clause for multi-prime projects requires the development of a proper schedule for project completion that shows the interrelationships of follow-on contracts within the same project, as well as third party projects that are dependent upon the particular project under consideration. Excluding these items would make proving the reasonableness of the LDs a difficult task. For a LDs clause to be enforceable, the contract should clearly define the owner's intention, interim milestones, substantial/final completion, and document all calculations along with assumptions. If specified in the contract, LDs may be assessed for delay in reaching intermediate milestones, substantial completion, and final completion (Thomas et al., 1995). In such cases, LDs may accrue across more than one missed milestone and through to completion (Allen, 1995). LDs and milestones formulated after the award of the contract are enforceable if there is a bilateral agreement

between the owner and the contractor. In addition, to be enforceable, the LDs calculated should be based on a realistic perception of damages at the time of contract formation and have no tie to actual damages. The author believes that since the owner has the right to assess anticipatory LDs, he should take a proactive role in enforcing the LDs provision. If a contractor is terminated before the project completion and the owner has not retained any money for anticipatory LDs, the bonding company takes over. Since the bonding company has now become responsible for any LDs incurred, if a milestone is not met, they can file a claim against the owner for not protecting their interest under the bonding program (McCormick, 2003).

Leon et al., (1993), examined LD estimating methods and their application to multiple-prime contractor projects. According to the authors, if more than one milestone is used in the LDs provision, upon breach of each milestone the contract should clearly define the impact of each LDs on both, the successive milestone, and entire project completion. The impacted contractor has no accountability for the delay caused by the preceding contractor and LDs should be transferred to the contractor who caused the impact. The authors used historic data that consisted of 14 projects in the range of $1.2 million to $194 million, completed between 1984 and 1994, to create a method for estimating time-dependent jobsite cost per diem. Equation 2.1 was utilized to calculate time-dependent jobsite cost per diem:

$$L = CV * l / u \qquad (2.1)$$

where,

L = the time-dependent jobsite cost per diem for desired contract value ($ per calendar day),

CV = contract value in millions of dollars,

l = the time-dependent jobsite cost per diem (based on historical data of above mentioned project), and

u = the unit on which l is based in millions of dollars.

The authors utilized the Eichleay formula (described below) to calculate office overheads for impacted contracts and statistical methods, like the normal distribution, to determine the probability of impacted delay. They applied these techniques to the CA/T project, which was ongoing at the time the study was conducted, to determine level of LDs for about 20 contracts awarded through 1992. They concluded that, with the exception of one contract, the LDs rate for substantial completion was directly related to both the size of the contract and size of interfaces with other contracts.

2.5.1 Eichleay Formula

While bidding for a project, contractors take into consideration both job site overhead and home office overhead. Extended home office overhead are the costs incurred after the original contract completion date incurred as a result of compensable delays. When delay occurs on a particular project, that project ceases to contribute in paying for overheads. Since overhead costs are assigned to all projects and cannot be tied to a specific project, these are difficult to estimate. The Eichleay formula is one of the techniques that a contractor may employ to calculate extended overheads allocable to a particular project.

The Eichleay formula was first adopted in 1960 by the Armed Services Board of Contract Appeals to determine a contractor's unabsorbed home office overhead costs. Overhead includes the cost of running the home office as well as job site office. "The Eichleay formula creates a per diem rate for overheads attributable to a single project, multiplying that rate by the number of days of delay to arrive at a total home office overhead award" (Sweet & Schneier, 2004).

Before employing the Eichleay formula to calculate these damages, the contractor must prove that: (1) the owning agency caused the delay, (2) the contractor was on partial or complete suspension of work, and (3) their inability to take on another project was directly affected due to the uncertainty of the delay duration. The basic Eichleay formula is usually applied at project completion. The damage is calculated as follows:

1. *Allocable Overhead:* this step calculates the portion of home office overhead that should be allocated to the particular project under consideration. It is calculated as:

$$O_P = \frac{B_P}{B_T} \times O_T \tag{2.2}$$

where,

O_P = project's allocable overhead,

B_P = total contract billings,

B_T = total company billings, and

O_T = total home office overhead.

2. *Daily Allocable Overhead:* this step determines the daily rate for the allocation of home office overhead as follows:

$$B = O_P / D \tag{2.3}$$

where,

B = daily allocable overhead rate,

O_P = project's allocable home office overhead, and

D = number of days of contract performance including delay days.

3. *Home Office Overhead Damages:* this step computes the home office overhead damages by simply multiplying daily allocable rate calculated in step two by the number of compensable delay days.

$$B \times d = E \tag{2.4}$$

where,

B = daily allocable overhead rate,

d = number of days of compensable delay, and

E = home office overhead damages or amount recoverable.

The Eichleay formula is one of the methods used to calculate unabsorbed home office overheads in public construction delay cases. Some courts demand actual evidence of extended overheads and do not allow the use of a formula while other courts recognize difficulties of proving actual losses and encourage the use of the formula. Though not perfect, the Eichleay formula provides a rough estimate of a difficult to establish loss (Sweet & Schneier, 2004).

2.5.2 Validity of LDs

In ascertaining the validity of LDs provisions, the US courts apply a "three-pronged test". The three-pronged test includes: (1) the intent test, (2) the difficulty test, and (3) the reasonable test (Jensen, 2000). The *intent test* determines whether at the time of contract, the contracting parties had intentions to liquidate damages that are likely to occur in the event of late completion of the project. The intent test reviews the actions, words, and circumstances of contracting parties during the contract formation (Jensen, 2000). Thus, contractual provisions should clearly define the assessment period, specific start and end dates, whether assessment is for workdays or calendar days, and if weekends and holidays are included. If the intent of the clause is to prevent a breach or to secure full performance by the contractor, the clause is deemed to be a penalty (Thomas et al., 1995).

The *difficulty test* ascertains the degree of difficulty involved in developing an accurate pre-estimation of anticipated future damages. For the courts, the more improbable the calculation of the damages is to determine in advance, the more valid the LDs clause becomes. On the other hand, the less difficult the value of actual damages are to estimate, the more likely the court will be to interpret the LDs clause a penalty and thus deem it invalid (Jensen, 2000). Thomas et al. (1995) describes how difficulty in pre-estimating damages was discussed in City of Fargo, ND v. Case Development Company, 401 N.W.2d 529 (1987). In 1984, Case agreed to develop a city-owned building into an office complex for the city of Fargo. Later, Case abandoned the project for financial reasons. The city assessed LDs of $100,000 per the contract for delaying the project. This was challenged in court by Case. The court found that the benefits to the public and

the monetary loss to the city were impossible to determine at the time of the contract. Therefore the court upheld the LDs clause (Thomas et al., 1995).

The *reasonable test* compares LDs rates charged to the contractor with actual damages incurred by the owner. If the difference is significant, the court will likely deem the LDs clause a penalty and not enforceable (Jensen, 2000). A penalty is a specified monetary amount that is disproportional to the actual damages incurred by the owning agency. It is meant to compel contractual performance by the contractor or to enrich the owning agency beyond compensation (Jensen, 2000; Thomas et al., 1995).

If challenged, the owning agency must demonstrate how the forecast of actual damages was estimated. Lack of proper documentation may indicate that LDs were arbitrarily determined (Allen, 1995). Usually, courts do not require evidence of actual damages while evaluating a LDs clause. Whether the actual damages did or did not occur does not prevent recovery of damages. By entering into the contract, each party takes a calculated risk and agrees that a reasonable LD provision will be substituted for any and all damages incurred (Thomas et al., 1995).

Jensen (2000) conducted a quantitative study to measure the application preference and time of preference for the intent test applied by the appellate courts in order to ascertain the validity of LDs clause. This research employed statistical methods such as chi-square test and Stuart-Cox sign test to analyze court rulings dating from 1853 to 1991. The study concluded that when the courts apply the intent test to determine the validity of the LDs provision in a construction contract, the preferred application time period is the time of contract formation and not the time of trial.

Thomas et al. (1995) examined more than 80 appellate decisions and identified the primary inquiries made by the court to resolve disputes over LDs. The issues they identified were the: (1) review of LDs clause in the contract, (2) intention of the owner, (3) level of difficulty in predicting actual damages, and (4) reasonability of the specified LDs rate. To verify the validity of these issues, the authors studied 10 appellate court cases since 1965 and inferred that the reasonable test was the deciding factor in most cases. The reasonable test ensures that specified LDs were a reasonable estimate of potential damages. The authors also maintain that the intent test helps in differentiating LDs from penalties and traditionally, courts consider the time of contract formation and not the time after the breach.

Scott et al. (2006) examined the use of LDs as an embedded option in contracts. When LDs are viewed as compensation and not as a penalty, as intended, non-excusable delay becomes a contract option. The contractor may find that incurring the additional cost of LDs allows him a benefit. For instance, by directing a work force to an alternative job, a contractor may accumulate LDs on the first job, but the incentive to complete the alternative job may be higher than the LD charges incurred on the first job.

2.6 COURT CASES

2.6.1 State of Alabama Highway Dept. v. Milton Construction Company, Inc.

In this case Milton Construction Company, Inc. brought suit against the State and the Highway Department of Alabama in August of 1991 on the basis that LD charges it had accrued were unenforceable due to them being a penalty. Milton Construction was contracted by the state to widen and repair a portion of Interstate 65 in Jefferson County

for concrete pavement rehabilitation, as well as an addition of median lanes to a portion of Interstate 59 in Jefferson County. The two contracts contained identical I/D and LDs clauses, therefore the contracts were tried as one. The I-65 contract was for $7,745,320.29 and the I-59 was $4,399,883.25. The disputed amounts that were withheld by the Highway Department are $300,000 and $240,000 for the I-65 and I-59 projects, respectively. The case originated in the Circuit Court, Montgomery County, No. CV-89-1192, in which the judge, H. Randall Thomas, ruled in favor of the defendant, the State; the plaintiff appealed. The appeal reached the Supreme Court of Alabama which held that the clause in the contract for disincentive payments for projects not completed by the deadline was void and unenforceable as a penalty. It was determined that the disincentive portion sought to recover costs already recovered by the LDs provision. In further proceedings the court denied the Highway Department a recovery of user costs and ordered the Highway Department to pay the money withheld (Milton, 1991).

2.6.2 Williams Construction Co., Inc. v. Maryland State Highway Administration

The Maryland SHA contracted Williams Construction to build a portion of I-97. The project consisted of a six-lane divided freeway, as well as the grading, paving, drainage, lighting, signing, reconstruction of ramps and intersections, traffic management, and sediment and erosion control associated with the project. The contract was awarded in 1994 for $11,149,787.89. The contract stipulated the project was to be completed by October 31, 1995(this was later extended to December 6, 1995) and it advised the contractor of LDs of $2,630 per calendar day over. The project extended beyond this date; as a result, the contractor was responsible for 134 days of delay equaling $352,420 in LDs. Williams Construction filed an appeal with the State of Maryland Board of

Contract Appeal contesting that the LD rate was unreasonable. The court found that the rate was reasonable since, the parties agreed to the rate at the time of contract formation and the rate was determined using a process and guidelines that the SHA had been following for 20 years without objection. The $2,630 rate was stipulated in the SHA's standard specification for contracts between $11 million and $14 million. The LD rate was based on two components: (1) the cost to the SHA for the work of its inspectors and (2) the cost to the SHA for its administrative expenses (i.e. overhead). The costs on which the monetary amount was based were actual historical costs. The guidelines used for the calculation of this LDs rate had been updated one year before the contract formation (Williams, 2001).

2.6.3 Melwood Construction Corp. v. State of New York

Melwood Construction Corporation contracted with the State of New York on May 10, 1977 for the rehabilitation of four bridge structures. The contract stipulated that the contractor must complete the project by April 1, 1978, however Melwood did not finish the project until December 20, 1978 resulting in $55,500 in LDs accumulated at a rate of $500 per day. The State acknowledged that the LDs were not intended to compensate the government, but "were intended solely as a compensation for the inconvenience to the public" (Melwood, 1984). As a result, Melwood claimed that injury suffered by the public did not constitute actual damages to the State; therefore, the LDs were an unenforceable penalty and must be struck down. The court found that since the government is a trustee of its citizens, it may impose LDs to compensate for actual damages imposed to the public by a contractor's delay.

2.6.4 Pennsylvania, DOT v. Interstate Contractors Supply Co.

In this case the Commonwealth Court of Pennsylvania reversed a decision in favor of Interstate Contractors Supply Company that claimed the LDs imposed by the Department constituted a penalty. The case stemmed from a contract between the two parties originating on February 24, 1986 for the painting and cleaning of six county bridges. PennDOT imposed LDs for overdue work amounting to $8,600. The Board of Claims originally ruled that the LDs were not a probable estimate of damages, but were a form of punishment meant to prevent a breach. They cited that the State would not show actual damages incurred or express dissatisfaction in the work performed. The Commonwealth found that the Board erred in implementing the law. It cited that there was no requirement for State to show actual damages or for LDs to be based on dissatisfaction in order to administer LDs. As a result the original ruling was reversed in favor of the State (PennDOT, 1990).

2.6.5 Kingston Contractors, Inc. v. Washington Metro. Area Transit Authority

Kingston Contractors entered into a contract with Washington Metropolitan Area Transit Authority (WMATA) for removal, destruction, and replacement of electrical transformers. The contract stipulated LDs of $1,000 per day for the late completion. WMATA found that the newly installed transformers were defective and required the contractor to redesign them. Because of design issues and rejection of the transformers, the project was delayed and WMATA assessed LDs. Kingston Contractors filed an appeal with the Corps of Engineering Board of Contract Appeals. The board found that LDs included Environmental Protection Agency (EPA) penalties that would not be

assessed against the project under consideration and therefore the board reduced LDs to $500 per day (Loulakis et al., 1997).

Although the board reduced the LDs rate, Kingston contractors appealed to the District court for District of Columbia. The court found that since the original LDs provision was unreasonable, the LDs clause must be stricken as an unenforceable penalty. Therefore, the new $500 per day rate was deemed unenforceable because the LDs clause had already been determined unenforceable and must be struck down in its entirety (Loulakis et al., 1997).

2.6.6 Pete Vicari General Contractors, Inc. vs. Naval Facilities Engineering

Pete Vicari General Contractor was awarded the contract for construction of two buildings and renovation of an existing building at a naval air station. The project had three phases: (A) site work, (B) construction of two buildings, and (C) renovation. Each phase had a phase specific LDs rate. All the three phases were granted time extensions. Even after these time extensions, Phase A was delayed by 62 days, phase B by 32 days and phase C by 0 days. Thus, the entire project was completed with the delay of 34 days (after granting time extensions). The LDs clause in the contract clearly stated that extensions did not waive the government's right to assess LDs for the delay in completion of the immediately preceding phase (Pete, 2001).

The government assessed the LDs of $200 per calendar day for Phase A ($12,400) and $2,113 per calendar day for Phase B ($67,616). Pete Vicari General Contractors filed an appeal with the Armed Services Board of Contract Appeals for complete recovery of LDs for Phase B. The contractor argued that: (1) LDs can be assessed only for the delay in

overall project completion and no LDs are due for the late completion of Phase B; (2) the overall delay was only 34 days. Furthermore, the contractor claimed that the LDs rate of $2,113 for Phase B was unreasonable and any delay in completion of Phase B would have been caused by delay in completion of Phase A and no delay in completion of Phase C (since it was the renovation of an existing building). Since the government had already withheld LDs for Phase A, the contractor demanded release of LDs for Phase B. Given that the contractor could not provide evidence that, the LDs rate for Phase B was unreasonable and since the LDs clause was well defined and documented by the government, the contractor's claim was denied (Pete, 2001).

2.6.7 Leighton Contractors Pvt. Ltd vs. State of Tasmania (Australia)

Leighton Contractors were selected to design, construct, and maintain a new highway in Tasmania in Australia for ten years. A dispute arose when the state maintained that the design documents were not in accordance with the contract and directed Leighton to redesign the highway. Leighton proceeded to construct the highway accordingly, however, claimed it was entitled to a change order and time extension. The state rejected Leighton's claim and assessed LDs for late completion. A LDs rate for late completion in Australian currency was $8,000 per day that was comprised of the state's additional E&I costs. The court found the estimate of daily charges for some of the personnel was extremely high and speculative. The court noted that the LDs were calculated for each calendar day while additional costs were only incurred by the state on six days of the week. The court also considered the fact that the state was claiming for only additional inspection costs and not for loss of revenue and public money each day as a result of the

delay. Therefore, the Court concluded that the LDs rate was totally disproportionate to the anticipated actual damages and deemed to be a penalty (Jaques, 2004).

2.6.8 McAlpine vs. Tilebox Ltd. (UK)

Tilebox Ltd. awarded a building contract to McAlpine. The contract stipulated LDs of £45,000 (pounds) per week for the late completion. The LDs rate was negotiated with McAlpine and was based on minimum weekly rental value of the completed building. The project was delayed and McAlpine filed an appeal. In 2005, the judge maintained that "there had to be a substantial discrepancy between the level of damages stipulated and the level of damages likely to be suffered, before the stipulated LDs would become unreasonable (Rose, 2005)." At the time of contract formation, Tilebox's foreseeable weekly losses arising from the late completion were greater than £45,000 (pounds) a week. Therefore the Court ruled that the LDs were a reasonable pre-estimate of actual damages and were enforceable. The Court drew support from the fact that the amount of LDs had survived scrutiny by both parties during contract negotiations. The Court did not consider the fact that the actual loss suffered was less than the estimated damages since the discrepancy was not significant that it demonstrated the sum could not have been a genuine pre-estimate of the likely loss. Therefore, it is wise to retain evidence demonstrating how LDs were calculated along with proof of negotiations, if any.

2.7 SUMMARY

In order to create a robust LDs provision it is clear that the "three-pronged test" should be applied to verify the intent, difficulty, and reasonableness of the LDs clause. Furthermore, in the event of litigation, the provision needs to have documentation that

shows that the LDs rates are calculated and are not arbitrary. From the abovementioned review, it is evident that significant amounts of research have been conducted regarding the enforceability of LDs, however there is lack of research on LD practices used by SHAs and the methodologies used to compute LD rates. Therefore, an objective of this research is to review the current state-of-the-practice regarding SHAs computational procedures and assessments of LDs, and recommend best practices used by SHA to develop guidelines for practitioners to follow when developing LD rates for future projects.

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CHAPTER THREE

SURVEY DEPLOYMENT AND PROCEDURE

3.1 INTRODUCTION

To obtain a better understanding of the state-of-the-practice concerning SHAs use of LD provisions and policies, an Internet based electronic survey (e-survey) was conducted in May of 2006. Prior to the survey, a review of the current LD provisions used by each state was conducted. While the majority of SHAs use a table or schedule to denote the amount of LDs to be charged based on contract value, similar to ALDOT's provision, only a select few had experienced litigation issues. With a 100% response rate for the survey, a complete overview of SHAs use of LDs was deduced.

3.2 CURRENT SHAs' LDs POLICIES

During the development of the questions for the e-survey, current SHAs' LD provisions were examined. The policies were obtained from each state's Standard Specifications via the internet. As later confirmed in the survey, the majority of the states use a table or schedule to designate LDs rates. Similar to ALDOT, these rates are a function of contract value. Appendix A contains an exhaustive compilation of the tables used in each SHA's Standard Specification.

The tables of LD rates were compiled for comparison purposes. Since each state designates different contract value ranges to stipulate LD amounts, seven representative contract values were used to calculate the resulting LD amount for each state. These

values were compiled into a box-plot in Figure 3.1. ALDOT's LD rates were plotted on the same chart to gain perspective on how their rates compare to other SHAs nationally.

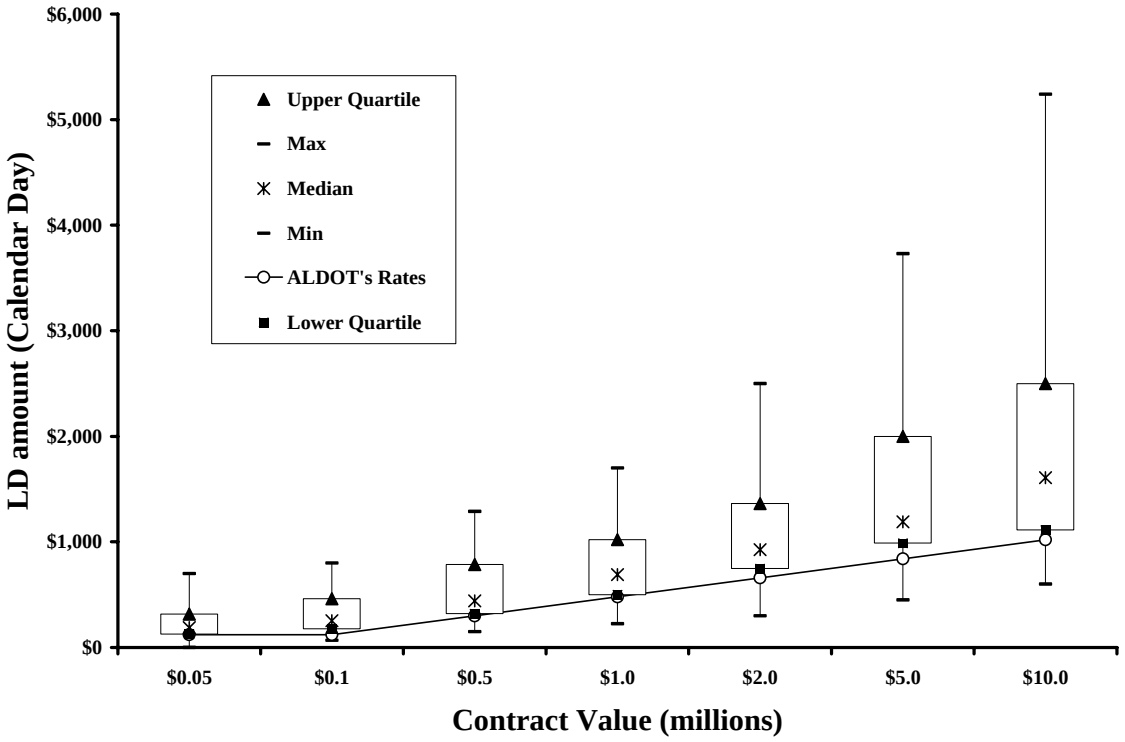

Figure 3.1 Box-plot of Each State's Table of LD Rates.

The most notable feature realized from Figure 3.1 is the increase in variability as the contract value increases. This shows the wide range of LDs rates used across the country. The median and quartile range increase with contract value, further emphasizing the trend for LDs to increase as the contract amount increases. Also note that ALDOT's rates are very low compared to the rest of the nation. It seems counterintuitive that ALDOT's rates are among the lowest, as determined from the survey, yet they have experienced the highest levels of litigation in the nation. One may presume that a contractor would not challenge such relatively low rates, as this may lead to an increase

in future rates. However, contractors are most likely unaware of other States LD rates across the nation and not realizing that ALDOT's rates are extremely low in comparison to other States. Contractors are more concerned with the current charges incurred on a project than with the future rates increasing as a result of re-review of the procedure for calculating LD rates.

The LD provisions of ALDOT and the surrounding southeastern states were compared since these states experience similar environmental conditions, labor and material availability concerns, and tend to work with the same contractors. This was done to determine inconsistencies in ALDOT's LD provision that may have contributed to the higher litigation experienced.

ALDOT and adjacent southeastern states, (Florida (FDOT), Georgia (GDOT), Tennessee (TDOT), Louisiana (LaDOT), and Mississippi (MissDOT)) all have similar LDs policies and report LDs as a schedule of damages in their standard specifications. None of these agencies use incremental LDs based on construction status such as substantial completion, physical completion, etc. LaDOT is the only state which assesses LDs for working in excess of typical 8 hr work day. Each state uses LD rates based on a range of contract amounts and does not take into consideration nature of the work. Design-bid-build (DBB) is the most widely used project delivery system among the group. Even though agencies such as FDOT and MissDOT contract many design-build (DB) projects, they use the same standard schedule of LD rates for DB contracts and do not compute project specific LDs. Except for MissDOT, none of the agencies have either an established procedure to calculate project specific LDs or a standard project staffing plan

for resource estimating. None of the states do a comparison of LD rates with actual damages.

While LDs are waived or reduced by granting time extensions at the state level, the determination of the substantial completion/final completion/acceptance is typically carried out by the local/resident engineer. Except for ALDOT (for LDs) and LaDOT (for road user costs), the LD provisions of these southeastern agencies have never been challenged in court.

Though all these agencies have similar LD policies, Table 3.1 indicates that their schedule of LDs rates varies substantially

Table 3.1 Comparison of the Southeastern States LD Schedules

Agency	Min. Contract Value	Max. Contract Value	Min. Daily Charge	Max. Daily Charge
Alabama	$0	≥ $10,000,000	$120	$1,200
Florida	≤ $50,000	≥ $20,000,000	$544	$ 8,624 (+ 0.00027 of any amount over $20 million
Georgia	$0	≥ $10,000,000	$75	$2,100
Louisiana	$0	≥ $10,000,000	$80	$630
Mississippi	$0	≥ $10,000,000	$140	$1,400
Tennessee	$0	≥ $10,000,000	$80	$1,400

Figure 3.2 presents a chart similar to Figure 3.1 which plots ALDOT's LD rates against a box-plot of the southeastern states' provisions. This figure further emphasizes the reasonableness of ALDOT's rates compared to its neighboring states. As seen in the chart, ALDOT's LD rates are close to the median values. Since each of the agencies do not use a standard methodology to compute the LDs rates, future litigation, such as that experienced by ALDOT, may be on the horizon.

In an effort to determine the best practices of SHAs' use of LD provisions, the standard construction specifications for each state were collected and analyzed. As later confirmed in the survey, the majority of SHAs use a schedule of LDs that specifies their rates as a function of the contract value. The majority of the remaining agencies' specifications state that LD rates will be specified in the construction contract. In other words, they use project specific method for applying LD rates.

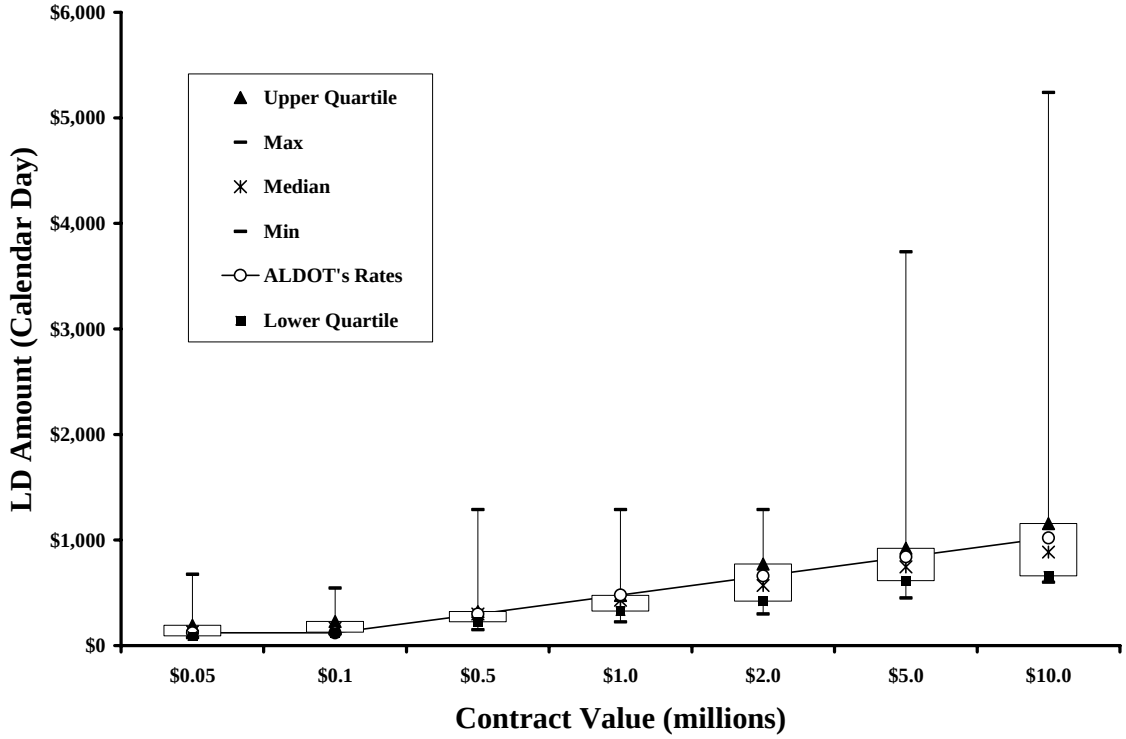

Figure 3.2 Box-plot of Southeastern States' Table of LD rates.

The purpose of this research effort was to develop a methodology to determine LD rates. However, some project specific methodologies were evaluated due to their progressive nature. Both Nebraska and Washington State specify a formula for determining LD rates. The formulas used by these states follow the same form and function as equation 3.1:

$$LD = \frac{R \cdot C}{T} \tag{3.1}$$

where,

LD = LDs per work day or calendar day,

C = original contract amount,

T = original number of calendar days or work days (whichever was specified in the contract), and

R = calculated coefficient (different for work and calendar days).

According to this formula the LDs to be applied on a job are a function of the original contract amount and the number of days specified in the contract. This takes the typical LDs table, which specifies LDs only by contract amount, to the next level by specifying LDs by both contract value and contract length.

The California Department of Transportation (CALTRANS) specifies a formula similar to equation 3.1 but includes project type as an additional factor. This method was of particular interest to this research since one of the methodologies being developed adds the project type designation as a factor in specifying LDs. For the equation used by CALTRANS, a table gave differing values for the *R* value in equation 3.1. The *R* values were specified as a function of the "project estimate" and project type. The table specified 6 project type categories: (1) Resurfacing/Rehab, (2) New Highway, (3) Realignment/Widening, (4) Landscaping, (5) Soundwalls, and (6) Other. The specifications do not divulge on how the *R* values were calculated or how the project type categories were determined. Nevertheless, the survey (outlined below) and follow-up

interviews revealed that CALTRANS will be moving away from this method to a more traditional table which only specifies the LDs by contract value.

3.3 SURVEY DEVELOPMENT

Several methods of conducting surveys such as postal surveys, telephonic surveys, and electronic surveys were discussed. After considering advantages and disadvantages of all the methods an e-survey (internet/web based survey) was chosen as a medium to launch the survey. An internet-based survey is one of the most widely used data collection techniques for conducting surveys. With this method, the survey can be launched in two ways: i.) creating a website and providing the respondents the website address (URL), where individual responses are stored in a database and, ii.) sending out the survey in the form of an email and asking the respondents to send their responses as an attachment with the return email. For this research the former was used and a website was created using the software "Zoomerang™". Respondents were contacted by email to provide them with the website address location (URL) of the online survey.

The main advantages of an e-survey include:

1. *Geographic coverage*: e-surveys are a means of gathering a large amount of information at a minimum expense in terms of finance, human resources, and cost.

2. *Economy*: e-surveys offer wide geographical coverage, resulting into relatively high validity of the results.

3. *Speed*: e-surveys are the quickest method of developing a survey. The responses can be received within minutes from the time of launch. Reminders can be sent to those who have not responded.

4. *Analysis of Data*: computer software allows for data and survey responses to be in a digital format making analysis easier.

The limitations of an e-survey include:

1. *Inflexible technique*: e-surveys do not give an opportunity for probing. If clarification is required or a response is misleading, e-surveys are unproductive. Usually e-surveys are followed by telephonic conversations/personal interviews.

2. *No control over respondents*: no guarantee that the right person will complete the survey, and no guarantee that the recipient will respond.

3. *Fatigue*: Universities, government agencies, and companies receive a "steady stream" of questionnaires and given the pressures of one's profession, surveys are a lower priority.

To overcome some of the limitations associated with the e-survey approach, follow-up interviews were conducted as suggested by Naoum (1998). Therefore, to facilitate further communication, detailed contact information was requested from each of the survey respondents. The survey was launched with the assistance of practitioners from ALDOT to help increase the response rate.

The response rate for the survey was 100%, with all 50 SHAs responding along with Puerto Rico, New Jersey Turnpike, and Washington, D.C. A total of 53 agencies' responses were received and analyzed. Unclear or incomplete responses were followed-up with a telephone interview to better understand the respondent's answer.

The survey consisted of 30 questions that were classified into the following six categories: (1) Contractual Principles, (2) Current LD Contract Provisions, (3) Contract Administration, (4) Cost Estimation Practices, (5) Legal Issues, and (6) Miscellaneous. Most of the questions were asked in a structured 'yes/no' format allowing for both quick responses and straightforward analysis. Comment boxes were included with each question to allow the respondents the opportunity to the express their views in greater detail or to use in clarifying their response. A sample of the survey has been attached as Appendix B and a summary of the survey results is presented in Appendix C.

The next three sections discuss the findings and insights realized from the survey responses regarding contractual, estimating, and administrative practices related to LD provisions among the participating SHAs.

3.4 CONTRACTUAL PRACTICES

Contractual practices encompass procedural choices made by agencies with respect to contract provisions. There are five distinct choices relating to damages for late completion which include: damage clauses, contract time (e.g. calendar day or work day projects), contract milestones, differentiated LD rates, and LDs with I/D clauses. These five procedural choices are discussed in the following section.

3.4.1 Damage Clause

The first choice among this list of five is whether or not specific damage amounts will be pre-specified within the contract. At the agencies discretion, an alternative contract provision may be written to provide for actual damages to be back-charged to the contractor or perhaps litigated in court. In the absence of such a provision, actual damages are generally permitted for any breach of the contract. All 53 responding agencies (100%) indicate that LDs are utilized in their contracts in lieu of recovering actual damages for a contractor's failure to complete the project by the fixed completion date. At first glance pre-specified LDs might be considered strictly as a benefit to the owner in administering the contract. However, a significant benefit accrues to the contractor in that a known monetary value represents the assessable damages and thus quantifies this risk component both during bid preparation and as completion options are assessed late in the overall performance of a project.

3.4.2 Contract Time

The second choice affecting LDs is the unit of time used in the contract. Of the 53 responding agencies, 38 use work days (72%) while 15 use calendar days (28%). The remaining 10 agencies indicated that some other form of contract time is used in special project specific situations.

This is more than a trivial choice since the contract unit of time chosen establishes the contract administration practice in managing contract time. With work days the contract time is essentially managed by the agency's field representative, where, with some measure of discretion, days are either charged to the contract or not. Alternatively, with a

calendar day contract the time is expended automatically and then managed retrospectively by the central office.

Contract time can even be defined on an hourly time interval per day making it possible to assign damages for hours worked beyond the allowed daily timeframe. Only 8 agencies (15%) reported that on specific projects they assess hourly LDs for work beyond a given daily maximum or work outside of a particular daily time window. These project specific cases tend to be high profile projects that will severely impact the traveling public subsequently resulting in excess RUCs. Therefore SHAs limit the construction operation to certain periods of the day where inconveniences will be minimized. The other 45 agencies (85%) indicate they do not use an hourly charge on projects.

3.4.3 Contract Milestones

The third choice affecting LDs is how the status of the project will be judged complete. This determination along with expended time establishes the assessment of LDs. There are two aspects to this contractual choice: i.) substantial completion and ii.) project phases (i.e. milestones).

Substantial completion defines a point short of final completion where damage assessments would end because the project is basically complete and the SHA can beneficially use the facility. The definition of substantial completion is included in 36 of the states' contracts (68%) while 17 agencies (32%) do not use this term. The comments provided suggest that most states are moving away from using an ill-defined term such as substantial completion and toward the requirement that contractual time stops when the contract is 100% complete and finally accepted. It should be noted that substantial

completion has less flexibility on a calendar day contract where time elapses automatically in comparison to a work day contract where discretion in contract time is provided in the field by the project engineer.

Project phases allow SHAs to incrementally judge the work for completeness with separate damages per increment or phase. Damages are assessed on project phases in 30 state agencies (57%), while 23 agencies (43%) indicate they do not. The comments provided by the respondents, however, indicate a slightly different perspective. It seems a project phase damage clause is used by nearly all agencies on a project-specific contract basis when RUCs represent a significant portion of the LD rate. A subsequent question asked if finishing the overall project on time would waive the agency's right to assess damages on intermediate phases. Four agencies (7%) indicate it does waive their rights, while 47 agencies (89%) indicate that it does not. Two agencies (4%) didn't respond to this question.

3.4.4 Differentiated LD Rates

The fourth choice is whether to differentiate the likely damages based on project characteristics such as construction status, project types, or delivery methods. Incremental damage rates based on construction status is used in 15 of the responding agencies (28%) and not by the other 38 agencies (72%). A comment made by one state mentioned that they use varying LD rates stipulating that the LD rates drop to half when a roadway is opened to the public in order to encourage the contractor to open the roadway as soon as possible. With regard to project types (i.e. bridge, highway, maintenance, etc.), 47 responding agencies (89%) indicate they do not vary LDs by project type, while

6 (11%) indicate they do. In the comments to this question many respondents indicated that LD rates vary with contract value, not type.

When asked about the contract delivery methods utilized in contracts, the respondents indicated their continued reliance on the "Design-Bid-Build" style of delivery with 45 of the 53 responses indicating their use of this technique. However other methods were used by agencies including design-build used by 12, construction management at risk used by 3, and construction management at agency by 7. Some agencies indicated that they used more than one method. When this question was succeeded with whether or not the delivery method varied the LD rates, 42 agencies (79%) said 'no', 9 (17%) said 'yes', and 2 agencies (4%) did not respond. Follow-up questions determined that comments indicating that the rates vary are reflecting a project specific approach to LDs more so than focusing strictly on delivery methods.

3.4.5 LDs with Incentive/Disincentive (I/D) Clauses

The fifth choice considered is whether or not to combine LDs along with a separate I/D clause. In responding to the survey, 45 of the respondents (85%) indicated they use both, while only 8 (15%) said that they do not. Some states indicated that their agency incorporates I/D clauses on a project specific basis and it is included as a special provision in the contract. The I/D values are typically based on whether or not the construction activity imposes a significant impact or inconvenience to the road user.

3.4.6 Summary of Contractual Practices

Summarizing this section, there are five LD related choices that are made by agencies and subsequently implemented into their contracts. The first choice among the five is

whether to use liquidated or actual damages. In response to this choice, all 53 agencies indicated that they use LDs. The second choice is what time unit should be utilized within the contract. The majority of states use work days which provides field level discretion in regards to assessing contract time. The third choice is how projects are judged complete with respect to LDs. Most states use only final completion as a milestone toward the end of the project, rather than incorporating a form of substantial completion. Project phases are also used as an intermediate completion date for LDs where the rates reflect significant RUCs. The fourth choice is to vary LD rates based on project types, delivery methods, or construction status. Most states vary rates with contract amount rather than with project types or delivery methods. Construction status is used by some agencies to reduce rates once project status changes (i.e. roadways/ramps are opened to traffic). The fifth choice is combining LDs with I/D contract clauses which is done by 45 of the 53 responding agencies.

Next, the discussion will focus on estimating practices used by state agencies in developing LD rates.

3.5 ESTIMATING PRACTICES

Estimating practices discussed here are those used by agencies in developing their contractually specified LD rates. These practices fall into five distinct areas: estimating process, recoverable costs, estimate details, revision cycle, and auditing.

3.5.1 Estimating Process

First among these is the estimating process itself which includes methodologies, worksheets, design aids, and the responsible SHA department for developing LD rates.

An established method for estimating LDs is crucial in demonstrating that the rates were not developed arbitrarily and do bear a relationship to actual anticipated damages. Lacking an estimating methodology does exactly the opposite, with rates appearing to be arbitrarily selected and without relationship to actual anticipated damages. Forty-two responding agencies (79%) indicated they use an established methodology in estimating LD rates, while 11 (21%) indicated they do not. It is interesting to note that 4 of these agencies that do not have a methodology, belong in a group of 11 SHAs reporting recent litigation on their LDs provision. In 14 of the state agencies (26%) this methodology was incorporated into a worksheet.

The task of undertaking this estimating process is most frequently done by the construction bureau in 32 of the 53 agencies (60%), followed by the engineering design bureau in 13 agencies (25%), while the remaining is spread among a variety of miscellaneous departments. Interestingly, the accounting department is responsible for developing rates in only one state agency, even though it may be expected that the accounting department generally has the most knowledgeable personnel to compile the supporting financial information.

3.5.2 Recoverable Costs

The second area of practice involves the categories of recoverable costs utilized in determining the LD rates. FHWA stipulates that at a minimum the LD rates will include daily construction engineering costs, but may also include other costs as well, such as RUCs. In response to what costs are covered, the majority of SHAs (33) indicate they include only the minimum construction engineering costs, while 20 agencies stipulate that other costs such as RUCs are included in their rates on a project specific basis.

3.5.3 Estimate Detail

The third area of estimating practice is related to the level of detail incorporated into the estimate. In probing this area, the question was asked about how LD rates are placed into the contract specifications. There are essentially two approaches used, a generic rate that is scaled based on total contract amount, or a project specific rate that is placed in the contractual arrangement. Thirty of the states use a table of average costs to set contract rates, while 13 use project specific costs, and 10 indicated they use something else. However, upon closer inspection many of these agencies use a table of average costs. The responses suggest LD rates represent order-of-magnitude estimates of anticipated actual costs more so than project specific costs.

In a similar vein, state agencies were asked if a resource staffing plan was utilized as a basis for developing the estimate. While 10 agencies report that they do use staffing plans in developing rates, 43 of the 53 agencies report they do not.

3.5.4 Revision Cycle

The fourth area of practice is the cycle on which rates are updated. FHWA requires all the agencies to review their non-project specific LD rates, at a minimum, every two years and adjust rates as necessary. One state updates every year, while 6 states indicated they only use project specific LD rates. A significant number of the states, 22 of the 53 responding, update every two years; 1 state updates their rates every year, 11 states update every 3 to 4 years, 8 states update every 5 years, while 3 states indicate they never update. Six states use project specific rates and two states did not respond to this question.

3.5.5 Auditing

The fifth area deals with auditing the estimates. A pre-estimate of incurred damages invites the question of how close did these estimates come to actual costs experienced. The states were asked if they conduct cost analysis or audits on selected projects to see how accurate their pre-estimate of damages comes to actual damages. Forty-one of the reporting agencies indicated that formal reviews and audits are not performed, while 12 states indicated that formal reviews and audits are performed. Many of the reviews are informally performed by internal staff as indicated by clarifying comments to the questions.

3.5.6 Summary of Estimating Practices

Summarizing the discussion within this section, there are five topic areas queried within estimating practices including: estimating process, recoverable costs, estimate details, revision cycle, and auditing. Forty-two states have established a methodology in estimating LD rates and 14 of these states have developed worksheets to reflect these methods. The estimating process is largely left to the construction bureaus to undertake. With respect to recoverable costs, most states agencies include only the construction engineering costs, which is the FHWA minimum. States largely chose to use broad order-of-magnitude rates reflected within specification tables of average costs made specific to a project by the total contract amount. The update cycle for rates is usually biennial, but in some states updates are infrequent. Auditing these pre-estimates against actual project experience is accomplished in only 12 states, often by an informal internal review.

Next, the discussion will review the survey results related to how the contract terms and LD rates are administered during contract performance, followed by considering the legal challenges states have encountered with LD provisions.

3.6 ADMINISTRATIVE PRACTICES AND LEGAL CHALLENGES

Administrative practices reveal how LD provisions and related contract clauses are implemented when project completion extends beyond the contract time. Although these contract provisions are written into the contract to recover late completion damages, it is ultimately the administration of these contract clauses that yield the desired cost recovery results. There are two contract administrative practices that are of interest with respect to LDs. First, is the practice of determining when the contract is in fact, complete. Second, are the practices involved with the administrative assessment and/or reassessment of the LD amounts actually due under the contract.

Along with administratively setting aside LD amounts, courts may be asked to set aside these contractual remedies based on legal challenges as well. Information was collected suggesting just how common these challenges are among SHAs and to what extent, if any, courts have dictated how LD terms are to be crafted into contracts.

3.6.1 Contract Completeness

The first area of administrative practice explored was determining contract completion (e.g. substantial completion), a determination that would stop time on the project. This is important to a contractor because this would be the point in time when LDs would no longer be assessed. Of the 53 responding agencies 42 rely on the resident/project engineer to make that determination, either fully, or in the case of 5 agencies, in

conjunction with the district engineer. Next, in order of frequency, is the district/area engineer where 10 states rely on these individuals to determine completion. Four agencies selected the choice 'other' and their comments indicated they do not use substantial completion, relying instead on the project being either complete or not. One agency did not respond to the question. None of the state agencies indicated that consultants would make that determination of completeness, although one state suggested in their comment that their consultant would if they were in the role of project engineer. These responses reflect the opinion that contract time is a field level contractual determination.

3.6.2 Administrative Actions

The second area involves administrative actions that alter LD amounts that are being withheld under the contracts. A structured question to all SHAs asked how often LD provisions are waived/reduced during or after construction. There were three possible responses: Never, Sometimes, or Often. Only one SHA respondent answered 'Never', while 46 (87%) answered 'Sometimes', and 6 (11%) answered 'Often'.

This question was followed with another inquiring how LDs are waived/reduced. Multiple selections were permitted within the provided responses. The most frequent response was by SHAs granting time extensions with 48 SHAs respondents selected this response. Three agencies selected 'adjusting payment documents during processing'. Five agencies selected 'Other'. Additional comments to this question were offered by 22 respondents which mostly indicated that time extensions are granted based upon the justification of submitted contractor claims requesting additional time on the contract.

A second follow up question asked at what level is the decision to waive LDs made. Two choices were provided to the respondents, either at the 'State Level' (which includes Division/District/Bureaus/etc.) or at the 'Local Level' (which includes Project/Resident/Field/etc). For 40 of the SHA responding, this decision is made at the state level, while 11 responding agencies indicate it is made at the local level. Two agencies didn't respond to the question.

LDs are clearly seen as an element of the contract close-out process. Contractors are seeking extra time on the project in part to avoid the assignment of LDs. From the provided responses, agencies view LDs as part of the bargaining process to resolve outstanding issues at contract close-out. Some agencies found that they can persuade a contractor to finish incomplete work by waiving the LDs charges. In some cases, LDs are no longer a means of reimbursing the state, but are a leveraging tool to coerce the contractor into timely performance.

3.6.3 Legal Challenges

The problem that began this research effort was the increasing legal challenges experienced by ALDOT in regards to their LD provision. The concern was that this was a nationwide problem; however, few states have experienced legal challenges with regard to their LDs provision. Of the responding agencies, 42 report their agency's provision has never been challenged in court. For the 11 that indicated their provision has been challenged, two of these were where local agencies incorporating state provisions into their contracts. Even though the number of legal challenges is low, appearing to be insignificant, this may be an indication of potential future trends associated with an increase in contractors challenging LD rates.

A subsequent question was limited to the 11 respondents that indicated their SHA had experienced legal challenges. The question asked for an indication about the level of actual or pending litigation over the last decade. Three structured responses were provided for selection by the respondents: (1) high level (quantified for the respondents as more that 10 challenges), (2) medium level (between 5 and 10 challenges), and (3) a low level (less than 5). None of the 11 respondents placed their states in the high category; only one selected the medium (which was the state sponsoring this research effort); and the other 10 selected low.

Again limited to those respondents that indicate a challenge, the survey probed whether or not that an agency would pursue actual damages if their provision for LDs were deemed unenforceable. Four of the 11 (36%) indicated their states would seek actual damages, two indicated their state would not, and five admitted they were not sure of the action their states would pursue in this matter.

Finally, the question was asked about legal precedents dictating how LDs were to be assessed. This again was limited to the eleven indicating a past legal challenge. Six answered 'yes' and five respondents answered 'no'.

At this time, legal challenges to the LD provisions in state contracts are not seen as a nationwide problem. Only 11 states have been challenged on their contract provision and even then, ten of these indicate little intensity.

3.6.4 Summary of Administrative Practices and Legal Challenges

In summarizing this section, there are two administrative practices of interests related to LD provisions. First, who judges the project as complete and thereby ends the

assessment of LDs on the contract. As reflected in the responses, contract time is seen as a field level determination owing to the fact that most states rely on their project engineers to assess completion. Second, how regimented is the administration of the LD contract provisions. Responses to the survey tell a story of flexibility in the application of these contract terms. LDs are largely seen by both the agencies and contractors as part of the contract close-out process. From an agency's perspective, these funds sometime become a "bargaining tool" in seeking closure on outstanding issues. Or, from the contractor's perspective contract time is sought from a variety of avenues specifically to make them whole on withheld monies. Legal challenges related to these provisions are rare. Only 11 states have experienced any type of court action over their provisions. Two of these weren't challenged directly; their provisions were challenged when used inappropriately by local agencies. Only one state among the eleven faces what might be considered a medium level of lawsuits on this issue over the last decade.

3.7 SUMMARY AND CONCLUSIONS

The findings reported here are from a comprehensive survey of all SHAs within the US on their LD practices. This survey queried the states on their contractual, rate estimating, and administration practices associated with LDs; along with the level of litigation they are currently experiencing or have experienced in the recent past on their LDs provision.

Contractual practices reflect choices made by SHAs that are implemented into their contracts. Five contractual choices SHAs typically make in relation to their LDs provision include: (1) damages for late completion are recovered through LDs provision in lieu of actual damages; (2) contract time is most frequently measured in work days,

where time is administered in the field; (3) contracts are either fully complete or not, and SHAs do not want to include intermediate stages of completion, such as substantial completion. However, project phases are used by states to set damages when RUCs are part of the rate; (4) LD rates are a function of contract amount, but not of project types or delivery method; and (5) LDs provisions combined with I/D clauses are considered for use by most SHAs but on a project specific basis.

Estimating practices utilized by states fall into five categories: (1) estimating processes follow established methods by most states, although few have developed worksheets to support these methods. The construction bureau most frequently undertakes this process for the SHAs; (2) states typically limit recoverable costs to the minimum required by the FHWA, choosing to recover only construction engineering costs; (3) estimates are developed at the order-of-magnitude scale, infrequently having detailed resource staffing plans to underpin their calculations; (4) LDs rate reviews are generally mandated by the FHWA every two years; however, some states exceed that period; and (5) few states actually audit their estimates in relation to actual project costs.

Administrative practices can be summarized within two general statements: (1) contract completion is most frequently assessed by field personnel; and (2) contract LD provisions are administered with some flexibility. Additionally, legal challenges to the LDs provision are infrequently experienced by SHAs.

Six conclusions may be drawn from these findings and are as follows:

1. LD provisions are the universal choice for SHAs to use in recovering their additional costs for contractor delayed completions.

2. Contractual terms are selected by states so that LD provisions are essentially administered at field level within state organizations.

3. LD rate estimates are developed at an order-of-magnitude detail. Little effort seems to be expended in providing a detailed, comprehensive assessment of the costs that are likely to be incurred on projects that overrun completion times stipulated in the contract.

4. LD rates specified by state agencies tend to be low, covering only the minimum category of costs. This provides the contractor with an unreasonably low estimate to factor in when facing a potential delayed completion. This may be why few states have their provisions challenged in court.

5. Administrative practices reflect a higher priority in closing out projects, than collecting LDs.

6. Legal challenges to these LD provisions are infrequent.

Using these conclusions, the formation of a standard methodology to compute LDs was initiated. The first step was to obtain historical project data from ALDOT. The next chapter discusses this process as well as how the data was organized and evaluated to determine proper LD rates to be used by ALDOT.

CHAPTER FOUR

DATA COLLECTION AND ANALYSIS

4.1 INTRODUCTION

The primary goal of this research effort was to develop an objective methodology for ALDOT to use when reviewing LD rates and updating when deemed necessary using historical project data. Two methodologies were identified for further investigation including: (1) a traditional LDs provision based on FHWA guidelines with the rates stipulated in a table as a function of the contract value, and (2) a more complex table in which the LDs rates are categorized by contract value as well as by project type (i.e. bridge, road, building, etc.). The first step in developing the methodologies was to acquire historical project data from ALDOT. Using this dataset, it would be possible to determine the daily costs incurred on a project based on the contract size and project type. Since the LD rates are meant to be pre-estimates of a typical project, an outlier analysis had to be conducted to purge the project data of atypical projects.

4.2 DETERMINATION OF REQUISITE DATA

LD rates are a pre-estimation of the daily costs to administer a project. The most effective way to estimate the daily administrative costs on a project is to base the amounts on actual costs incurred from past projects. In ALDOT's case, the daily administrative costs are represented as engineering and inspection (E&I) costs. ALDOT's recordkeeping system records E&I costs as the actual administrative costs incurred as a result of a specific job. This value may be composed of the salaries of employees working on the job, the fringe benefits associated with the employees, the

employees' vehicles, materials testing, office supplies, etc. E&I costs are not an estimated value, but represent actual expenses incurred from administrating a particular project. Since the E&I costs are actual costs incurred on a project, it was important to use the actual days used to complete a project and not the number of days specified in the contract. It is not uncommon for a project to be completed in a different number of days than what is specified in the contract. Therefore, if the days specified in the contract were used to calculate daily E&I values, the rate would frequently be different than the daily costs associated with actual days used.

ALDOT uses two methods of specifying a project's length in contracts: (1) calendar day/date and (2) work day. For a calendar day project, each day that passes on a calendar is deducted from the allotted time specified in the contract. So, whether or not work is accomplished on a project during a day, the day is expended and counted against the contract.

Work day projects are charged days against the contract at the discretion of a field representative working for the SHA. ALDOT's Standard Specifications define a work day as, "Any Calendar Day from midnight to midnight, exclusive of Saturdays and Legal Holidays, on which the Contractor could proceed with construction operations for a period of six hours or more with the normal working forces engaged in performing work on the controlling item or items of work" (ALDOT, 2006). So, for instance, if inclement weather prevents a contractor from completing six hours of work in a day, the project will not lose any of the days specified in the contract to complete the work. On the other hand, if it is determined that the contractor could have worked for six hours but doesn't, the day will still be charged.

Due to the different methods for charging time to projects, contracts using calendar days tend to allot a higher number of days to complete the project than a workday project of equal stature. On the backside of a project, this results in a different number of recorded days used to complete a project. Since the days used is a major factor in calculating the daily E&I costs on a project, the contract time is an important aspect to consider when calculating LDs. The projects must be separated into their respective contract time categories, otherwise, the daily E&I costs would be skewed due to the different number of days used. For instance, calendar day projects have lower daily E&I costs than work day projects. This does not mean that calendar day projects are administered more efficiently, just that the total E&I cost for the project are spread over an additional number of days than work day projects.

Therefore, when specifying LD rates it is important to specify them for calendar day and work day projects separately. Therefore, it was important to obtain the contract time and days used on each project during the collection of historical project data.

In addition to the abovementioned data requirements, the original contract values and project type designations were required to categorize LD rates by type of project. The first methodology to be developed by this research effort consists of a schedule of LDs categorized by contract value. This is the most prominent method used by the SHAs across the country, and is the method currently used by ALDOT. The second methodology specifies LDs by both contract size and project type.

4.3 COLLECTION OF DATA

The required project data was downloaded from ALDOT's Mainframe Construction Status file. This database outputs a single mainframe file using the VSAM file format (a record key file that is a precursor to database files). The historical data was comprised of all projects with a completion date occurring in 2003, 2004, and 2005, totaling 856 projects. The projects were composed of 726 work day projects and 130 calendar day/date projects. The data were obtained in a space delimited text file that was imported into a spreadsheet program. Each project listing consisted of, among other things, the original contract amount, days used to complete the project, total E&I amount for the project, a Comprehensive Project Management System (CPMS) project number, and a contract size designation. The contract size designation was a number from 1 to 8 which grouped the projects by the original contract amount based on ALDOT's current LDs provision. The breakdown of the contract size values is shown in Table 4.1 below.

Table 4.1 Contract Values for Each Contract Size Group

Group	Contract Amount	
	From	To and Including
1	$0	$100,000
2	$100,000	$200,000
3	$200,000	$500,000
4	$500,000	$1,000,000
5	$1,000,000	$2,000,000
6	$2,000,000	$5,000,000
7	$5,000,000	$10,000,000
8	$10,000,000	----------

It should be noted that the data obtained from the Mainframe Construction Status file by ALDOT lacked a project type description. This occurred because the project type description for each project is stored in a separate file system. Therefore, ALDOT

accessed another system and developed a file which was composed of selected columns from their preconstruction and letting system. This system is based on TRNSPORT which is a suite of software owned by the American Association of State Highway and Transportation Officials (AASHTO) who allows its member states to license the software.

4.4 ANALYSIS OF COLLECTED DATA

4.4.1 Organization of Data

Once the historical data had been obtained from ALDOT and imported into a spreadsheet program, it was organized for analysis. The 856 projects were first divided into their respective contract time groups. This resulted in 726 (84.9%) work day projects on one worksheet and 130 (15.1%) calendar day/date projects on another. Calendar day/date projects were excluded from further analysis due to their small sample size once subdivided into contract value ranges.

For the second methodology developed in this research, the project type designation was required for each of the project listings. Since the project type designation was obtained from a separate database system than the rest of the project data, the two files had to be linked together. To do this the two files were imported into Microsoft Access where they were linked together using the CPMS project number. This number is a 9 digit project number that is assigned to each project in ALDOT's CPMS. The project type designations given by the TRNSPORT software are only three letter abbreviations. A third file containing a key to the full name of each project type designation was created and linked to the project type abbreviations. Once linked, the three files were queried to

produce a single file containing the complete project data including the project type designation. Since the TRNSPORT software containing project type designations has only been implemented in the past few years, not all the projects contained a project type designation. For analysis purposes, the projects lacking a project type description were categorized manually as "unclassified".

4.4.2 Determination of Daily E&I Amounts

The daily E&I costs for each of the past projects collected were computed using the equation 4.1.

$$DailyE\&I = \frac{E\&Icosts}{\#ofDaysUsed} \tag{4.1}$$

According to equation 4.1, the data needed to compute the daily E&I costs for each project are the: (1) E&I costs associated with the project and (2) days used to complete the project. These calculated values were the basis for the determination of LDs.

4.4.3 Elimination of Outliers

Since the schedule of LD rates developed from this research will be utilized to determine an appropriate rate for a typical project, the historical project data used for the rate calculation needed to be composed of only typical projects. Therefore, all abnormal and atypical projects needed to be removed from the data pool. However, in order to create a method for determining LD rates that was statistically justifiable, each step in the process had to be entirely objective. As a result, the tedious process of evaluating each project individually to determine whether it was a typical or atypical project would not only be inefficient, but it would be invalid, as well. Instead, a statistical method was used to

evaluate the data and determine the outliers, or projects which are significantly different from the others. Because the outlier analysis was blind to the specifics of each project and focused only on its relationship to the other projects, it would not only determine atypical projects, but also projects that may have been keyed into the system incorrectly.

As mentioned earlier, the daily E&I values of the historical project data were used as a basis for the calculation of the LD rates. Since daily E&I is a calculated value composed of a project's total E&I costs and the total number of days used to complete the project, it was important to evaluate outliers in the data using the total E&I values and total days used, independently. If, instead, the calculated daily E&I values were used for analysis, then projects which would have been considered outliers according only to their total E&I costs, may be skewed back into the majority of the projects due to the days used for the project, and vice versa. For instance, take a project which has an extraordinarily large total E&I costs. This may be a specialty project which required a lot of administrative personnel. Due to its atypically high E&I costs, it should be considered an outlier. But, when the number of days used, which may be consistent with projects of similar contract value, are applied as in equation 4.1, the daily E&I value resulting may not be abnormal enough for the project to be labeled an outlier. On the other hand, conducting an outlier analysis based on daily E&I costs as a parameter for outlier analysis could incorrectly identify typical projects as atypical and eliminate them from the dataset.

In order to conduct the outlier analysis, the total E&I costs as well as the total days used were adjusted using the project's contract value. Since both the E&I costs and days used on a project increase as the contract value increases, the values had to be made relative to each other by applying their respective contract values. As a result, E&I costs were

transformed into E&I as a percentage of contract value as shown in equation 4.2. Using this equation, projects which had an atypical amount of E&I costs in relation the general population of projects could be identified.

$$\%EI = \frac{E\&I}{CV} \tag{4.2}$$

where,

$\%EI$ = E&I as a percent of contract value (%),

$E\&I$ = total E&I for the project ($), and

CV = Original contract amount ($).

The number of days used to complete a project was evaluated by converting days used to dollars placed per day, as seen in equation 4.3. This parameter compared the days used to complete a project to the total contract value of that project. As a result, projects with an abnormal amount of days used could be identified as outliers.

$$\$/day = \frac{CV}{d} \tag{4.3}$$

where,

$\$/day$ = dollars placed per day ($/day),

d = total number of days used for a project (days), and

CV = original contract amount ($).

By evaluating the projects according to these two parameters, the projects can be analyzed according to how typical they are regardless of their contract size. For all the work day projects the average percent E&I was found to be 10.25% and the average dollars placed per day was $15,785.

For the projects to be analyzed to identify outliers, a normal distribution was required. In statistics, a normal distribution is a probability distribution in which the highest frequency of data is concentrated at the mean and it decreases as the distance from the mean increases. It is most commonly characterized by a bell-shaped curve on a histogram. Since the parameters being evaluated (i.e. E&I as a percentage of contract value and dollars placed per day) have an absolute minimum of zero, they produce a log-normal distribution, which was verified using a chi-squared test. In a log-normal distribution the bell-curve is skewed to one side; in our case, it was skewed to the left. The data was made normal by performing a logarithmic transformation on the parameters. In other words, this involves taking the *log* of the percent E&I and dollars placed per day for each project.

Once the data had been transformed into a normal distribution, it was evaluated to determine atypical projects. This was done using a 95% confidence interval which was represented by two standard deviations from either side of the mean. Using the 95% confidence interval makes the assumption that 95% of ALDOT's projects are considered "typical" projects, while the other 5% are either atypical or recording errors. The 95% confidence interval was used because it is a standard acceptable statistical practice. It was confirmed to be a valid measure after conducting a sensitivity analysis. In the sensitivity analysis, the effect of more or less standard deviations on the relationship between the average and median values of each parameter were evaluated. The sensitivity analysis for both percent E&I and dollars placed per day are illustrated in Figure 4.1 and Figure 4.2, respectively.

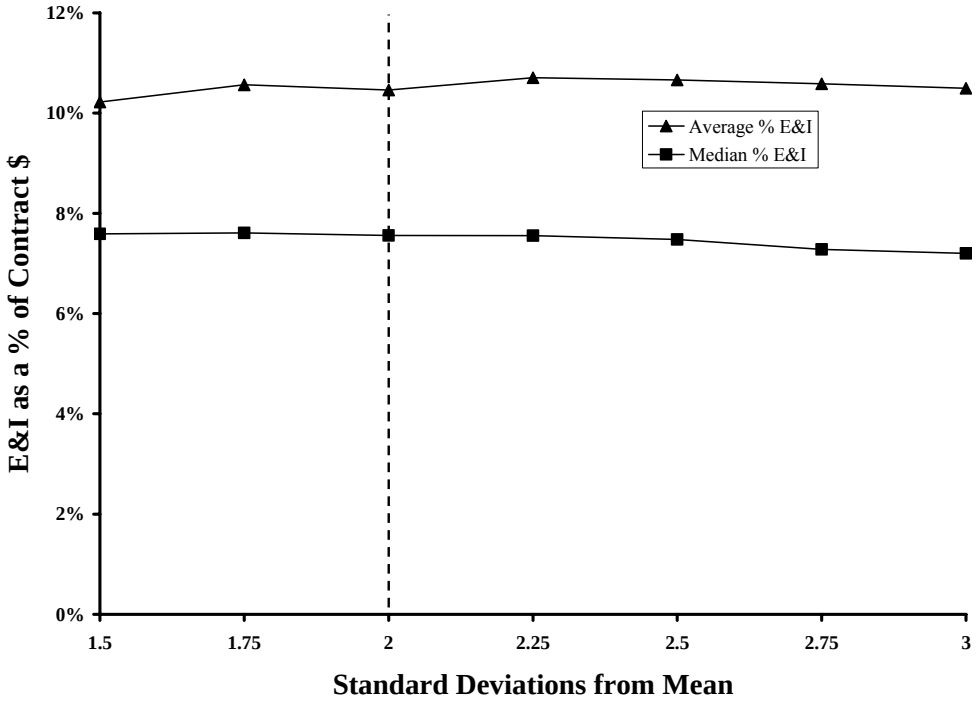

Figure 4.1 Sensitivity Analysis of E&I as a Percent of Contract Value.

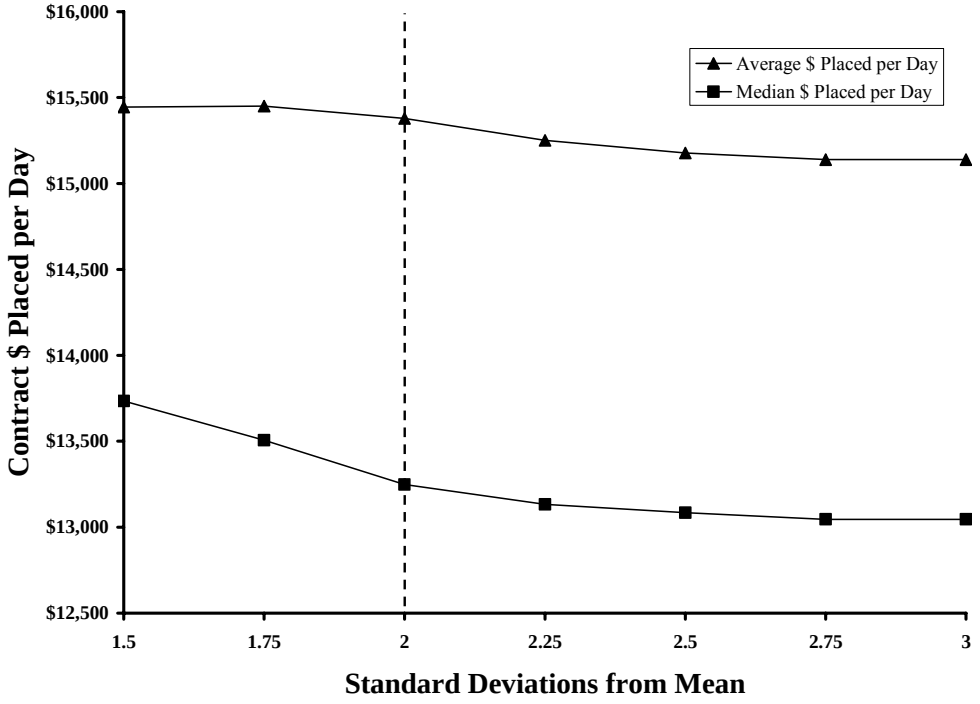

Figure 4.2 Sensitivity Analysis of Contract Dollars Placed per Day.

To conduct the sensitivity analysis, all the work day projects contained within each standard deviation from 1.5 to 3 are used to calculate the average and median values. Then, the two values are graphed to analyze the relationship. From the figures, it is evident that ±2 standard deviations was an acceptable limit since only minor differences between the averages and medians were observed when any value beyond ±2 standard deviations from the mean were utilized. Therefore, all work day projects, in which the E&I as a percent of contract value and/or the dollars placed per day values were more than ±2 standard deviations from the mean, were removed from the pool of projects and the remainder was used for analysis.

4.4.4 Remaining Data

The outlier analysis identified 36 (5.0%) atypical work day projects according to their E&I costs as a percentage of contract value, 24 (3.3%) work day projects according to the dollars placed per day, and 1 work day project which was an outlier under both parameters. The 61 work day projects identified as outliers represent 8.4% of the data. This closely resembles the expected percentage of outliers of 5% resulting from the ±2 standard deviation criteria. This resulted in 665 remaining work day projects to be used for the calculation of LDs. The complete set of data used for this research, with outliers, can be found in Appendix D.

Figure 4.3 illustrates the outliers that were identified using ±2 standard deviations from the average E&I as a percent of contract value (squares). The dashed lines represent the upper and lower limits determined by ±2 standard deviations from the mean.

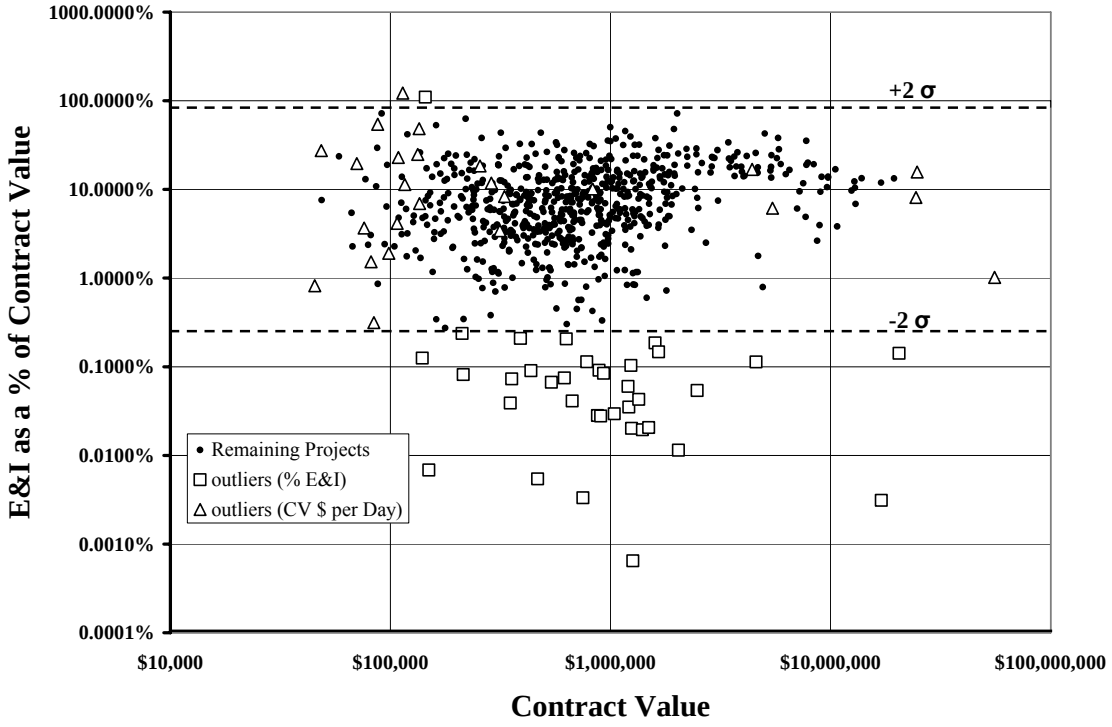

Figure 4.3 Results of Outlier Analysis by E&I as a Percent of Contract Value.

From Figure 4.3 it can be seen that the vast majority of the outlying projects according to E&I as a percentage of contract value lie below the lower limit. These outliers represent projects which had abnormally low E&I costs in relation to their contract value.

Figure 4.4 shows the same data as Figure 4.3 except the y-axis has been changed to dollars placed per day to show the ±2 standard deviation limiting criteria. The outliers identified using dollars placed per day (triangles) are more evenly distributed above and below the limiting criteria, however, the majority are still located below the lower limit. These "low" projects are characterized as projects which had an abnormally high amount of days used in relation to the contract amount.

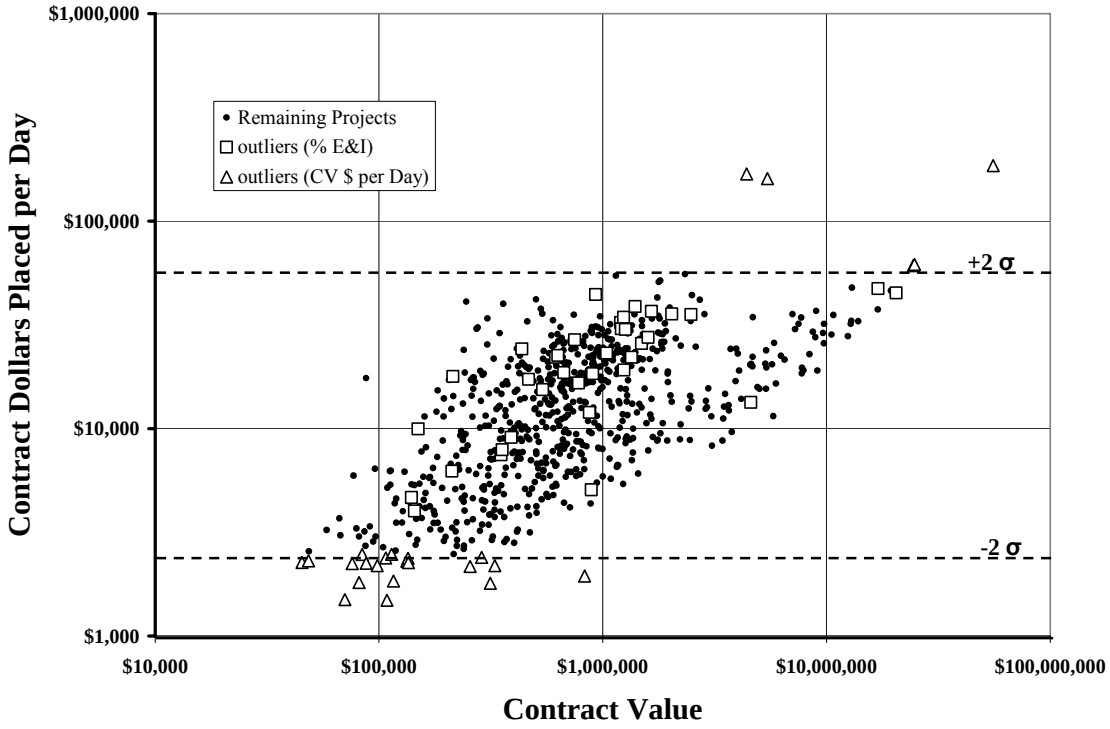

Figure 4.4 Results of Outlier Analysis by Dollars Placed per Day.

Figure 4.3 and Figure 4.4 show the limiting criteria, individually, for projects which were eliminated using E&I as a percentage of contract value and the dollars placed per day. When viewing these charts, many projects which are outliers according to the parameter not represented on the y-axis seem to lie within the acceptable bounds. This is because according to that parameter they are acceptable. By changing the axes of the graph to be dollars placed per day versus E&I as a percent of contract value, the outlying projects according to both parameters are clearly defined. Figure 4.5 shows this relationship with the limiting criteria represented by dotted lines. From this view, there is no confusion as to which projects are outliers and which are not, since the axes represent both of the evaluated parameters.

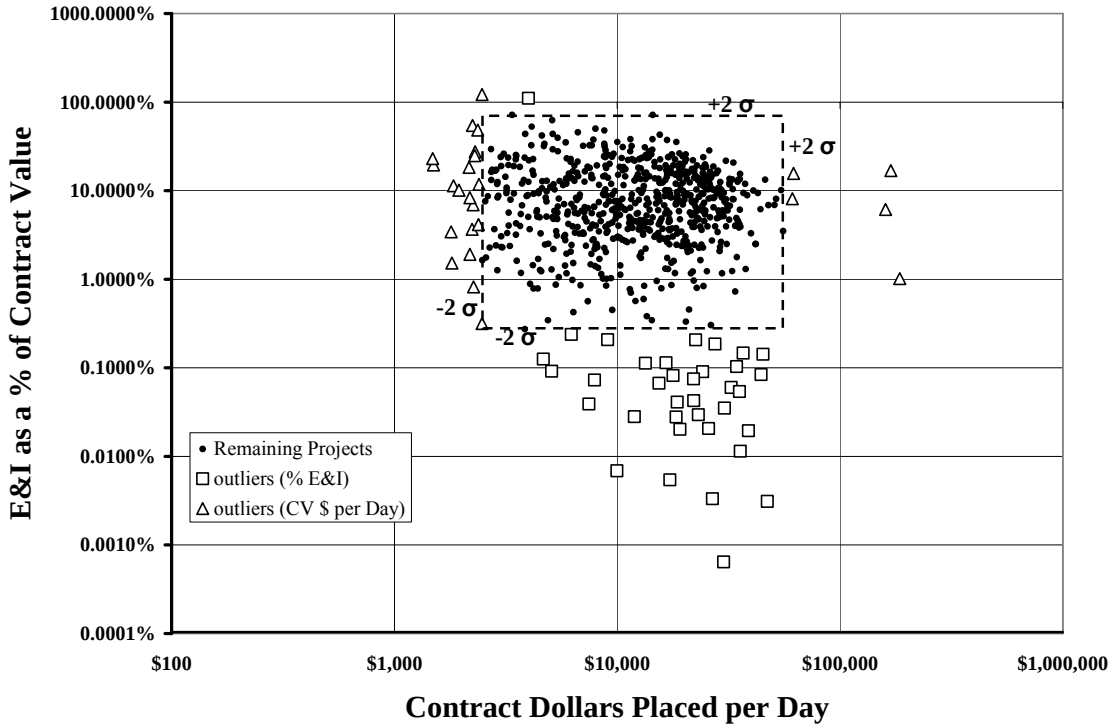

Figure 4.5 Outliers Identified by Analysis by E&I as a Percent of Contract Value vs. Dollars per Day.

Lastly, the daily E&I values were plotted as a function of the contract value in Figure 4.6. Since the daily E&I value are representative of potential LDs, it is important to look at the distribution of projects which will be used and which were identified as outliers. It is interesting to note that some of the outlying projects fall among the distribution of typical projects. This proves the theory, mentioned earlier, that using the daily E&I values for outlier analysis would not accurately identify all the atypical projects.

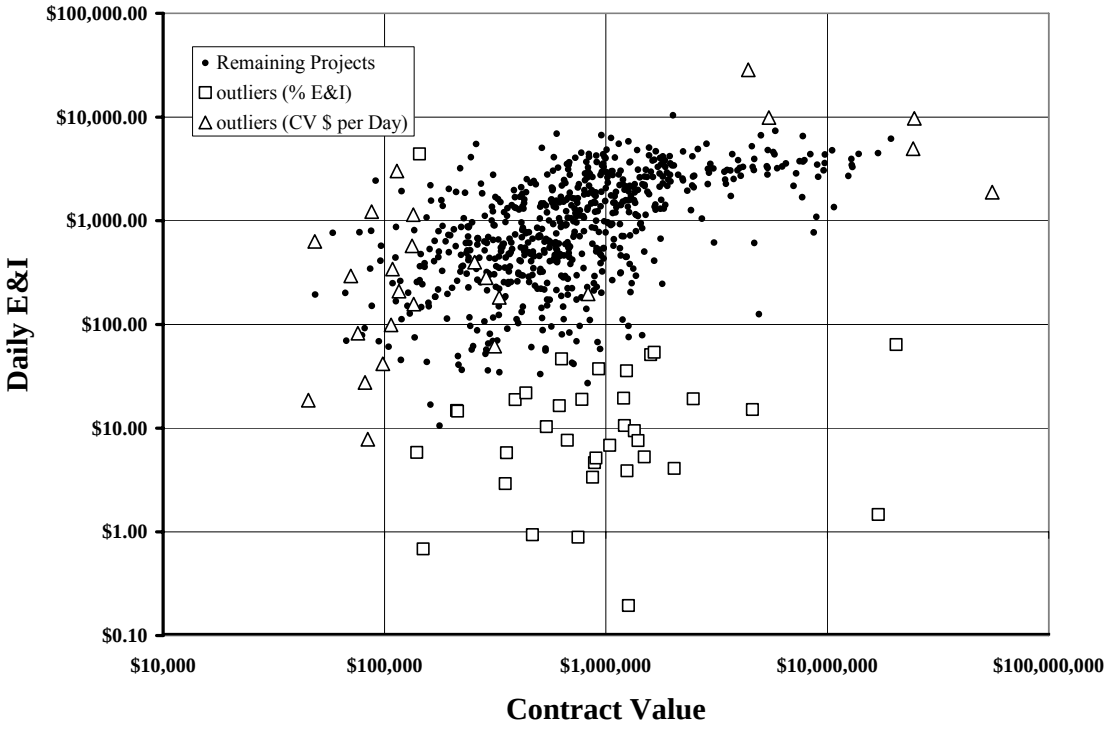

Figure 4.6 Outliers Plotted as Daily E&I.

Upon removal of the outliers by the statistical technique described in this chapter, the development of the methodologies for determining LD rates could commence. Chapter 5 outlines the current procedure used by ALDOT to update their own rates, as well as two new methodologies developed under this research. Comparisons between the current and proposed procedures are conducted in order to identify an acceptable biennial review procedure to be adopted by ALDOT.

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CHAPTER FIVE

METHODOLOGY DEVELOPMENT AND GUIDELINES

5.1 INTRODUCTION

This research effort sought to develop two methodologies for calculating a schedule of LD rates that would be statistically justifiable and hold up to the scrutiny of the courts. The first calculates LDs and presents them in a table as a function of contract value. The second methodology uses the same data set and follows the same basic steps, yet it presents them, not only as a function of contract size, but also as a function of project type.

The methodologies developed from this research are based, in their most basic form, on the guidelines set forth by the FHWA in 23 CFR 635.127. These guidelines stipulate that each SHA must, "develop and maintain their own LD rates that will cover, as a minimum, the SHA's average daily construction engineering costs attributable to a contract overrun" (23 CFR 635.127). It provides minimal direction as how a SHA is to calculate LDs, but does indicate that each SHA must review their LD rates at a minimum of every two years and update them if necessary. Due to: (1) an influx in litigation experienced by ALDOT, (2) a review of pertinent literature on the subject, and (3) a survey of all SHAs' LD provisions, it has become apparent that a LDs clause used in construction contracts must be robust, objective, statistically justifiable, and solid in the eye of the court. As a result, this research effort has produced two methods for the determination of LD rates for use by ALDOT.

5.2 ALDOT'S CURRENT METHOD

For comparison purposes, the current procedure used by ALDOT to calculate LD rates is described in this section. This description is not meant to scrutinize the current method used, but to compare it to the methodologies developed in this research.

In December of 2006, ALDOT released an update to the LD rates they had been using for over a decade. The previous rates were established in 1988 and reviewed in 1990, but were developed the same way as the recent update. This update, was meant to estimate current daily construction engineering costs more accurately and be used as an interim provision until results of this project were completed.

The method used by ALDOT to determine its current LD rates is as follows:

Step One: Collection and Organization of Data

The historical project data used by ALDOT for the estimation of future daily construction engineering costs consisted of three previous years (2003, 2004, 2005) of project data collected from the ALDOT Mainframe Construction Status File that includes: (1) contract value, (2) contract type (i.e. work day or calendar day/date), (3) E&I costs, and (4) the number of days used to complete the project. For the recent update, this project data was composed of all projects with a completion date in 2003 through 2005. With the data in-hand, all the calendar day/date projects were removed from the data set and only work day projects were considered for further analysis because, the total number of work day projects far outweighed the number of calendar day/date projects. ALDOT did not perform any sort of outlier elimination on the historical project data because they

could not justify the elimination of particular projects. All the work day projects were organized by contract size by arranging them into the groups shown in Table 5.1.

Table 5.1 Contract Values for Each Contract Size Group

Group	Contract Amount	
	From	To and Including
1	$0	$100,000
2	$100,000	$200,000
3	$200,000	$500,000
4	$500,000	$1,000,000
5	$1,000,000	$2,000,000
6	$2,000,000	$5,000,000
7	$5,000,000	$10,000,000
8	$10,000,000	--------

Step Two: Calculation of Work Day LD Rates

The overall daily E&I costs for each contract size grouping were calculated by dividing the *total* E&I costs for that group by the *total* number of days used in that group.

$$DailyE\&I_i = \frac{\sum_{j=1}^{n} E\&Icosts_{ij}}{\sum_{j=1}^{n} \#ofDaysUsed_{ij}} \tag{5.1}$$

where,

$DailyE\&I_i$ = daily E&I cost for all projects in group *i*,

$E\&Icosts_{ij}$ = E&I costs for project *j* in group *i*, and

$\#ofDaysUsed_i$ = number of days used project *j* in group *i*.

At this point, the calculated daily E&I costs for each group can be seen in Table 5.2 below. Using engineering judgment, contract size groups which had similar daily E&I values (e.g. groups 1, 2, and 3) were combined into a single group and LD rates were determined based on the findings in Table 5.2.

Table 5.2 Overall Daily E&I Values for Each Contract Size Group

Group	Daily E&I
1	$488.31
2	$613.76
3	$571.94
4	$1,023.23
5	$1,955.77
6	$3,096.29
7	$3,742.44
8	$3,657.13

Step Three: Calculation of Calendar Day LD Rates

With the work day LD rates determined, the focus turned to calculating the calendar day/date rates. Since the number of calendar day projects was limited, a statistical analysis, similar to the one performed on work days, would not be feasible. Instead, historical rainfall data was examined to determine the number of work days for each calendar month. In this procedure, experienced ALDOT engineers calculated the number of possible work days for each month based on historical project data back in 2003. This work was not a part of the research effort documented in this report. First, all Saturdays, Sundays, and Legal Holidays were excluded. Then, by examining the amount of rainfall each day, the engineers, using past on-site experience, determined if that day would be a feasible workday based on the amount of rainfall experienced. If so, it was counted. This process was carried out for each month and for four geographic regions in Alabama. The regions were: North Alabama (Divisions 1 & 2), Central Alabama (Divisions 3, 4, & 5), Southeast Alabama (Divisions 6 & 7), and Southwest Alabama (Divisions 8 & 9). Figure 5.1 provides an illustration of the aforementioned ALDOT divisions.

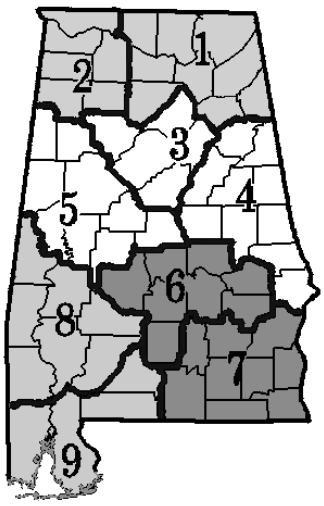

Figure 5.1 Map of ALDOT Divisions.

In each region, multiple sites were used to determine the feasibility of working on any given day. Overall, a statewide average number of work days per calendar year was determined to be 189. This is equivalent to 52% of the year which was rounded to an even two to one ratio. The data used to determine this ratio is shown in Table 5.3.

Table 5.3 Table of the Average Available Workdays

Average Available Workdays					
Month	**Division**				**Statewide Average**
	1 & 2	**3, 4 & 5**	**6 & 7**	**8 & 9**	
January	11	12	15	16	13.5
February	10	12	15	15	13.0
March	15	16	16	16	15.8
April	16	17	17	18	17.0
May	16	17	18	19	17.5
June	15	15	15	15	15.0
July	16	16	15	16	15.8
August	18	17	18	17	17.5
September	16	16	16	17	16.3
October	18	19	19	19	18.8
November	16	16	16	16	16.0
December	10	13	15	14	13.0
Total:	177	186	195	198	189.0
% of 365	48%	51%	53%	54%	**52%**

The averages shown in Table 5.3 compared well with a similar study conducted by ALDOT practitioners in 1989. Since calendar days occur twice as often as actual workable days, the calendar LD rates can be computed as 50% of the work day rates. The resulting LD rates, for both work days and calendar days from the outlined procedure are presented in Table 5.4. These rates were included in contracts with a December 2006 letting.

Table 5.4 Table of LD Rates Calculated by ALDOT

Contract Value		LD rates	
From	**To & Including**	**Work Day**	**Calendar Day/Date**
$0	$500,000	$500	$250
$500,000	$1,000,000	$1,000	$500
$1,000,000	$2,000,000	$1,800	$900
$2,000,000	$5,000,000	$2,600	$1,300
$5,000,000	$10,000,000	$3,200	$1,600
$10,000,000	----------	$3,600	$1,800

These results are also presented in a graphical context in Figure 5.2. In this chart, the distribution of projects, as well as the contract size categories are depicted.

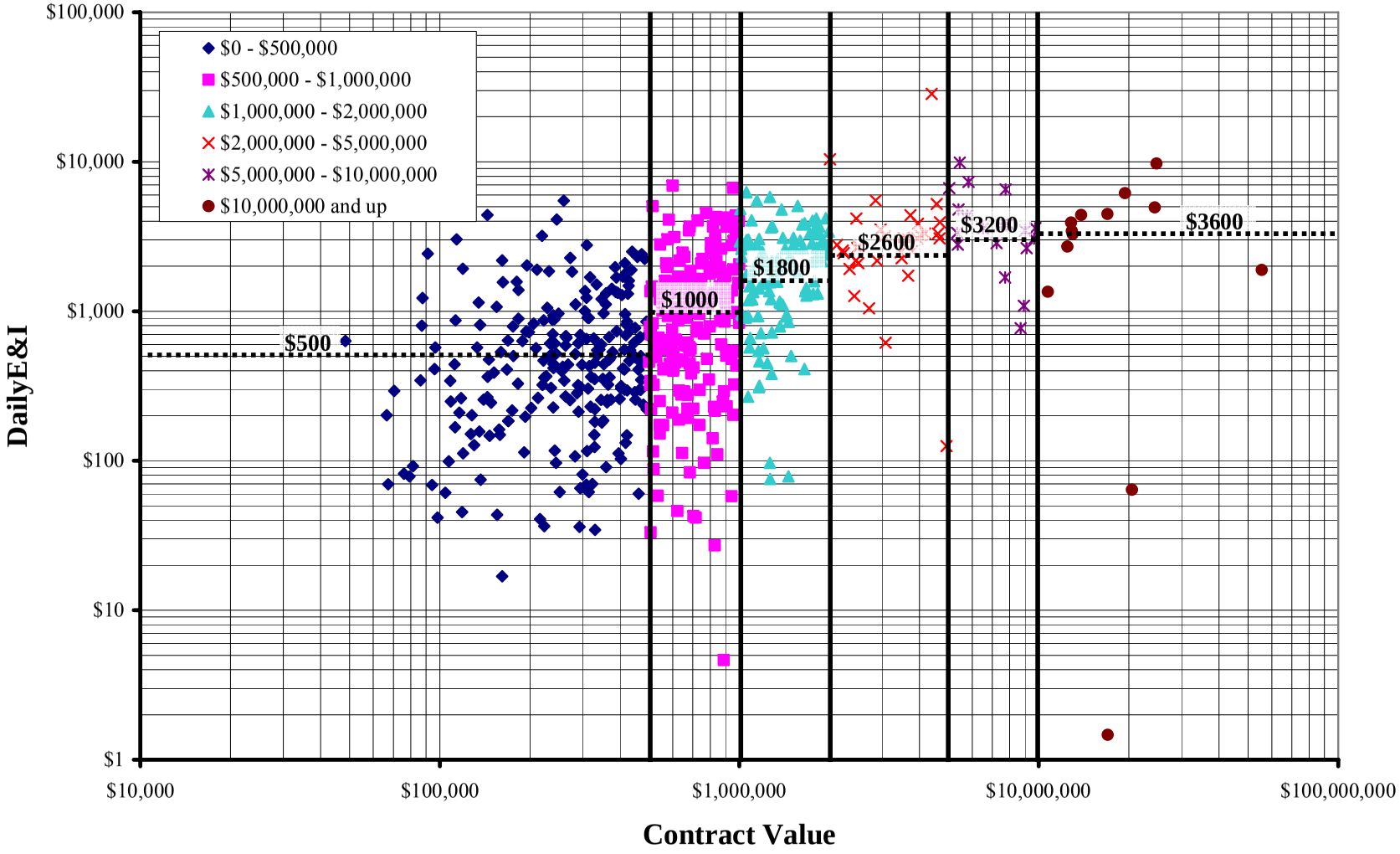

Figure 5.2 Distribution of LD Rates using ALDOT's Method.

5.3 PROPOSED CONTRACT VALUE METHODOLOGY

The first methodology proposed by this research effort calculates LD rates and presents them in the traditional table by contract size. This method is meant to be statistically justifiable and defendable in court. The process used to determine the LD rates for this first methodology is as follows:

Step One: Collection and Organization of Data

The acquisition and modification of the historical project data used for this methodology is described in detail in Chapter 4. This process consisted of collecting three previous years (2003 to 2005) of project data from the ALDOT Mainframe Construction Status File comprised of: (1) contract value, (2) contract type (i.e. work day or calendar day/date), (3) E&I costs, and (4) the number of days used to complete each project. It also involved the removal of all calendar day projects, and an outlier analysis which identified and removed all atypical work day projects. For this methodology, the collection and linking of the project type designation was not necessary. The outlier analysis in Chapter 4 resulted in 665 work day projects that were used for the calculation of LD rates by this methodology.

Step Two: Calculation of Daily E&I Values

The first step in calculating the LD rates was to determine the daily E&I costs for each *individual* project. The daily E&I costs were calculated using equation 5.2.

$$DailyE\&I = \frac{E\&Icosts}{\#ofDaysUsed} \tag{5.2}$$

where,

$DailyE\&I$ = Daily E&I costs of each project,

E&I costs = Total E&I costs for each project, and

#ofDaysUsed = Total number of days used to complete each project.

Step Three: Determination of Contract Size Groups

Once the daily E&I values for each project had been calculated, a statistical procedure to determine which contract size groups were statistically different from the others had to be performed. This is important because if there is a statistically significant variance in the averages for different sized projects, then each contract group should have separate averages. On the other hand, if there are not statistically significant variances between the groups then they should be combined into one group.

To test for these variances in the populations it was important to know if the data follows a normal distribution. This will determine the type of test that can be used to ascertain if there are any statistically significant differences. If the dataset is normally distributed, then the one way analysis of variance (ANOVA) test can be performed. If the dataset is not normally distributed then other non-parametric tests can be conducted such as the Kruskal-Wallis (K-W) test.

Parametric refers to a statistical method that makes assumptions about the distribution of the population (Navidi, 2006). The ANOVA test is a parametric statistical test because it assumes that the dataset follows the normal distribution, and the K-W test is non-parametric statistical technique because it makes no assumptions about the distribution of the data being tested. The K-W test is a more complicated procedure, but it offers more flexibility, in that, a data set does not have to be normally distributed, although it can be.

Since the data used were not normally distributed and future data sets may or may not be normally distributed, the test for variance needed to be non-parametric. Therefore, the K-W test was used.

The K-W test does not assume that the data follows the normal distribution; instead, it rank orders the data. This is done by ranking all the data from the groups together from 1 to *N*. The K-W test determines the test statistic *K* using equation 5.3.

$$K = \frac{12\sum_{i=1}^{g} n_i \left(\frac{\sum_{j=1}^{n_g} \overline{r_{ij}}}{n_i} - \bar{r} \right)^2}{N(N+1)} \tag{5.3}$$

where,

K = test statistic,

n_g = number of observations in group g,

$\overline{r_{ij}}$ = is the rank (among all observations) of observation i from group g,

$\overline{\boldsymbol{r}}$ = average rank of all the observations, equal to (N+1)/2, and

N = total number of observations across all groups.

Once the K was determined, a p-value was approximated using equation 5.4.

$$\Pr\left(\chi^2_{g-1} \geq K\right) \tag{5.4}$$

where,

K = test statistic (probability distribution) and

χ^2_{g-1} = chi-squared distribution.

The probability distribution of the outcome should approximately follow that of the chi-square distribution, with greater variances occurring between groups with *N* less than 5. The null hypothesis used for this test is that there is no difference in the groups, and the alternative hypothesis is that there is at least one difference in the groups. Similar to an ANOVA test, the difference is not indicated, only that there is some variance between the two groups (Wikipedia, 2007). For this reason, each group was tested against all the other groups individually using the K-W test. To expedite the iterations required to evaluate the data, MINITAB™ statistical software was used for the K-W tests. The p-value used to test for significance during the tests was 0.05. This means that when the outcome of the K-W test was less than 0.05, for two groups being tested, the groups were determined to be significantly different from each other. A p-value of 0.05 was chosen because it is a typical value used that balances the chances of a Type I error with those of a Type II error. With the 0.05 indicating that there is at most a 5% chance that the data has random variance that causes it to have a Type II error (Navidi, 2006). A Type I error rejects the null hypothesis when it is true (indicating that there is no difference in the two groups when one actually exists), while a Type II error fails to reject the null hypothesis when it is false (indicating that there is a difference when one does not actually exist) (Navidi, 2006). If the p-value for the groups was 0.05 or greater than the groups were statistically similar and were combined into a single group. For example, if the contract size groups 1 and 2 are being compared to each other, all the daily E&I values of 1 and 2 are ranked from smallest to largest in one group. If any of the daily E&I values are the

same, then the ranks the data points would have received are averaged and the like-values are all given the averaged rank. The test then computes the median of the ranks corresponding to each contract size group. It then compares the medians of each group to determine if there is a statistically significant difference between two groups.

The K-W test was performed on each group against all other groups to determine the new contract size groups. This resulted in combining groups 1 and 2 together as well as combining groups 7 and 8 together.

Once the contract size groups had been determined, the average daily E&I for each group was calculated using equation 5.5.

$$AvgDailyE\&I_i = \frac{\sum_{j=1}^{n} DailyE\&I_{ij}}{n_i} \tag{5.5}$$

where,

$AvgDailyE\&I_i$ = average daily E&I costs for all projects in group i,

$DailyE\&I_{ij}$ = daily E&I costs for project j in group i, and

n_i = total number of projects in group i.

The LD rates were calculated by rounding the average daily E&I for each group to the nearest $100. The contract size groupings along with the average calculated daily E&I values and LD rates for each grouping are shown in Table 5.5.

Table 5.5 Contract Groups and LD Rates

Contract Value		Average Daily E&I	Work Day LD Rate
From	To & Including		
$0	$200,000	$518.23	$500
$200,000	$500,000	$728.94	$700
$500,000	$1,000,000	$1,283.73	$1,300
$1,000,000	$2,000,000	$2,027.23	$2,000
$2,000,000	$5,000,000	$3,055.27	$3,100
$5,000,000	---------	$3,704.43	$3,700

Step Four: Calculation of Calendar Day/Date LD Rates

With the work day LD rates determined, calculation of calendar day rates could proceed. The same procedure used by ALDOT to determine calendar day/date rates was used for this first procedure. The resulting LD rates, for both work day and calendar day/date project as calculated by this methodology are presented in Table 5.6 and in a graphical context in Figure 5.3.

Table 5.6 Overall Daily E&I Values for Each Contract Size Group

Contract Value		LD rates	
From	To & Including	Work Day	Calendar Day/Date
$0	$200,000	$500	$250
$200,000	$500,000	$700	$350
$500,000	$1,000,000	$1,300	$650
$1,000,000	$2,000,000	$2,000	$1,000
$2,000,000	$5,000,000	$3,100	$1,550
$5,000,000	----------	$3,700	$1,850

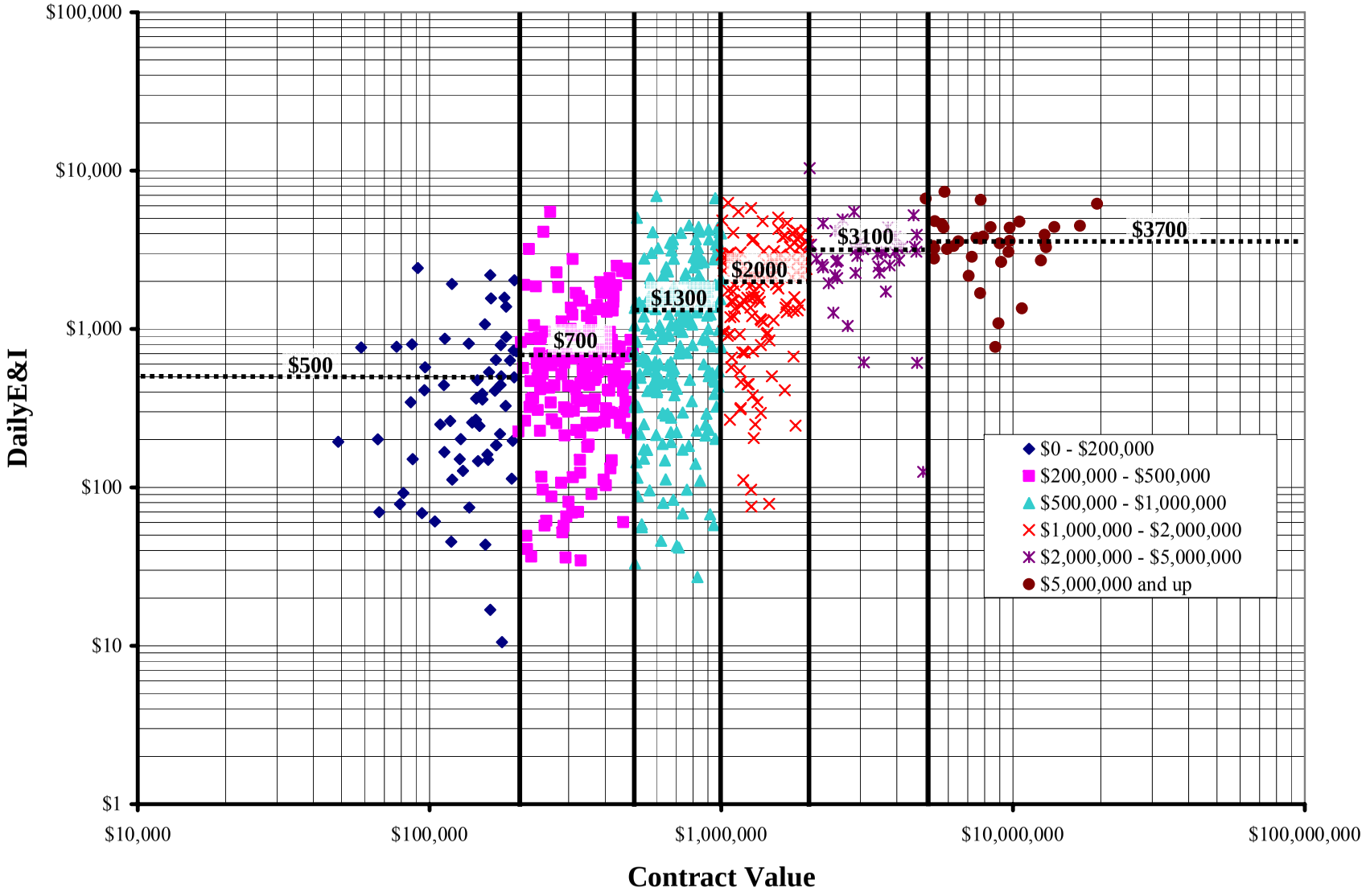

Figure 5.3 Distribution of LD Rates based on Contract Value Method.

5.4 PROPOSED PROJECT TYPE METHODOLOGY

SHAs contract many different types of projects in an effort to satisfy the public's transportation demands. They spend a lot of money on resurfacing and rehabilitating in-place pavements, renovating and building bridges, and maintaining existing structures. The broad range of work even includes pavement striping, lighting roadways, and landscaping the right-of-way. The characteristics of each of these projects differ, as do the costs to manage them. A bridge replacement project requires a different amount of personnel and materials testing than a resurfacing project of equal contract size. The purpose of this second methodology is stipulate LDs not only by contract size, but also by the project type in an effort to account for these differences. Doing so can result in a more accurate estimate of the actual costs incurred by a SHA on a daily basis.

The second proposed methodology of this research closely follows that of the first; however, the project type designations were incorporated into the analysis as described in Section 4.4.1. The process used to determine the LD rates for this second methodology is as follows:

Step One: Collection and Organization of Data

The first step in this methodology is identical to that used in the first methodology outlined in section 5.3, however, it also incorporates the collection of the project type designation from the TRNSPORT software.

Step Two: Calculation of Daily E&I Values

The calculation of the daily E&I values for each project was determined using the same procedure outlined in section 5.3 using equation 5.2.

Step Three: Determination of Contract Size and Project Type Groups

The contract size groupings were determined using the non-parametric K-W test as described in the first methodology in section 5.3. Once the contract size groups were determined, the same K-W procedure was followed to determine which project type groups are statistically different from the others. Table 5.7 lists the all the project type groups available in the TRANSPORT database system.

Table 5.7 Project Type Designations

CODE DESCRIPTION
Building Work
Bridge Repair, Bridge Rehabilitation
Bridge Replacement Only
Bridge Painting
Clearing, Clearing and Grubbing
Bridge Culvert and Culvert/Pipe Ext.
Erosion Control, Rip Rap, Slide/Drainage
Grade Drain Base Pave or Bridge & Approach
Guardrail
Intersection Improvements, Turn Lanes
Lighting
Landscaping
Road Side Mowing
Pavement Rehab, Resurfacing
Rest Area Building, Rehab, Complete
Roadway Widening, Add'l Lanes, Pass Lane
Railroad Work
Signals, Markings, Signalization
Signing, Sign Rehab, Delineators
Structure Removal
Soil Remediation, Tank Removal
Traffic Striping, Pavement Markings
Unclassified
Wetland Mitigation
Weigh Station

Table 5.7 reveals the vast number of different project type designations present in the ALDOT database system. In order to conduct the K-W procedure based on project type, groups which were similar were combined based on their name to reduce the total

number of groups and to increase the sample size for each group. Table 5.8 shows the regrouping of the original project type groups which were used for analysis.

Table 5.8 Project Type Group Consolidation

Groups Used for Analysis	Categories Included in Each Group
Bridge	Bridge Repair, Bridge Rehabilitation
	Bridge Replacement Only
	Bridge Culvert and Culvert/Pipe Ext.
Grade, Drain, Base, & Pave	Grade Drain Base Pave or Bridge & Approach
Signals & Markings	Signals, Markings, Signalization
	Traffic Striping, Pavement Markings
Road and Pavement	Intersection Improvements, Turn Lanes
	Pavement Rehab, Resurfacing
	Roadway Widening, Add'l Lanes, Pass Lane
Miscellaneous	Structure Removal
	Lighting
	Guardrail
	Erosion Control, Rip Rap, Slide/Drainage
	Unclassified
Unused Categories	Bridge Painting
	Building Work
	Clearing, Clearing and Grubbing
	Landscaping
	Road Side Mowing
	Rest Area Building, Rehab, Complete
	Railroad Work
	Signing, Sign Rehab, Delineators
	Soil Remediation, Tank Removal
	Wetland Mitigation
	Weigh Station

The K-W analysis was run on the five categories in the left-hand column of Table 5.8 by comparing the daily E&I values. The procedure resulted in three statistically different project size groups: (1) 'Bridge', (2) 'Road and Pavement', and (3) 'Miscellaneous'. The 'Grade, Drain, Base & Pave' and 'Signals & Markings' groups were combined into the 'Miscellaneous' group. Once the contract size and project type groups had been determined, the LD rates were calculated the average daily E&I for each group and rounding the value to the nearest $100.

Step Four: Calculation of Calendar Day/Date LD Rates

Once the work day LD rates had been determined, calendar rates were calculated using the same procedure as before, which is outlined in section 5.2. The resulting LD rates, for both work day and calendar day/date projects as calculated by this methodology are presented in Table 5.4 and graphically in Figure 5.4. The chart in Figure 5.4 illustrates how the LD rates for the different project type groups change in relation to each other as the contract value changes.

Table 5.9 LD Rates by Contract Size and Project Type

		Daily Liquidated Damages Rates					
Contract Value		**Bridge**		**Road**		**Miscellaneous**	
From	**To & Including**	**Work Day**	**Calendar Day/Date**	**Work Day**	**Calendar Day/Date**	**Work Day**	**Calendar Day/Date**
$0	$200,000	$400	$200	$700	$350	$500	$250
$200,000	$500,000	$400	$200	$800	$400	$800	$400
$500,000	$1,000,000	$600	$300	$800	$400	$1,600	$800
$1,000,000	$2,000,000	$1,500	$750	$1,100	$550	$2,200	$1,100
$2,000,000	$5,000,000	$3,800	$1,900	$3,900	$1,950	$2,800	$1,400
$5,000,000	----------	$3,300	$1,650	$2,700	$1,350	$3,800	$1,900

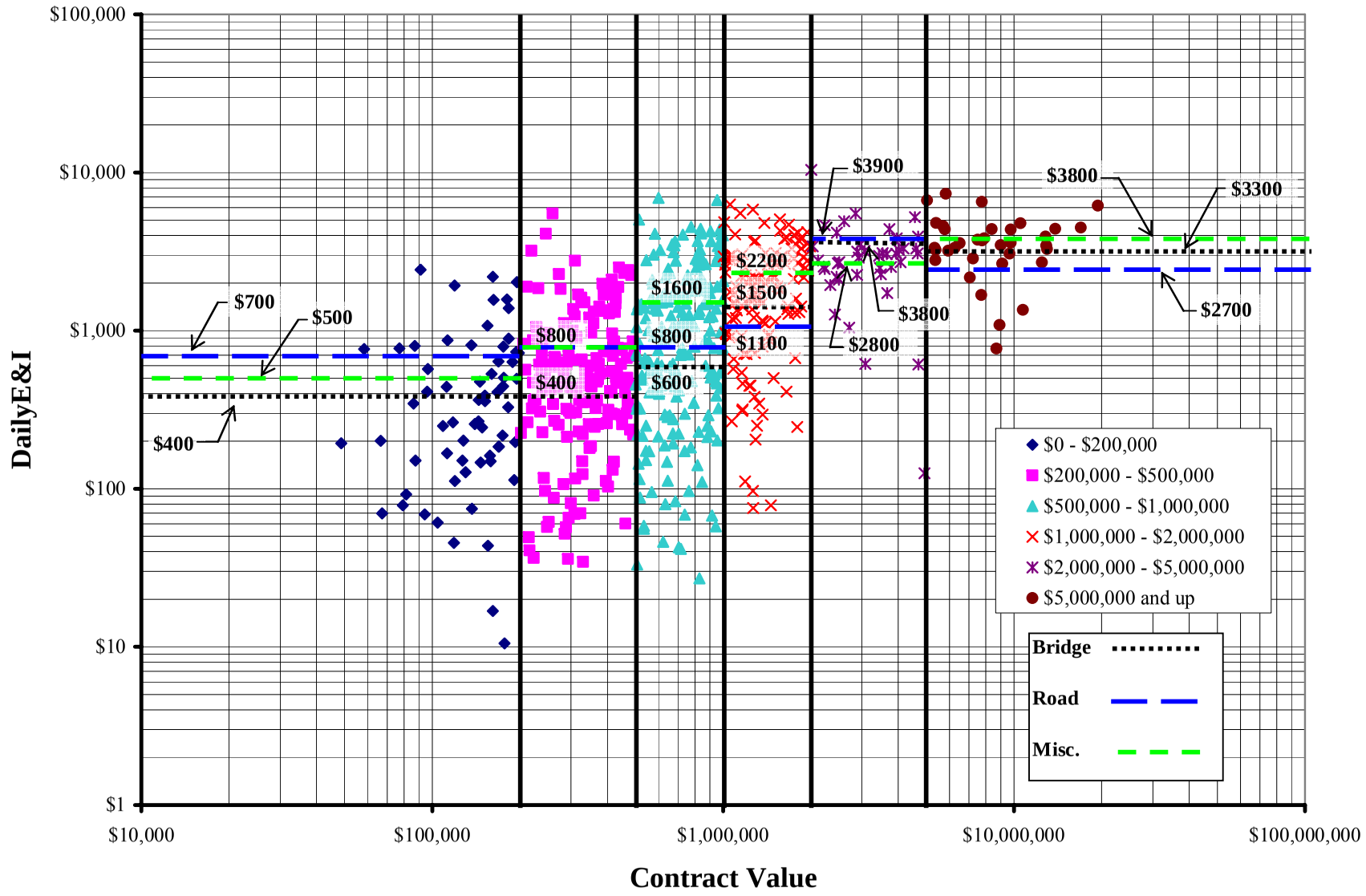

Figure 5.4 Distribution of LD rates Based on Project Type Method (Work Day Projects).

5.5 EVALUATION OF METHODS AND RECOMMENDATIONS

The three methodologies stipulated in this chapter for calculating LDs all follow a similar procedure. They each use historical project data to calculate a daily E&I value in order to estimate what LD rates should be used on future projects. The purpose of this research was to develop a statistically justifiable method for calculating LDs, since ALDOT's current policy has come under legal scrutiny. Therefore, the two methodologies proposed in this research effort were designed to be the most robust methods possible for calculating LDs. In order to compare the methodologies and determine the best procedure for calculating LDs, six criteria were used to objectively evaluate the methods relative to each other: (1) the statistical justification of the method, (2) the repeatability of the method, (3) the accuracy of the resulting LD rates, (4) ease of development of the LD rates, (5) the acceptability of the procedure, and (6) the ease of comprehending the procedure. The methods were assessed on how well they fulfilled each criterion by rating them as *weak*, *moderate*, or *strong*. The results of this evaluation are presented in Table 5.10.

From Table 5.10 it is clear that the contract value methodology proposed under this research is most adequate at determining LD rates for ALDOT on a periodic basis. This method presents LD rates in the same way as ALDOT's current policy. However, the process used to attain the rates differs. It uses statistical procedures to eliminate atypical projects from the data pool, and to determine which contract size groups are significantly different from the others. Finally, it adds a standardized method for determining the LDs rate based on the calculated daily E&I average for each group. By eliminating subjectivity, this methodology is the most robust and least susceptible to failing under

legal scrutiny. A stepwise guide for ALDOT to follow depicting the steps used to complete this procedure is available in Appendix E.

Table 5.10 Evaluation of Methodologies

Evaluation Criteria	Method		
	ALDOT	Contract Value	Project Type
Statistical Justification	**Weak**. The ALDOT method did not employ statistical techniques to evaluate the data, determine contract size groupings, or to calculate the LD rates.	**Strong.** The first method proposed under this research follows a statistical procedure that objectively eliminates outliers, determines contract size groupings and calculates the LD rates.	**Moderate.** The second method proposed under this research followed the same statistical procedures as the contract value method to eliminate outliers, determine contract size & project type groupings, and calculate the LD rates, but required some assumptions.
Repeatability	**Weak**. Due to the use of engineering judgment for determining the contract size groupings as well as the LD rates, the repeatability of this procedure is weak.	**Strong.** Since this methodology follows a stepwise procedure to determine the LD rates from historical data, it can be easily repeated by any practitioner for biennial updates.	**Moderate.** While this method follows the same stepwise procedure as the first proposed method, it does involve engineering judgment to consolidate the project type groupings. This reduces the repeatability of this procedure.
LD Rate Accuracy	**Weak**. The ALDOT method does not identify or eliminate outliers from the data. As a result, atypical projects and even typographical errors could potentially skew the resulting LD rates to be inaccurate.	**Moderate.** Through the use of an outlier analysis to eliminate atypical projects, this method produces accurate estimated daily E&I costs corresponding to a contract size range for typical projects.	**Strong.** By incorporating the same statistical procedure as the contract value method to eliminate outliers and by stipulating LDs by both contract size and project type, the resulting LD rates more accurately resemble actual daily E&I costs encountered.

(continued below)

Table 5.10 Evaluation of Methodologies (continued)

Evaluation Criteria	Method		
	ALDOT	Contract Value	Project Type
Ease of Development	**Moderate.** The ALDOT method does not involve many steps to determine LD rate, however, up to this point, the steps have not been documented and require specialized knowledge to make engineering judgments	**Strong.** LDs are determined by following the stepwise guide developed under this research. No specialized training is necessary.	**Moderate.** This procedure involves a more complicated process than calculating LDs by just contract size. Since assumptions are required in order to determine some project types, this procedure requires specialized knowledge.
Acceptability of Procedure	**Weak.** Clearly this procedure has not been accepted well due to the high level of litigation it has encountered.	**Strong.** Due to the statistical stepwise procedure involved in the determination of the LD rates, this method would be more inclined to be accepted.	**Moderate.** Even though the procedure consists of a stepwise method, it still requires assumptions to be made which may weaken the method in the eyes of its critics.
Ease of Comprehension	**Weak.** Before the method had been documented in this research it was difficult to understand. It involves a process only known to those that perform it and includes steps which require engineering judgment.	**Moderate.** While this procedure involves statistical techniques which the average person is not familiar with, it follows a logical stepwise process. The results produce a schedule of LD rates familiar to the majority of practitioners.	**Moderate.** The project type method is a fairly original way to stipulate LDs. Since it is new, practitioners are not currently familiar with it. Also the many steps involved in the procedure add to its complexity.

The project type methodology proposed by this research is an extension of the contract value method. The same procedure is followed to determine the contract size groups. Then, in order to create more detailed presentation of the LD rates, project type designations are incorporated into the analysis. The historical project data is organized according to the type of project performed and a statistical analysis is performed to determine which project types have significantly different daily E&I costs than the others. The main hurdle this method encountered was the limited number of projects in the data pool with a project type designation. Also, the project type groups have not been

standardized by ALDOT, so there are numerous groups, some of which are redundant, requiring the consolidation of some categories into a single group using subjective engineering intuition.

Applying the lessons learned from the literature review and SHA survey; and comparing the two proposed methodologies developed under this research with ALDOT's current policy; it is recommended that the first methodology proposed by this research be adopted by ALDOT for future calculations of LD rates. While the second method allows the LD rates to be stipulated in a more detailed and consequently a more accurate format, this research found that the assumptions required to incorporate the project type designations into the method, weakened the objectivity of this procedure. In the future, standardized project type categories and better record keeping may allow this second methodology to be incorporated by ALDOT. At the time being, the recommended methodology seems to be sufficiently based on the current state-of-the-practice of LDs used by SHAs across the country.

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CHAPTER SIX

SUMMARY AND CONCLUSIONS

6.1 INTRODUCTION

This research project focused on four specific goals: (1) to administer a survey to determine the state-of-the-practice on a national scale of SHAs' use of LD provisions in construction contracts, (2) to develop a methodology for reviewing and computing LDs that are statistically justifiable, entirely objective, and flexible enough to be used to update LD rates periodically, (3) to compare the two methodologies investigated to the current ALDOT method to identify the most appropriate method for computing LDs, and (4) develop guidelines for practitioners to use for reviewing and updating LDs on a periodic basis. The successes, shortcomings, and recommendations for future work in all four areas will be addressed in the following sections.

6.2 SURVEY OF THE STATE-OF-THE-PRACTICE

The first step in achieving the ultimate goal of this research was to obtain a better understanding of the state-of-the-practice concerning SHAs use of LD policies. This was accomplished through the use of an online survey. The initial response rate was low, but through follow-up interviews, responses from all 50 states, Washington D.C, Puerto Rico, and the New Jersey Turnpike Authority, were obtained. The survey first revealed that LD rates are kept low by the state agencies, covering only the minimum category of costs. This provides the contractor with an unreasonably low estimate to factor in when facing a potential delayed completion. This may be why few states have their provisions challenged in court. Secondly, administrative practices reflect a higher priority in closing

out projects, than collecting LDs. Finally, legal challenges to these LD provisions are infrequent which contradicts the situation experienced by ALDOT.

6.3 LDs METHODOLOGY DEVELOPMENT

The second objective of this research was to develop two new methodologies for the calculation of LDs. The methodologies were meant to be statistically justifiable and free from subjectivity. The purpose was to develop a method for calculating LDs that had no weaknesses which could be scrutinized by the courts. The first method that was developed accomplished these goals. The procedure involved collecting historical project data, statistically eliminating atypical projects, statistically determining contract size groups, and objectively calculating and stipulating LD rates in a tabular format by contract size. The second methodology followed the same initial steps as the first one. In an effort to stipulate LDs in a more detailed format, a project type designation was applied to the data. The method was able to successfully produce a LDs table in which the rates were specified by both contract size and project type. However, assumptions had to be made in order to accomplish this by: classifying projects without a type description as "unclassified" and consolidating the many project type categories. It is a relatively new procedure for ALDOT to record the project type designation. As a result, not all of the projects used for analysis contained this designation. Also, there is no standardized set of project type categories resulting in an excessive number of and redundancy in the categories. These assumptions weaken the procedure by introducing bias into the methodology.

6.4 COMPARISON AND RECOMMENDATION OF LD METHODOLOGIES

From the two methodologies developed in the research effort, the first methodology which stipulates LDs in a traditional table categorized by contract size is recommended to ALDOT for adoption. It was determined to be the most effective for calculating LD rates in a statistically justifiable procedure. This was determined by evaluating the two proposed methodologies against ALDOT's current method according to six criteria. A synopsis of the results of this comparison can be seen in Table 6.1.

Table 6.1 Comparison of Methodologies

Evaluation Criteria	Method		
	ALDOT	Contract Value	Project Type
Statistical Justification	●	●●●	●●
Repeatability	●	●●●	●●
LD Rate Accuracy	●	●●	●●●
Ease of Development	●●	●●●	●●
Acceptability of Procedure	●	●●●	●●
Ease of Comprehension	●	●●	●●

●●● = Strong
●● = Moderate
● = Weak

The contract value method proposed under this research follows a stepwise procedure lacking subjectivity and incorporates statistical techniques to verify the results. While the project type method allows the LD rates to be stipulated in a more detailed and consequently a more project tailored format, this research found that the assumptions required to incorporate the project type designations into the method, weakened the overall objectivity of that procedure. In the future, standardized project type categories

and better record keeping may allow this second methodology to become completely subjective and potentially be incorporated by ALDOT.

6.5 DEVELOPMENT OF GUIDELINES FOR CALCULATING LDs

The final objective of this research was to develop guidelines which can be used by practitioners at ALDOT to update their rates biennially. This was successfully accomplished and a stepwise guide was developed for the recommended methodology. The FHWA requires that states review their LD policies at a minimum of every two years and update them if necessary. These guidelines clearly define the steps required for ALDOT to complete the process outlined in this research and obtain updated LD rates above and beyond the guidance provided by the FHWA. The guidelines present a robust set of policies and procedures for the biennial evaluation of LD rates and are presented in Appendix E.

6.6 USEFULNESS TO THE PRACTICE

The formulation of an easily understood guideline for developing LDs gives practitioners a mechanism for developing statistically justifiable LD rates. The methods obtained from this research will allow ALDOT to stipulate LD rates accurately, preventing future litigation. By eliminating the additional costs and time of defending LDs in the courts, the new methodology could reduce ALDOT's overhead considerably. This research fills a gap in the general knowledge in regards to SHAs development of LDs provisions. Used as a resource, the results of the survey and this research could aid other states in the development of more robust LD policies and procedures.

6.7 RECOMMENDED FURTHER RESEARCH

6.7.1 Development of a Project Specific LD Calculation Methodology

The methodologies developed under this research stipulate LD rates in a tabular format to be used to easily attain LD charges for a typical project. However, SHAs frequently encounter projects which are either atypical in form or require the incorporation of additional costs into LDs. The federal regulations for LDs permit SHAs to include additional amounts into LD charges to cover other anticipated costs such as delays or inconveniences to the SHA or the public. The regulation specifies road user costs (RUC) as one of the additional costs (23 CFR 635.127). In order to include such items, the LD charges would need to be evaluated on a project specific basis, since the additional costs would vary so much from project to project. Therefore, further research needs to be conducted to develop a project specific methodology for computing LDs. This method would also include a method for determining the amount of RUCs a project requires. RUC are defined as the estimates of incremental daily costs to the traveling public which results from construction work being performed (Daniels et al., 2000). These costs are primarily the result of time lost to the public due to added delays of detours, reduced roadway capacity, or a delay in the opening of a new facility.

The most obvious scenario for the incorporation of RUC is on high-profile urban freeway reconstruction projects, since there is a strong potential for very high motorist delay costs. These projects would require the assistance of traffic modeling software to estimate the effects a construction project will have on public delay. But, by evaluating historical project data and comparing it to traffic models, it may be feasible to develop expected RUC based on a project's characteristics. Presented in tabular form, the

estimated RUC for smaller projects could be quickly and efficiently determined for LD estimation.

6.7.2 Adaptation of New LD Guidelines by the FHWA

The current guidelines provided by the FHWA on the development of a LDs provision are broad, leaving the method for calculation up to the SHAs. As a result, the policies developed by many SHAs could potentially face future litigation if they are not sound methods. There exists a need for updated federal guidelines directing SHAs on how to properly determine LD rates. The results of this research would provide a basis for the guidelines. The federal provision would need to be general enough to accommodate the different administrative practices of the SHAs but, at the same time, remain detailed enough to provide sufficient guidance. Furthermore, the results of future research could be incorporated into a workshop in which SHA official could attend and receive hands-on training on how to develop a proper LDs policy.

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APPENDIX A

SHAS' LIQUIDATED DAMAGES TABLES

ALABAMA (PRE-2006)

Contract Value		Daily LD Rate	
More Than	To and Including	Calendar Day	Work Day
$0	$100,000	$120	$200
$100,000	$200,000	$180	$300
$200,000	$500,000	$300	$500
$500,000	$1,000,000	$480	$800
$1,000,000	$2,000,000	$660	$1,100
$2,000,000	$5,000,000	$840	$1,400
$5,000,000	$10,000,000	$1,020	$1,700
$10,000,000	---	$1,200	$2,000

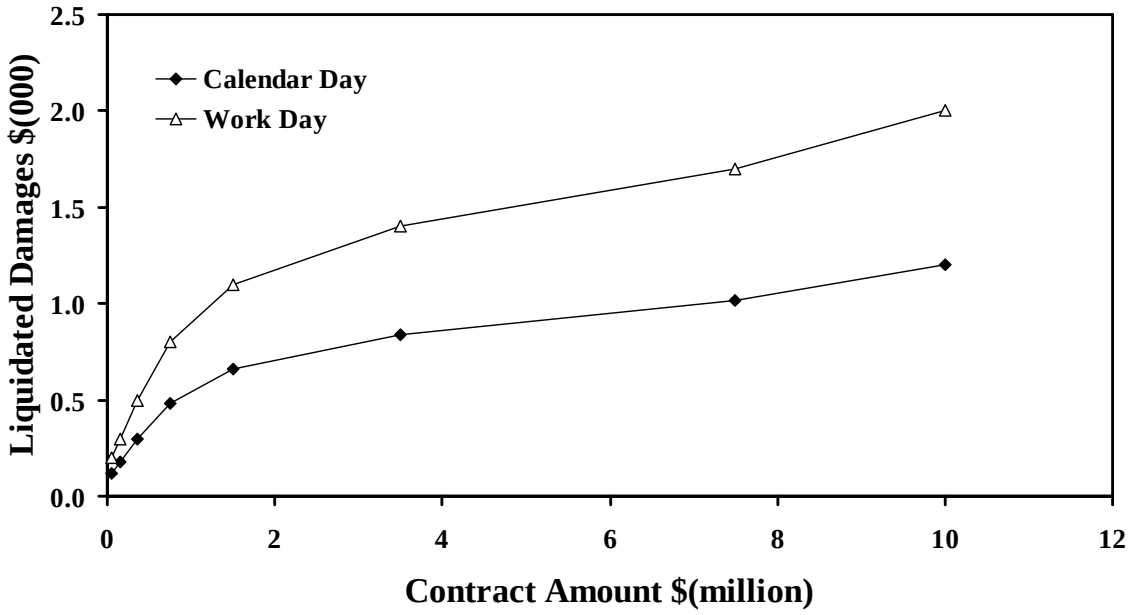

Figure A-1 Alabama DOT Schedule of Liquidated Damages (Pre-2006).

ALABAMA (2006)

Contract Value		Daily LD Rate	
More Than	To and Including	Calendar Day	Work Day
$0	$500,000	$250	$500
$500,000	$1,000,000	$500	$1,000
$1,000,000	$2,000,000	$900	$1,800
$2,000,000	$5,000,000	$1,300	$2,600
$5,000,000	$10,000,000	$1,600	$3,200
$10,000,000	---	$1,800	$3,600

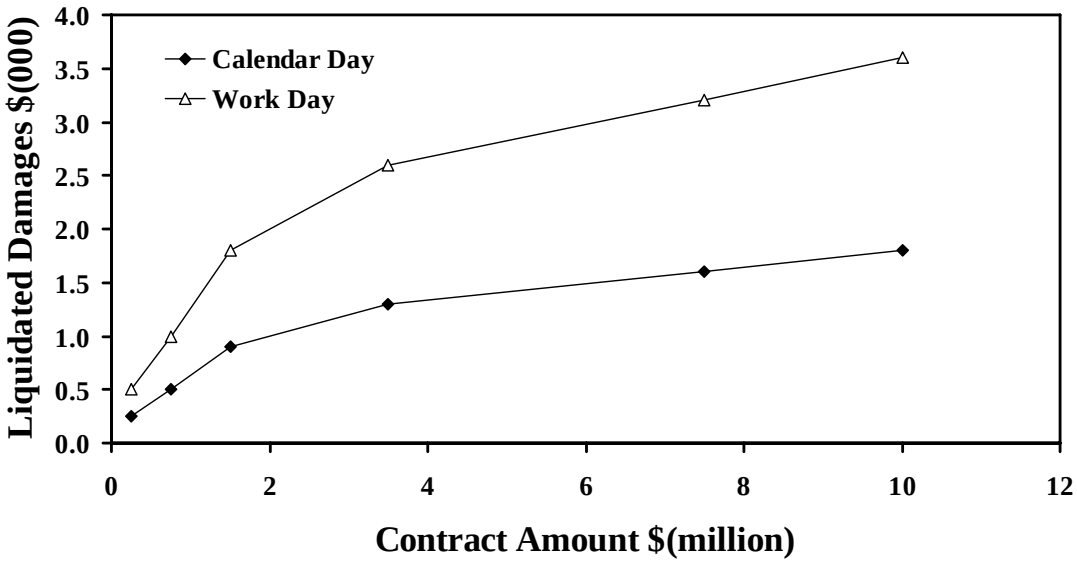

Figure A-2 Alabama DOT Schedule of Liquidated Damages (2006).

ALASKA

Contract Value		Daily LD Rate
More Than	To and Including	Calendar Day
$0	$100,000	$300
$100,000	$500,000	$550
$500,000	$1,000,000	$750
$1,000,000	$2,000,000	$1,000
$2,000,000	$5,000,000	$1,500
$5,000,000	$10,000,000	$2,500
$10,000,000	---	$3,000

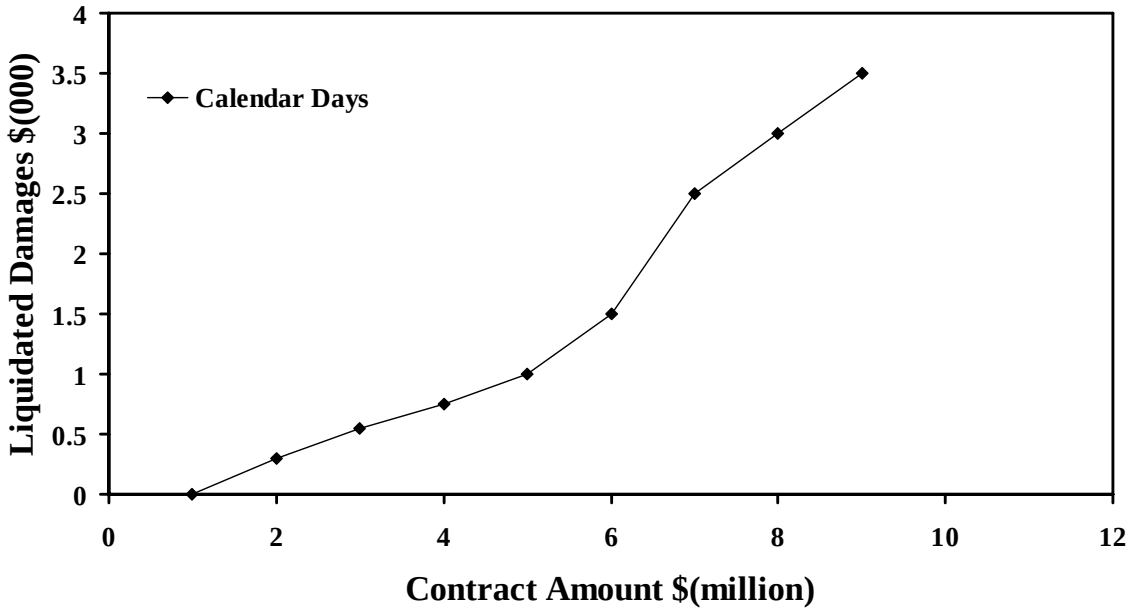

Figure A-3 Alaska DOT Schedule of Liquidated Damages.

COLORADO

Contract Value		Daily LD Rate
More Than	To and Including	Calendar Day
$0	$100,000	$67
$100,000	$250,000	$174
$250,000	$500,000	$430
$500,000	$1,000,000	$1,086
$1,000,000	$2,000,000	$1,778
$2,000,000	$4,000,000	$2,363
$4,000,000	$10,000,000	$3,240
$10,000,000	---	$3,240 plus $583 per additional $1,000,000 over $10,000000

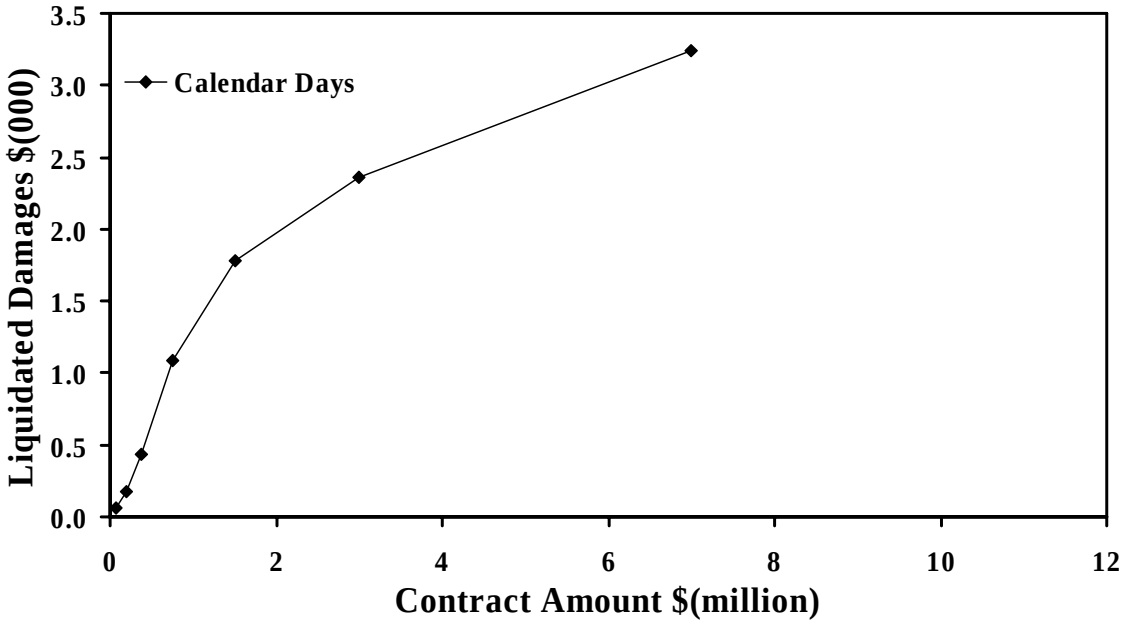

Figure A-4 Colorado DOT Schedule of Liquidated Damages.

DELAWARE

Contract Value		Daily LD Rate	
More Than	To and Including	Work Day	Calendar Day
$0	$25,000	$380	$275
$25,000	$50,000	$400	$290
$50,000	$100,000	$540	$390
$100,000	$500,000	$840	$600
$500,000	$1,000,000	$1,090	$780
$1,000,000	$2,000,000	$1,350	$960
$2,000,000	$5,000,000	$1,410	$1,010
$5,000,000	$10,000,000	$1,590	$1,130
$10,000,000	$15,000,000	$2,510	$1,790
$15,000,000	$20,000,000	$4,180	$2,990
$20,000,000	$25,000,000	$5,850	$4,180
$25,000,000	$30,000,000	$7,520	$5,370
$30,000,000	$35,000,000	$9,190	$6,570
$35,000,000	---	$10,870	$7,760

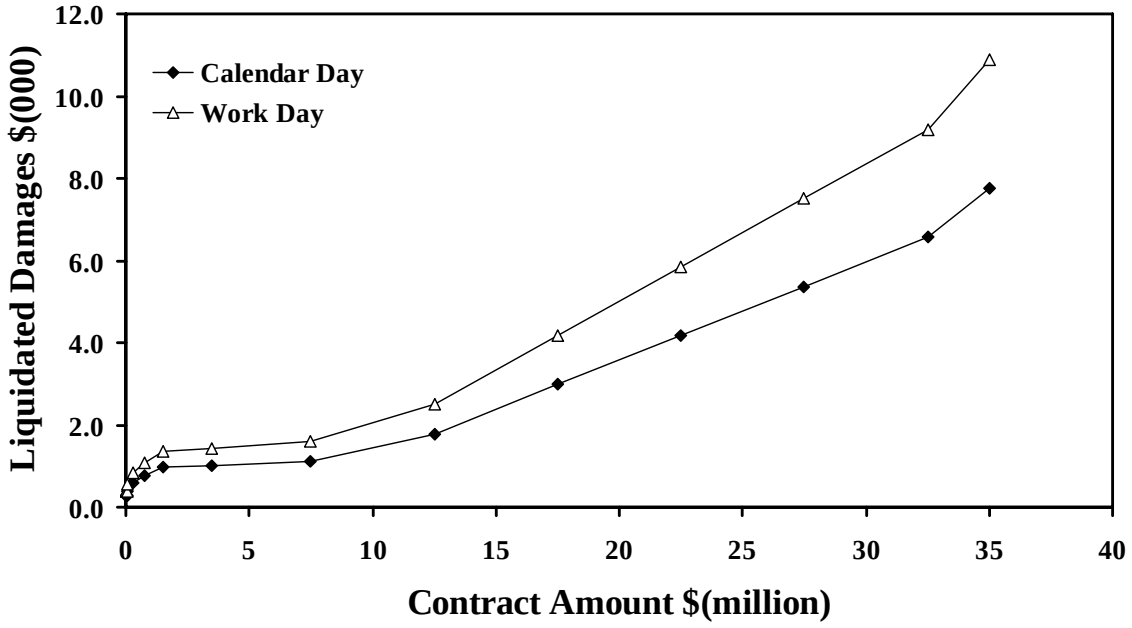

Figure A-5 Delaware DOT Schedule of Liquidated Damages.

DISTRICT OF COLUMBIA

Contract Value		Daily LD Rate
More Than	To and Including	Calendar Day
$0	$100,000	$200
$100,000	$500,000	$400
$500,000	$1,000,000	$650
$1,000,000	$2,000,000	$800
$2,000,000	$4,000,000	$950
$4,000,000	$7,000,000	$1,100
$7,000,000	$10,000,000	$1,350
$10,000,000	$20,000,000	$1,500
$20,000,000	---	$1,700

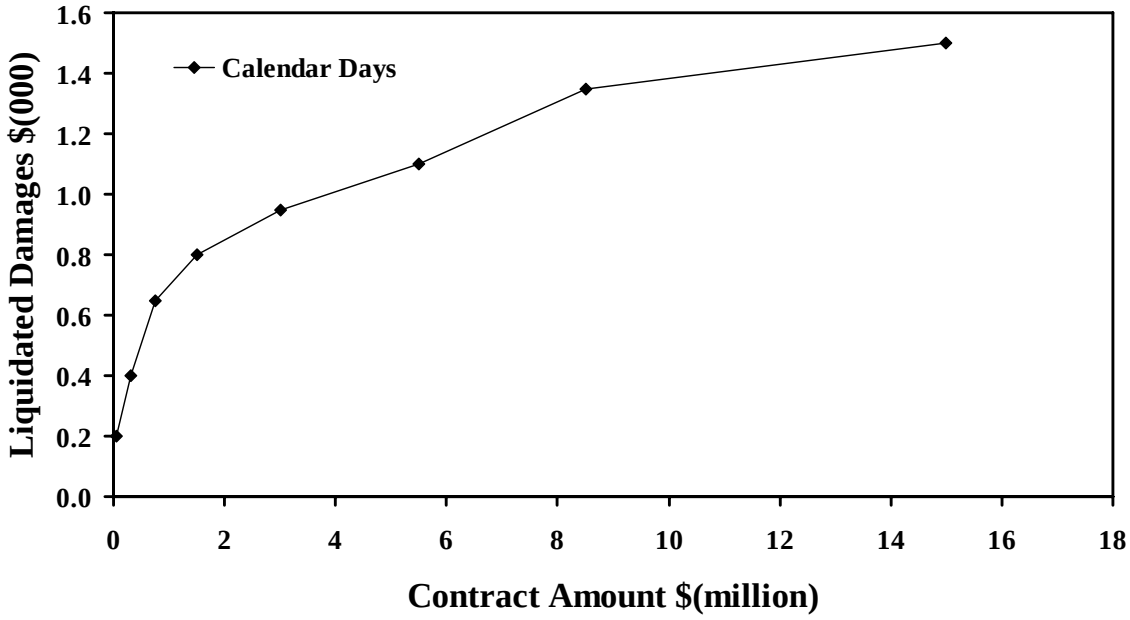

Figure A-6 District of Columbia DOT Schedule of Liquidated Damages.

FLORIDA

Contract Value		Daily LD Rate
More Than	To and Including	Calendar Day
$0	$50,000	$674
$50,000	$250,000	$544
$250,000	$500,000	$634
$500,000	$2,500,000	$1,288
$2,500,000	$5,000,000	$2,470
$5,000,000	$10,000,000	$3,370
$10,000,000	$15,000,000	$5,240
$15,000,000	$20,000,000	$6,078
$20,000,000	---	$8,624 + 0.00027 of any amount over $20 million

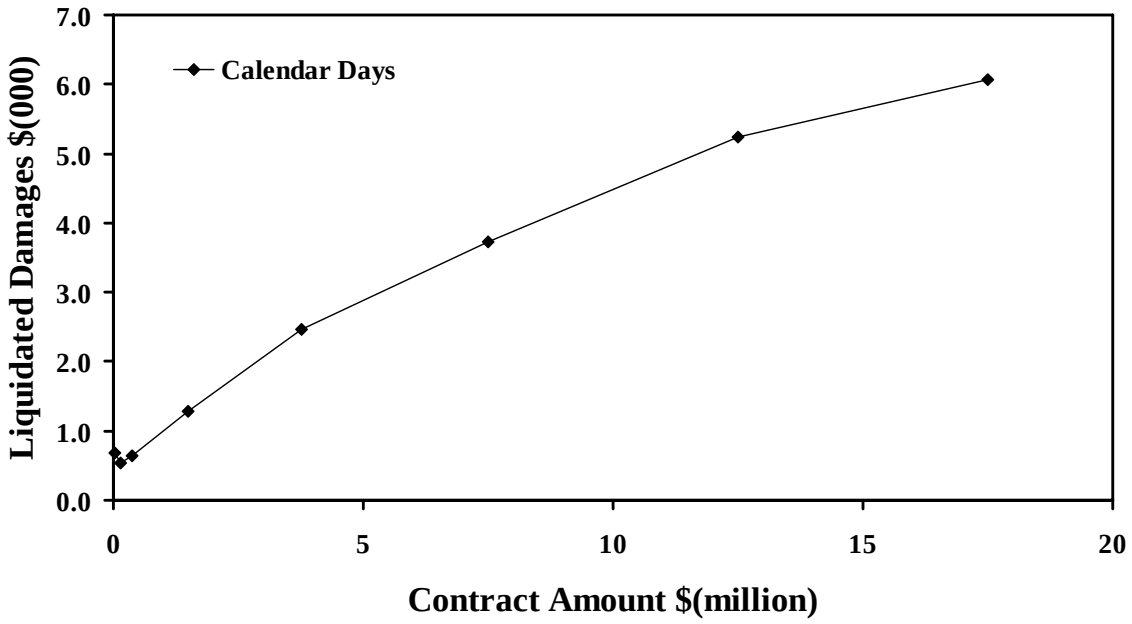

Figure A-7 Florida DOT Schedule of Liquidated Damages.

GEORGIA

Contract Value		Daily LD Rate	
More Than	To and Including	Work Day	Calendar Day
$0	$50,000	$105	$75
$50,000	$100,000	$150	$110
$100,000	$500,000	$210	$150
$500,000	$1,000,000	$350	$225
$1,000,000	$2,000,000	$420	$300
$2,000,000	$5,000,000	$630	$450
$5,000,000	$10,000,000	$840	$600
$10,000,000	$20,000,000	$1,050	$800
$20,000,000	$40,000,000	$1,900	$1,000
$40,000,000	---	$4,000	$2,990

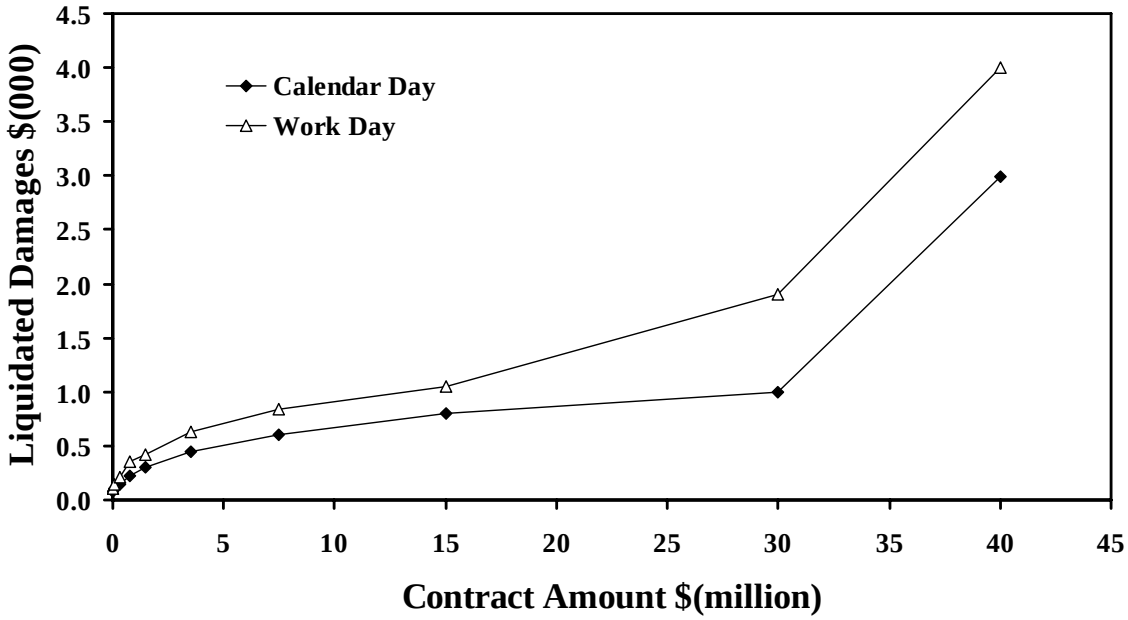

Figure A-8 Georgia DOT Schedule of Liquidated Damages.

ILLINOIS

Contract Value		Daily LD Rate	
More Than	To and Including	Work Day	Calendar Day
$0	$25,000	$60	$50
$25,000	$50,000	$125	$100
$50,000	$100,000	$250	$200
$100,000	$500,000	$515	$370
$500,000	$1,000,000	$800	$575
$1,000,000	$2,000,000	$1,025	$735
$2,000,000	$3,000,000	$1,250	$895
$3,000,000	$5,000,000	$1,475	$1,055
$5,000,000	$7,500,000	$1,700	$1,215
$7,500,000	$10,000,000	$2,000	$1,425
$10,000,000	$15,000,000	$2,700	$1,925
$15,000,000	$20,000,000	$3,400	$2,425
$20,000,000	$25,000,000	$4,100	$2,925
$25,000,000	$30,000,000	$4,800	$3,425
$30,000,000	$35,000,000	$5,500	$3,925
$35,000,000	---	$6,200	$4,425

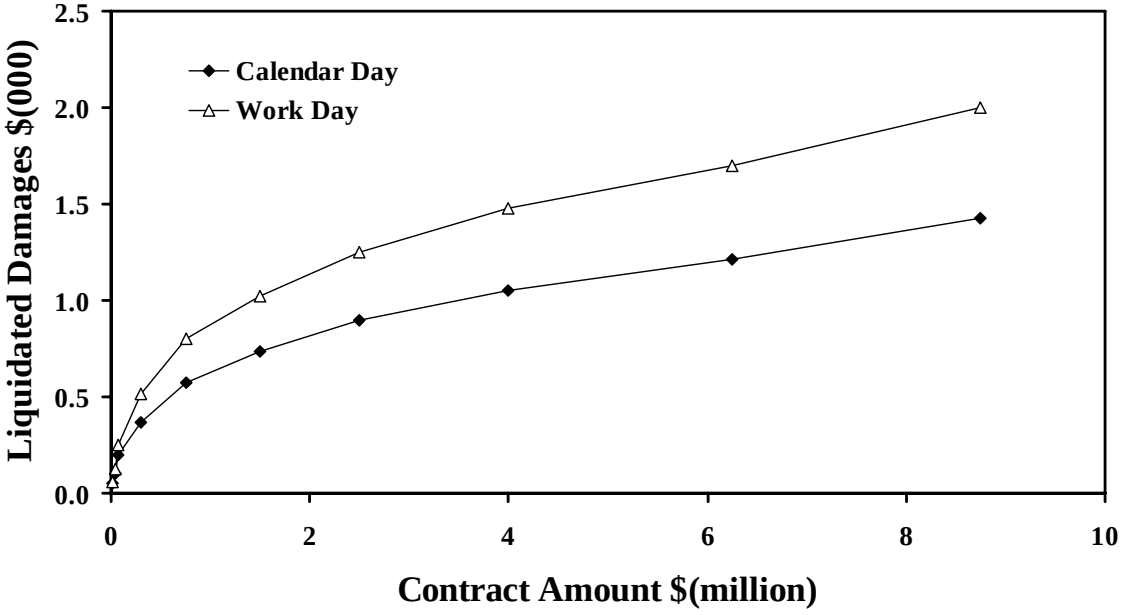

Figure A-9 Illinois DOT Schedule of Liquidated Damages.

INDIANA

Contract Value		Daily LD Rate	
More Than	To and Including	Calendar Day	Work Day
$0	$500,000	$500	$700
$500,000	$1,000,000	$1,000	$800
$1,000,000	$5,000,000	$1,500	$1,100
$5,000,000	$10,000,000	$2,000	$2,000
$10,000,000	---	$2,500	$3,000

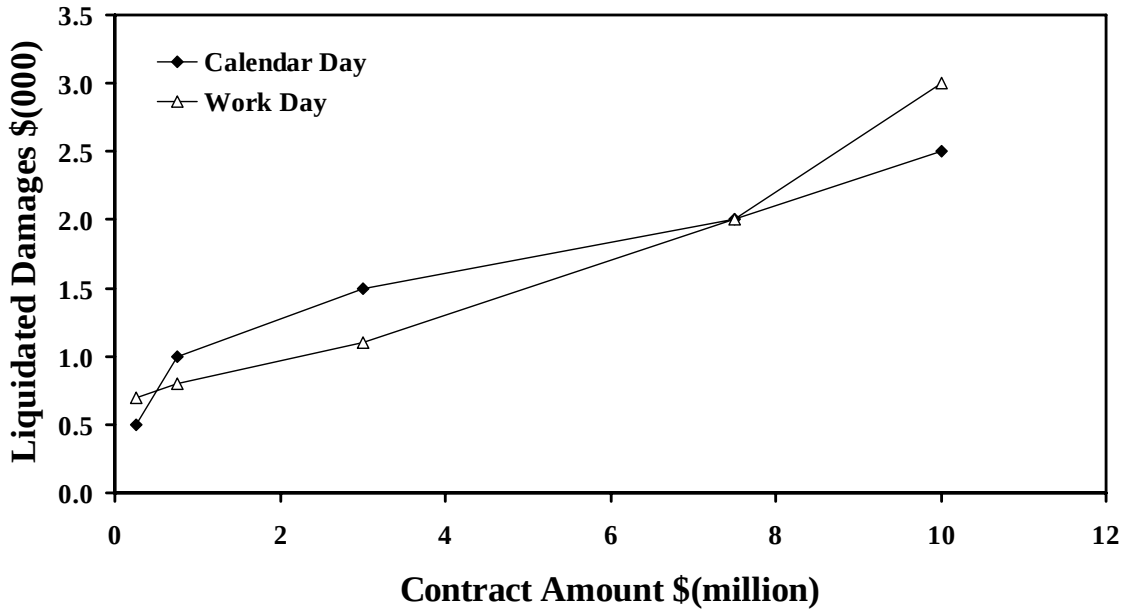

Figure A-10 Indiana DOT Schedule of Liquidated Damages.

KANSAS

Contract Value		Daily LD Rate
More Than	To and Including	Calendar Day
$0	$25,000	$75
$25,000	$50,000	$125
$50,000	$100,000	$200
$100,000	$500,000	$400
$500,000	$1,000,000	$600
$1,000,000	$2,000,000	$925
$2,000,000	$5,000,000	$1,375
$5,000,000	$10,000,000	$2,000
$10,000,000	---	$3,000

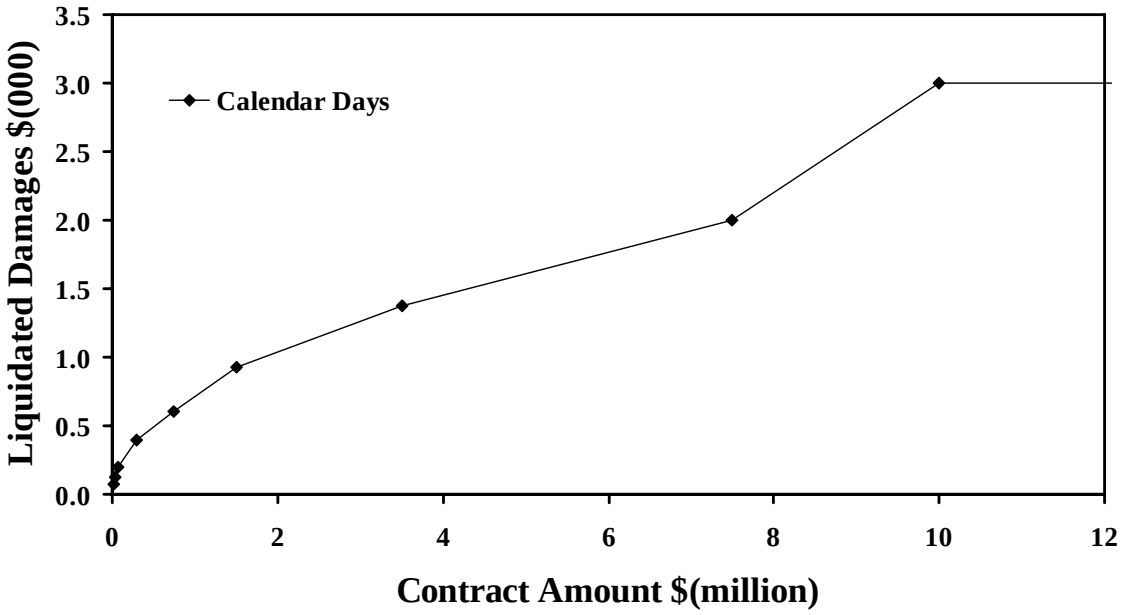

Figure A-11 Kansas DOT Schedule of Liquidated Damages.

KENTUCKY

Contract Value		Daily LD Rate
More Than	To and Including	Daily Charge
$0	$100,000	$150
$100,000	$500,000	$200
$500,000	$1,000,000	$300
$1,000,000	$2,000,000	$400
$2,000,000	$5,000,000	$600
$5,000,000	$10,000,000	$800
$10,000,000	$20,000,000	$1,600
$20,000,000	---	$3,000

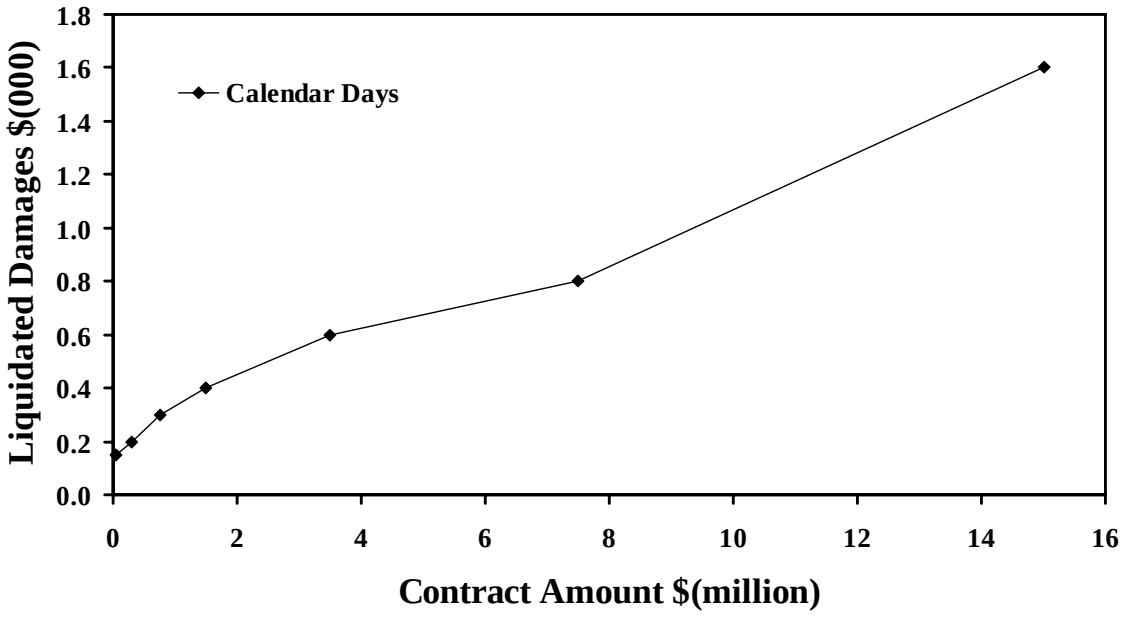

Figure A-12 Kentucky DOT Schedule of Liquidated Damages.

LOUISIANA

Contract Value		Daily LD Rate	
More Than	**To and Including**	**Work Day**	**Calendar Day**
$0	$25,000	$195	$80
$25,000	$50,000	$345	$210
$50,000	$100,000	$400	$240
$100,000	$500,000	$510	$270
$500,000	$1,000,000	$595	$330
$1,000,000	$2,000,000	$695	$400
$2,000,000	$5,000,000	$825	$480
$5,000,000	$10,000,000	$975	$600
$10,000,000	---	$1,115	$630

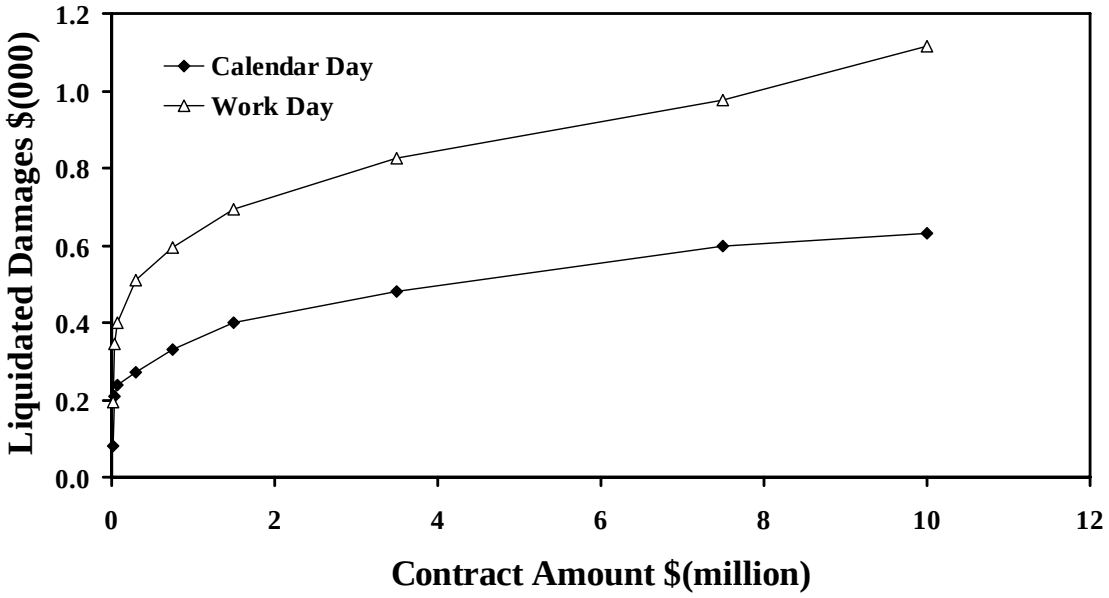

Figure A-13 Louisiana DOT Schedule of Liquidated Damages.

MAINE

Contract Value		Daily LD Rate
More Than	To and Including	Calendar Day
$0	$100,000	$100
$100,000	$300,000	$175
$300,000	$500,000	$250
$500,000	$1,000,000	$325
$1,000,000	$2,000,000	$500
$2,000,000	$4,000,000	$750
$4,000,000	---	$1,000

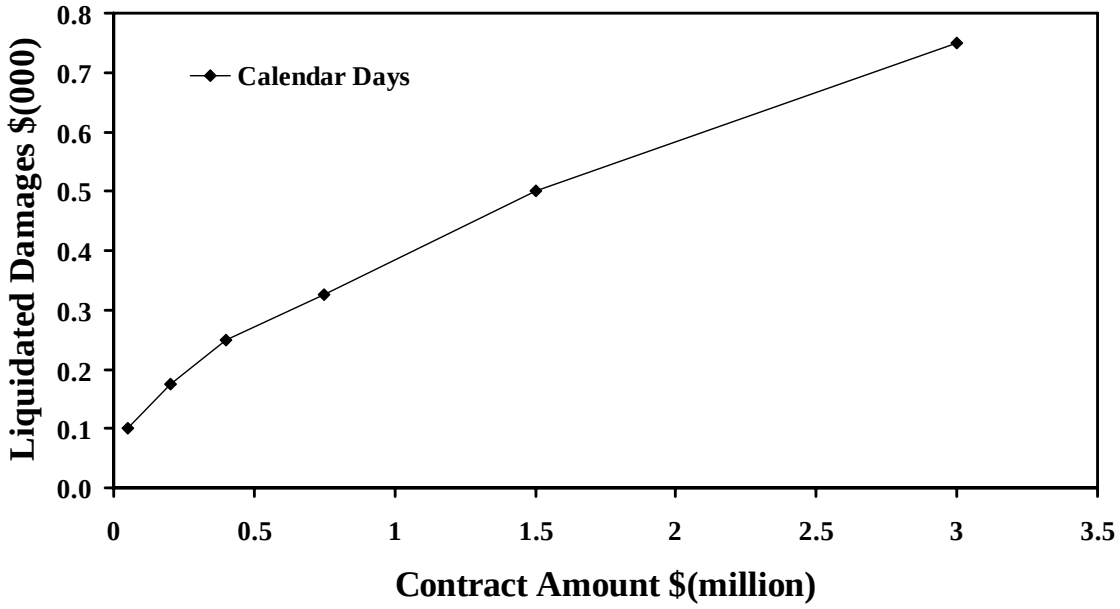

Figure A-14 Maine DOT Schedule of Liquidated Damages.

MICHIGAN

Contract Value		Daily LD Rate
From	To	Calendar Day
$0	$49,999	$75
$50,000	$99,999	$150
$100,000	$499,999	$450
$500,000	$999,999	$900
$1,000,000	$1,999,999	$1,300
$2,000,000	$4,999,999	$1,550
$5,000,000	$9,999,999	$2,650
$10,000,000	---	$3,000

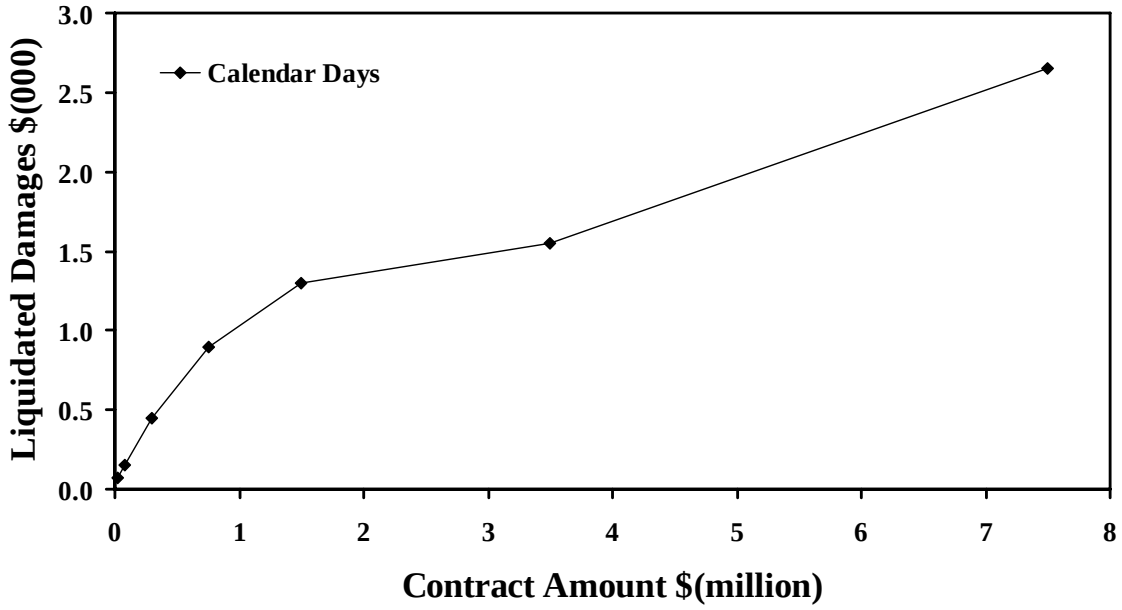

Figure A-15 Michigan DOT Schedule of Liquidated Damages.

MINNESOTA

Contract Value		Daily LD Rate
More Than	To and Including	Calendar Day
$0	$25,000	$150
$25,000	$100,000	$300
$100,000	$500,000	$600
$500,000	$1,000,000	$1,000
$1,000,000	$2,000,000	$1,500
$2,000,000	$5,000,000	$2,000
$5,000,000	$10,000,000	$3,000
$10,000,000	---	$3,500

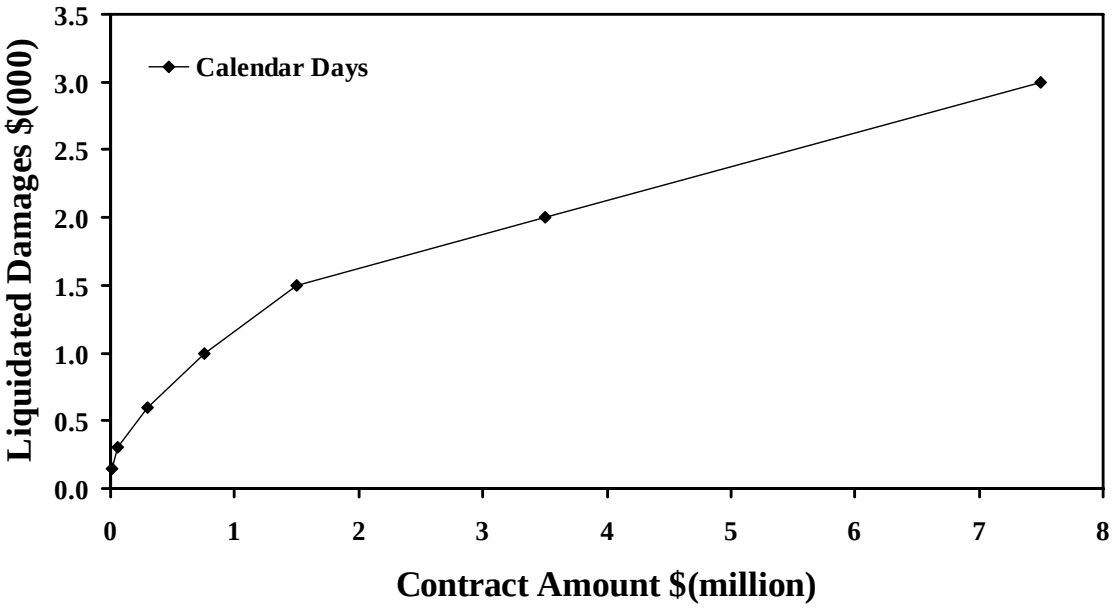

Figure A-16 Minnesota DOT Schedule of Liquidated Damages.

MISSISSIPPI

Contract Value		Daily LD Rate
More Than	To and Including	Calendar Day
$0	$100,000	$140
$100,000	$500,000	$200
$500,000	$1,000,000	$300
$1,000,000	$2,000,000	$400
$2,000,000	$5,000,000	$650
$5,000,000	$10,000,000	$750
$10,000,000	---	$1,400

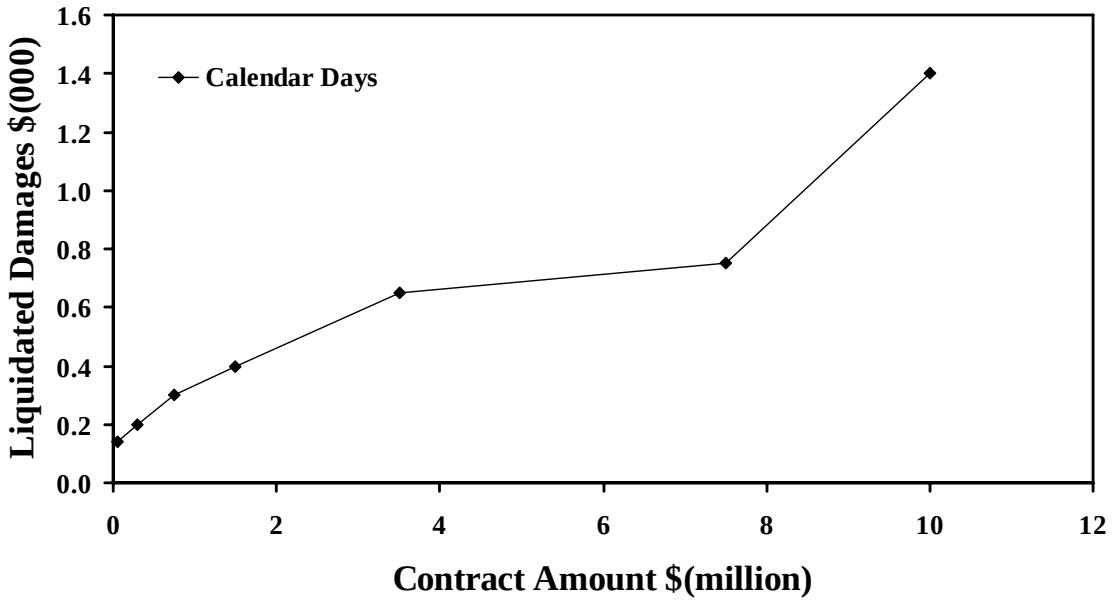

Figure A-17 Mississippi DOT Schedule of Liquidated Damages.

MONTANA

Contract Value		Daily LD Rate
More Than	To and Including	Calendar or Working Day
$0	$50,000	$478
$50,000	$100,000	$618
$100,000	$500,000	$967
$500,000	$1,000,000	$1,171
$1,000,000	$2,000,000	$1,505
$2,000,000	$5,000,000	$2,341
$5,000,000	$10,000,000	$2,804
$10,000,000	---	$3,379

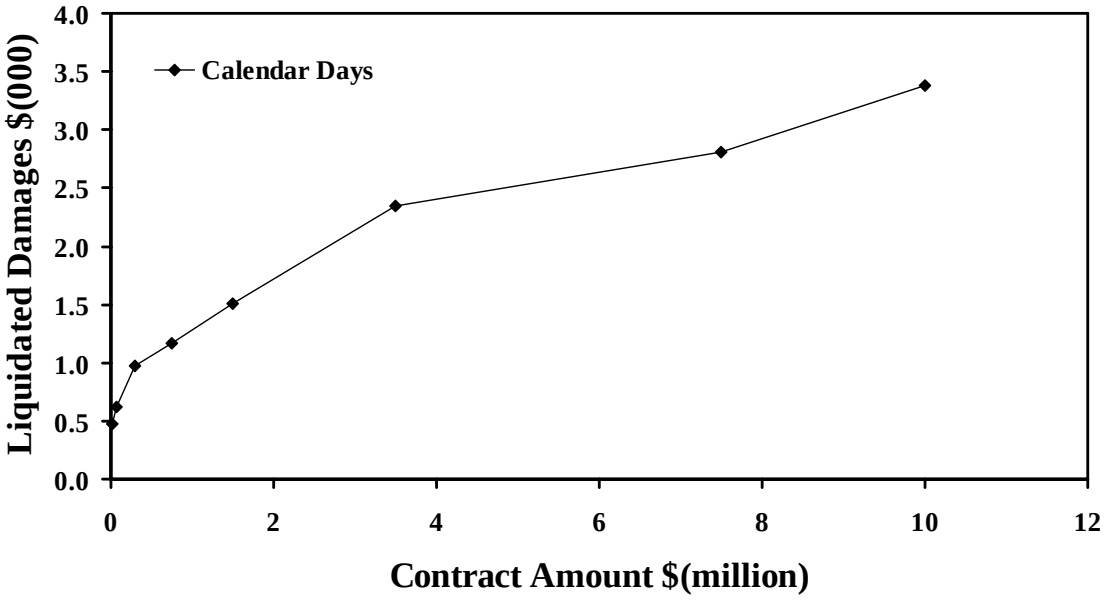

Figure A-18 Montana DOT Schedule of Liquidated Damages.

NEW HAMPSHIRE

Contract Value		Daily LD Rate	
More Than	**To and Including**	**Work Day**	**Calendar Day**
$0	$25,000	$200	$135
$25,000	$50,000	$250	$165
$50,000	$100,000	$400	$265
$100,000	$500,000	$450	$300
$500,000	$1,000,000	$800	$535
$1,000,000	$2,000,000	$1,200	$800
$2,000,000	$5,000,000	$1,600	$1,065
$5,000,000	$10,000,000	$2,000	$1,335
$10,000,000	---	$2,400	$1,600

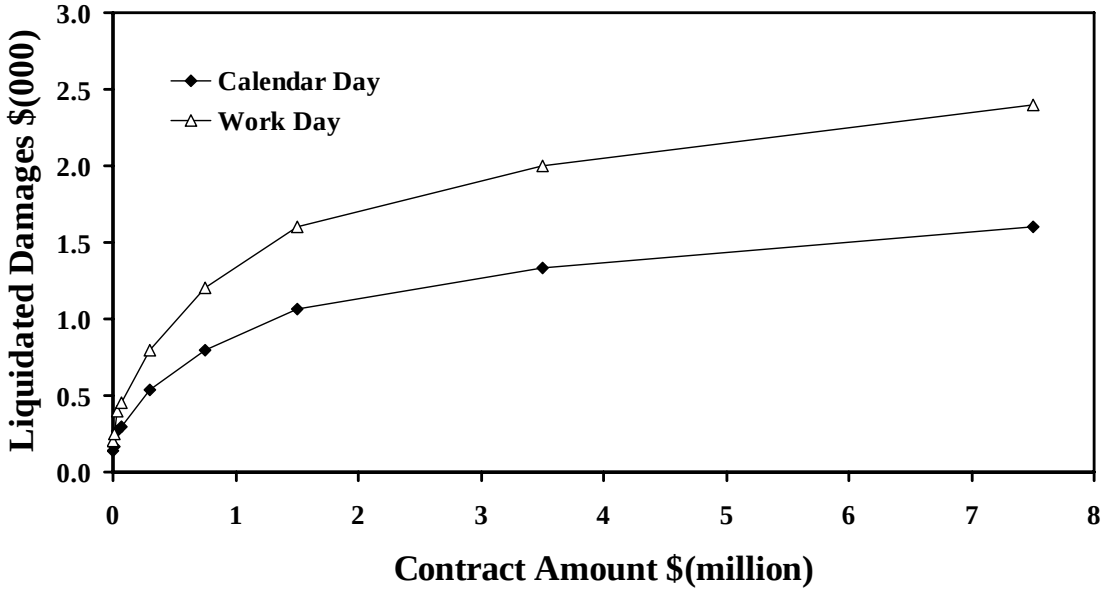

Figure A-19 New Hampshire DOT Schedule of Liquidated Damages.

NEW MEXICO

Contract Value		Daily LD Rate	
More Than	To and Including	Work Day	Calendar Day
$100,000	$500,000	$1,000	$800
$500,000	$1,000,000	$1,400	$1,000
$1,000,000	$2,000,000	$1,900	$1,400
$2,000,000	$4,000,000	$2,300	$1,600
$4,000,000	$7,000,000	$2,900	$2,000
$7,000,000	---	$3,200	$2,300

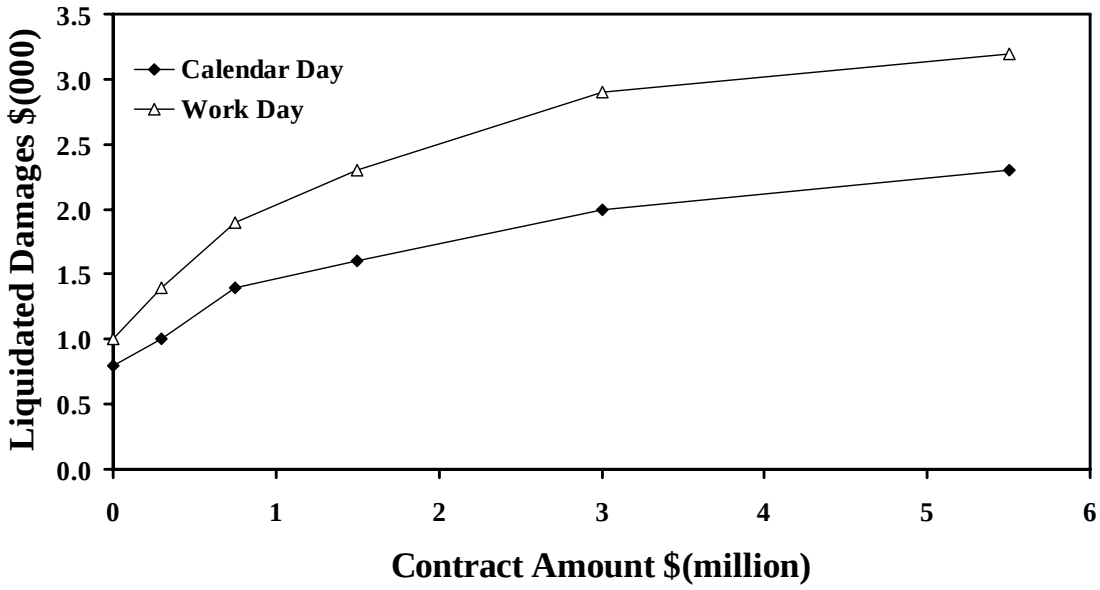

Figure A-20 New Mexico DOT Schedule of Liquidated Damages.

NEW YORK

Contract Value		Daily LD Rate
More Than	To and Including	Calendar Day
$0	$100,000	$500
$100,000	$500,000	$1,000
$500,000	$2,000,000	$1,500
$2,000,000	$5,000,000	$2,000
$5,000,000	$10,000,000	$2,500
$10,000,000	$20,000,000	$4,000
$20,000,000	---	$7,000

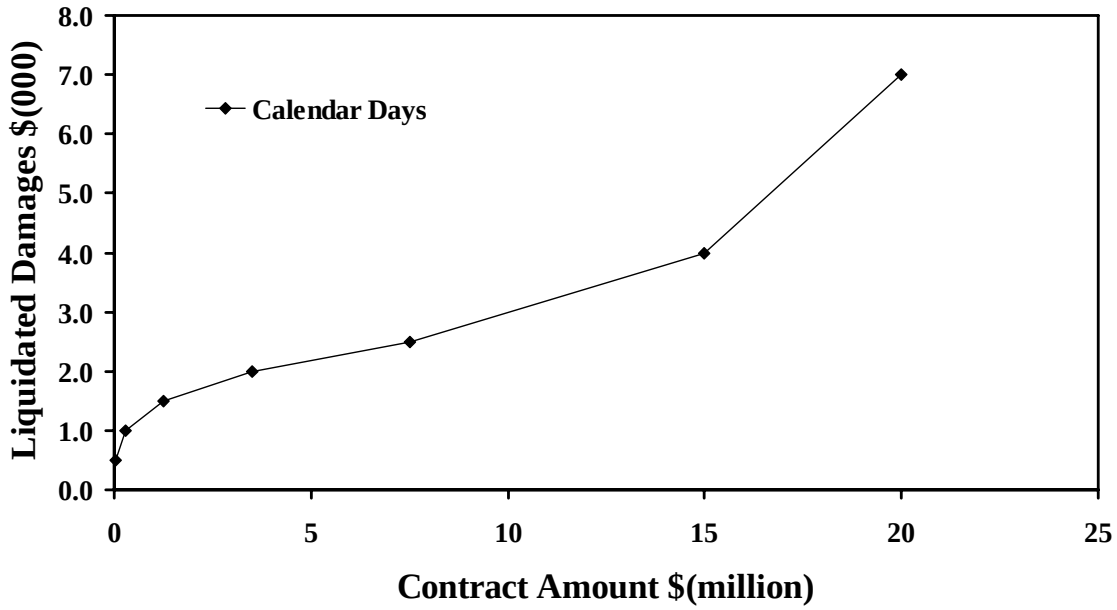

Figure A-21 New York DOT Schedule of Liquidated Damages.

NORTH DAKOTA

Contract Value		Daily LD Rate	
More Than	To and Including	Work Day	Calendar Day
$0	$50,000	$250	$200
$50,000	$100,000	$550	$400
$100,000	$250,000	$700	$500
$250,000	$500,000	$875	$650
$500,000	$1,000,000	$1,100	$800
$1,000,000	$2,000,000	$1,350	$950
$2,000,000	$3,000,000	$1,700	$1,200
$3,000,000	$5,000,000	$2,075	$1,475
$5,000,000	$8,000,000	$2,575	$1,800
$8,000,000	---	$3,200	$2,225

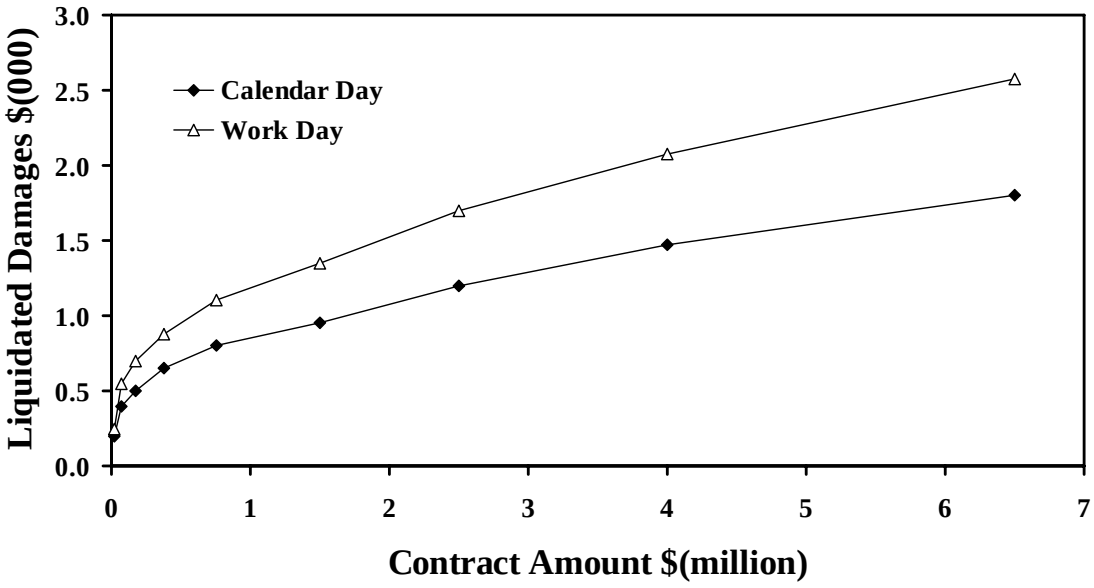

Figure A-22 North Dakota DOT Schedule of Liquidated Damages.

OHIO

Contract Value		Daily LD Rate
More Than	To and Including	Calendar Day
$0	$500,000	$700
$500,000	$2,000,000	$760
$2,000,000	$10,000,000	$1,250
$10,000,000	---	$2,000

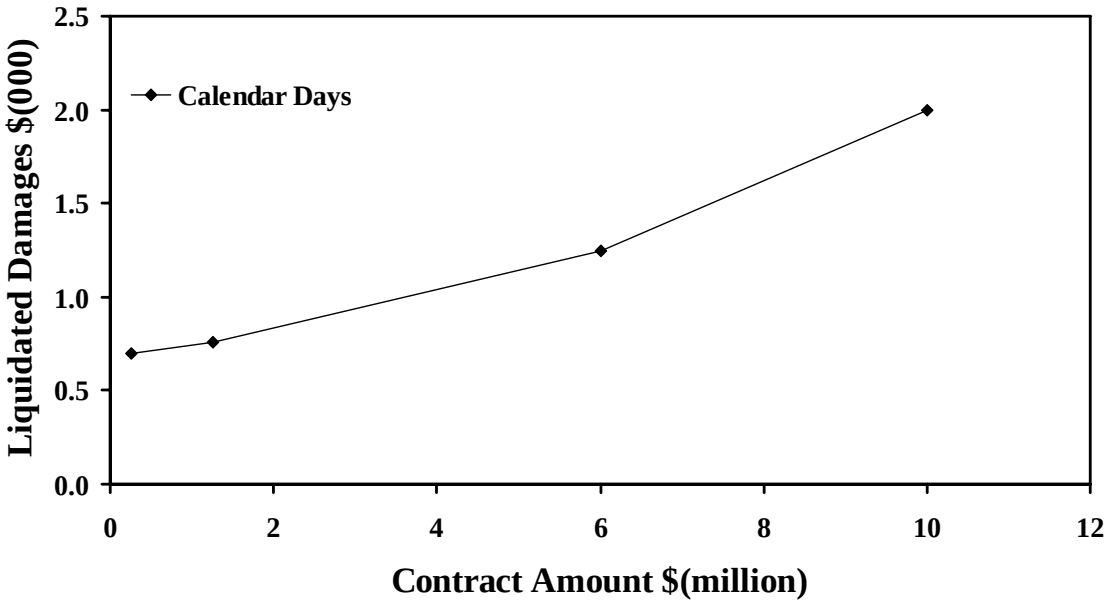

Figure A-23 Ohio DOT Schedule of Liquidated Damages.

PENNSYLVANIA

Contract Value		Daily LD Rate
More Than	To and Including	Calendar Day
$0	$400,000	$350
$400,000	$1,000,000	$700
$1,000,000	$5,000,000	$925
$5,000,000	$10,000,000	$1,200
$10,000,000	$15,000,000	$1,500
$15,000,000	---	$1,975

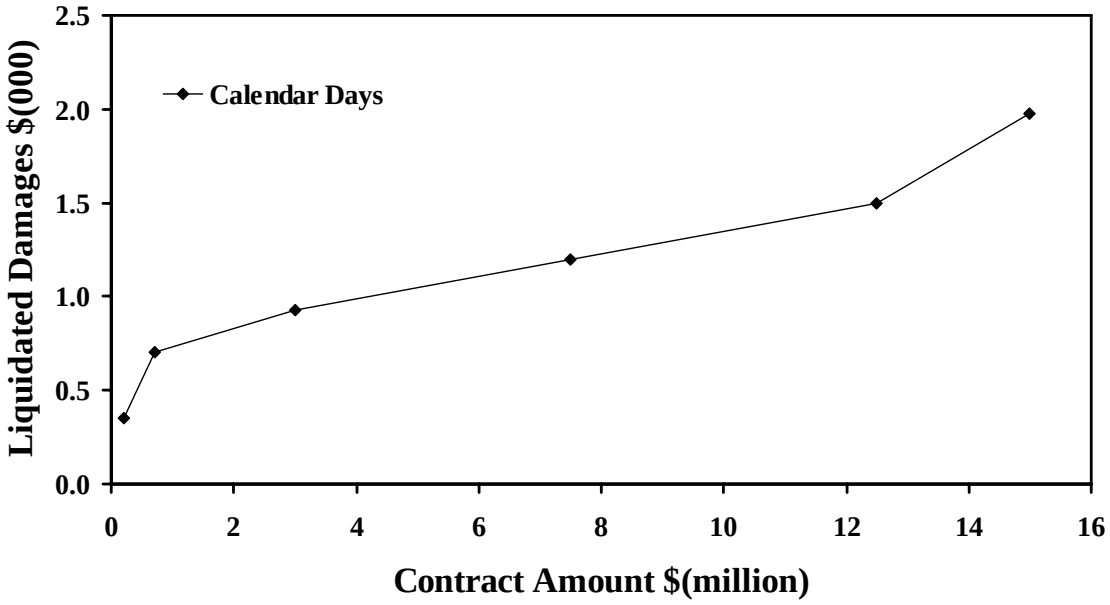

Figure A-24 Pennsylvania DOT Schedule of Liquidated Damages.

PUERTO RICO

Contract Value		Daily LD Rate
More Than	To and Including	Calendar Day
$0	$100,000	$150
$100,000	$500,000	$200
$500,000	$1,000,000	$400
$1,000,000	$2,000,000	$500
$2,000,000	---	$600

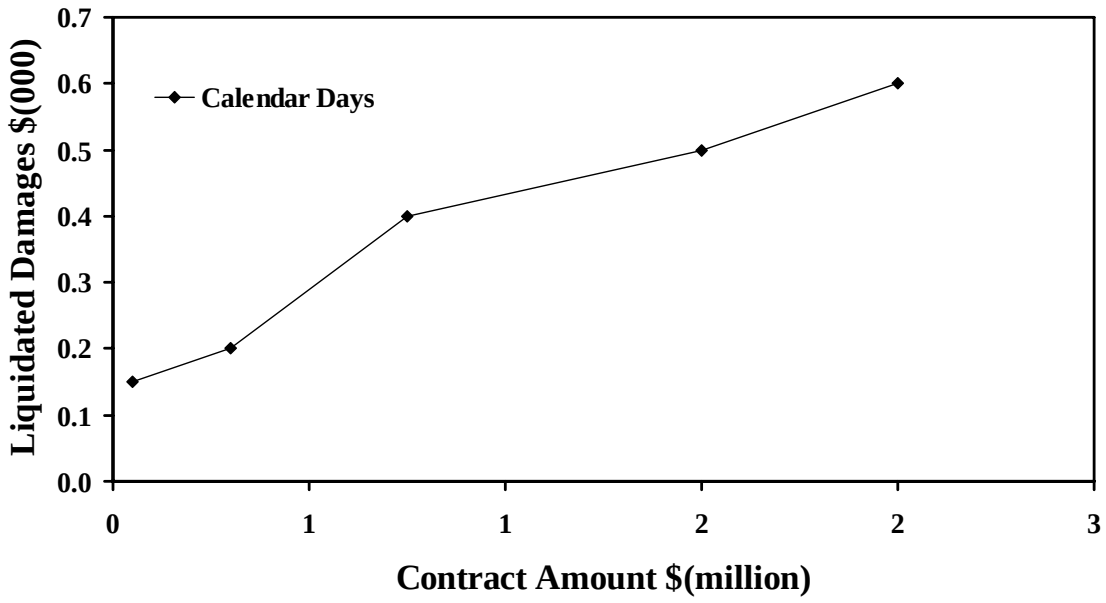

Figure A-25 Puerto Rico DOT Schedule of Liquidated Damages.

RHODE ISLAND

Contract Value		Daily LD Rate	
More Than	To and Including	Work Day	Calendar Day
$0	$25,000	$250	$200
$25,000	$50,000	$400	$300
$50,000	$100,000	$600	$450
$100,000	$500,000	$750	$550
$500,000	$1,000,000	$1,250	$900
$1,000,000	$2,000,000	$1,650	$1,200
$2,000,000	$4,000,000	$2,050	$1,500
$4,000,000	$6,000,000	$2,450	$1,750
$6,000,000	$10,000,000	$3,150	$2,250
$10,000,000	---	$3,700	$2,700

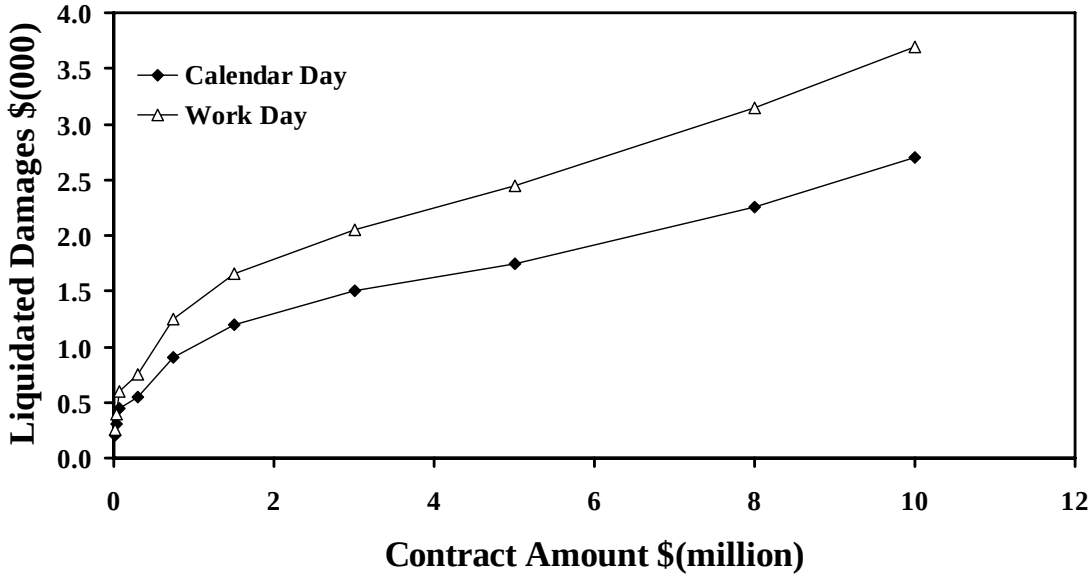

Figure A-26 Rhode Island DOT Schedule of Liquidated Damages.

SOUTH CAROLINA

Contract Value		Daily LD Rate
More Than	To and Including	Calendar or Fixed Day
$0	$50,000	$100
$50,000	$100,000	$200
$100,000	$500,000	$400
$500,000	$1,000,000	$600
$1,000,000	$2,000,000	$800
$2,000,000	$5,000,000	$1,100
$5,000,000	$10,000,000	$1,400
$10,000,000	---	$1,800

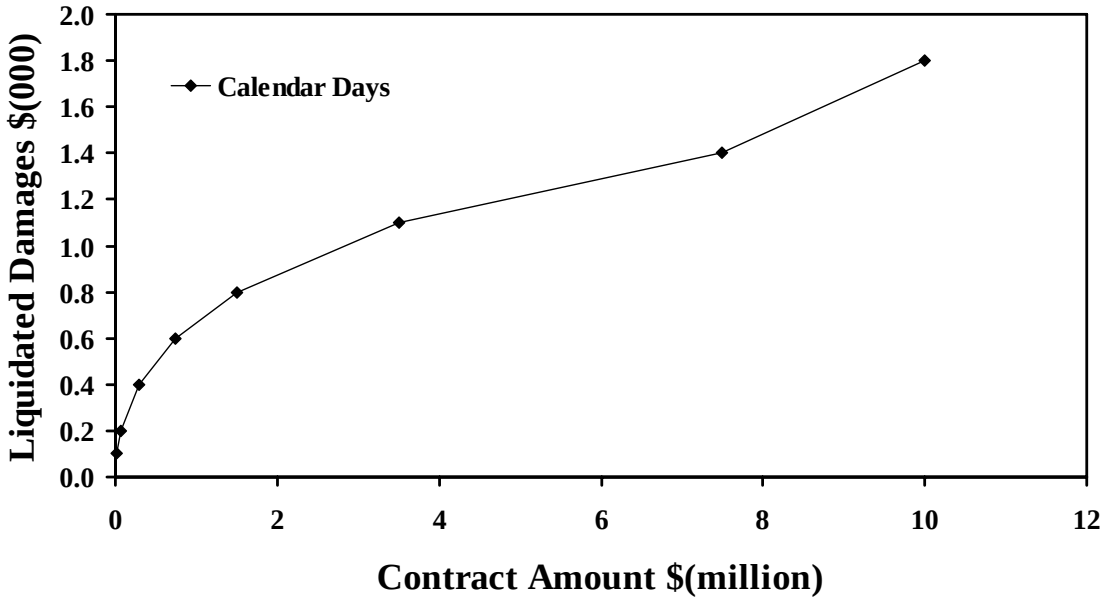

Figure A-27 South Carolina DOT Schedule of Liquidated Damages.

SOUTH DAKOTA

Contract Value		Daily LD Rate
More Than	**To and Including**	**Calendar or Fixed Day**
$0	$50,000	$250
$50,000	$100,000	$325
$100,000	$500,000	$500
$500,000	$1,000,000	$725
$1,000,000	$2,000,000	$900
$2,000,000	$4,000,000	$1,450
$4,000,000	$6,000,000	$1,650
$6,000,000	$8,000,000	$1,800
$8,000,000	$10,000,000	$2,150
$10,000,000	---	$2,300

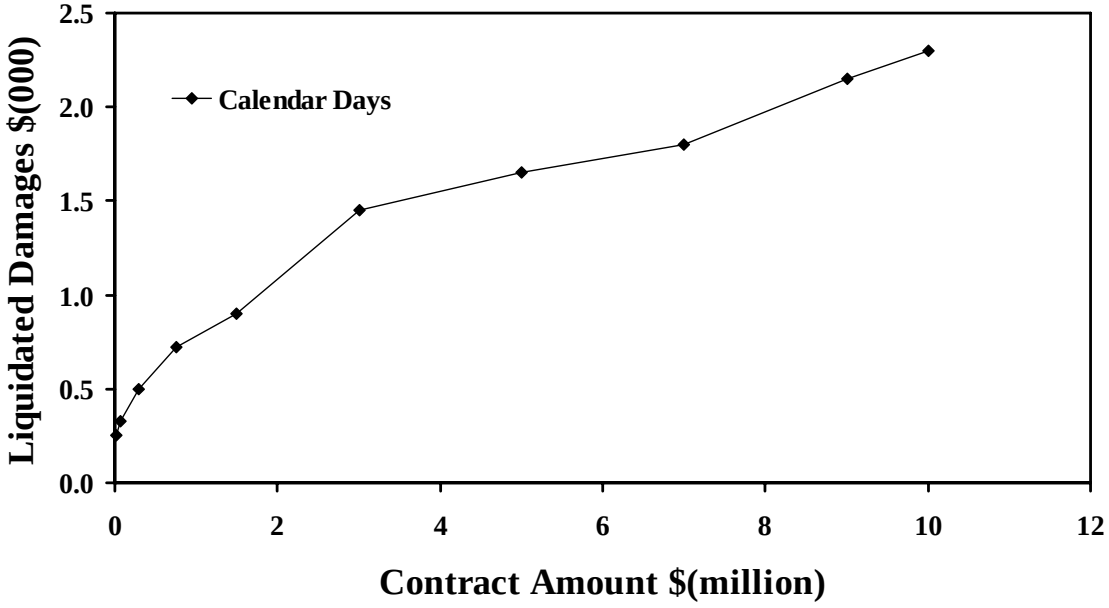

Figure A-28 South Dakota DOT Schedule of Liquidated Damages.

TENNESSEE

Contract Value		Daily LD Rate	
More Than	To and Including	Work Day	Calendar Day
$0	$100,000	$270	$80
$100,000	$500,000	$410	$190
$500,000	$1,000,000	$710	$300
$1,000,000	$2,000,000	$1,080	$460
$2,000,000	$5,000,000	$1,690	$810
$5,000,000	$10,000,000	$2,260	$950
$10,000,000	---	$2,850	$1,200

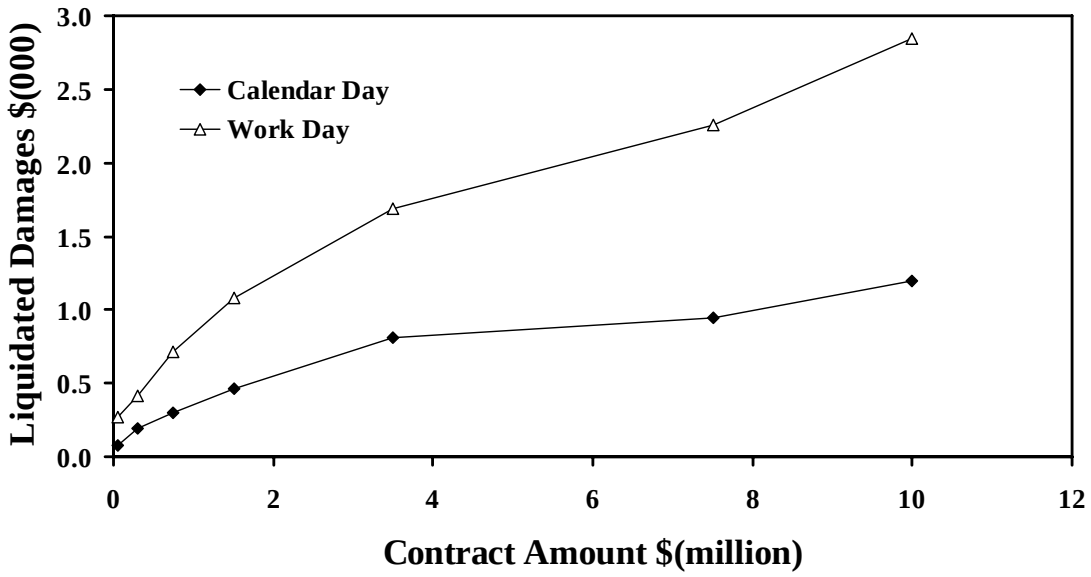

Figure A-29 Tennessee DOT Schedule of Liquidated Damages.

UTAH

Contract Value		Daily LD Rate	
More Than	To and Including	Work Day	Calendar Day
$0	$100,000	$830	$210
$100,000	$500,000	$950	$450
$500,000	$1,000,000	$1,380	$680
$1,000,000	$5,000,000	$2,170	$1,270
$5,000,000	$10,000,000	$2,950	$1,860
$10,000,000	$30,000,000	$4,930	$2,770
$30,000,000	---	$8,240	$4,100

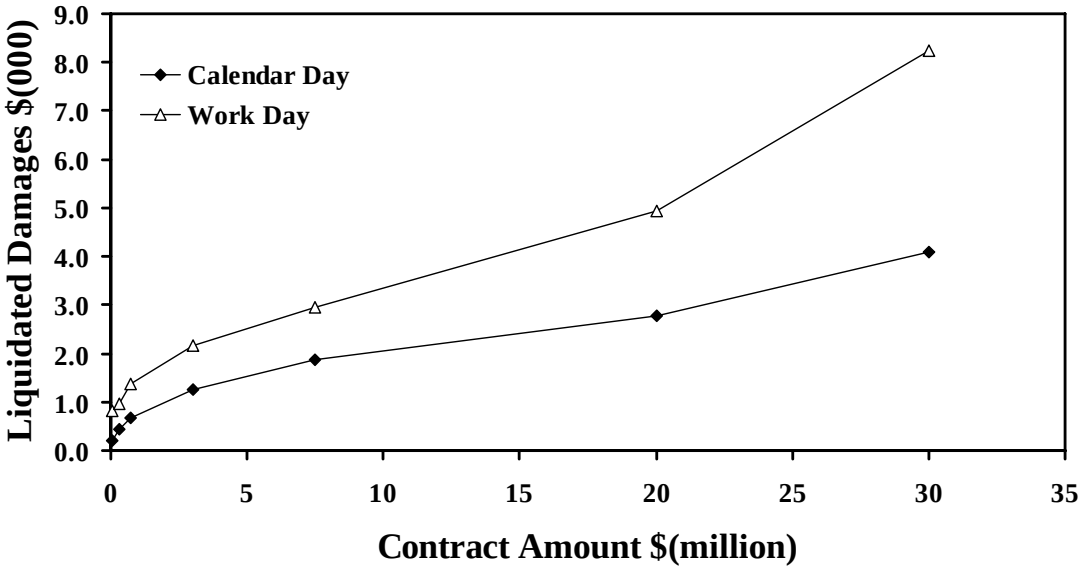

Figure A-30 Utah DOT Schedule of Liquidated Damages.

VERMONT

Contract Value		Daily LD Rate
More Than	To and Including	Daily Charge
$0	$300,000	$390
$300,000	$500,000	$670
$500,000	$1,000,000	$1,000
$1,000,000	$1,500,000	$1,700
$1,500,000	$3,000,000	$2,500
$3,000,000	$5,000,000	$3,500
$5,000,000	$10,000,000	$3,500
$10,000,000	---	$3,500

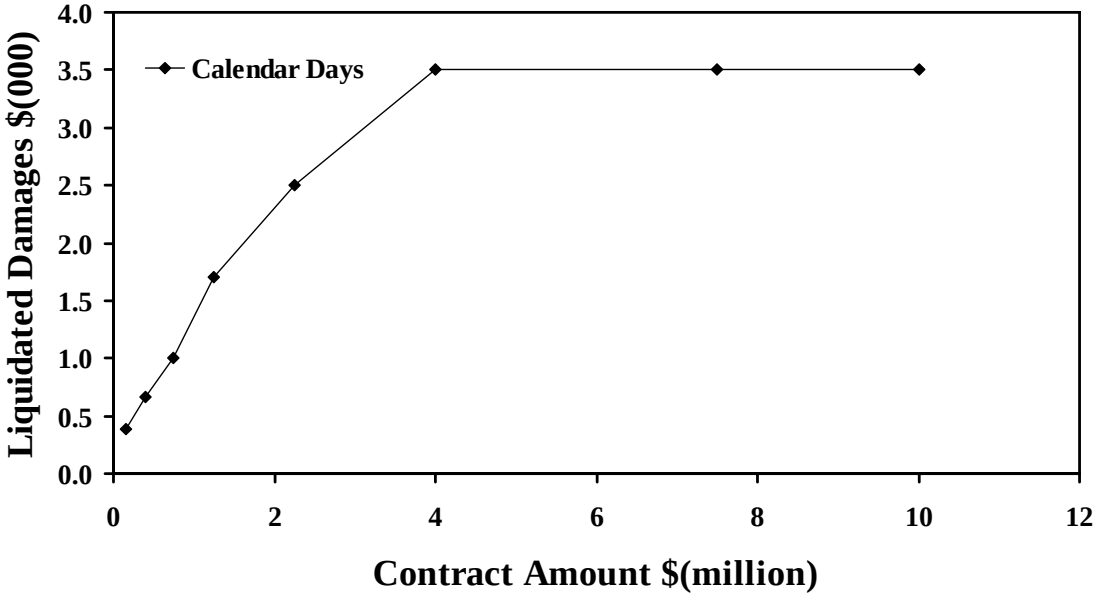

Figure A-31 Vermont DOT Schedule of Liquidated Damages.

VIRGINIA

Contract Value		Daily LD Rate
More Than	To and Including	Daily Charge
$0	$100,000	$175
$100,000	$500,000	$350
$500,000	$2,000,000	$600
$2,000,000	$8,000,000	$1,000
$8,000,000	$15,000,000	$1,100
$15,000,000	---	$1,400

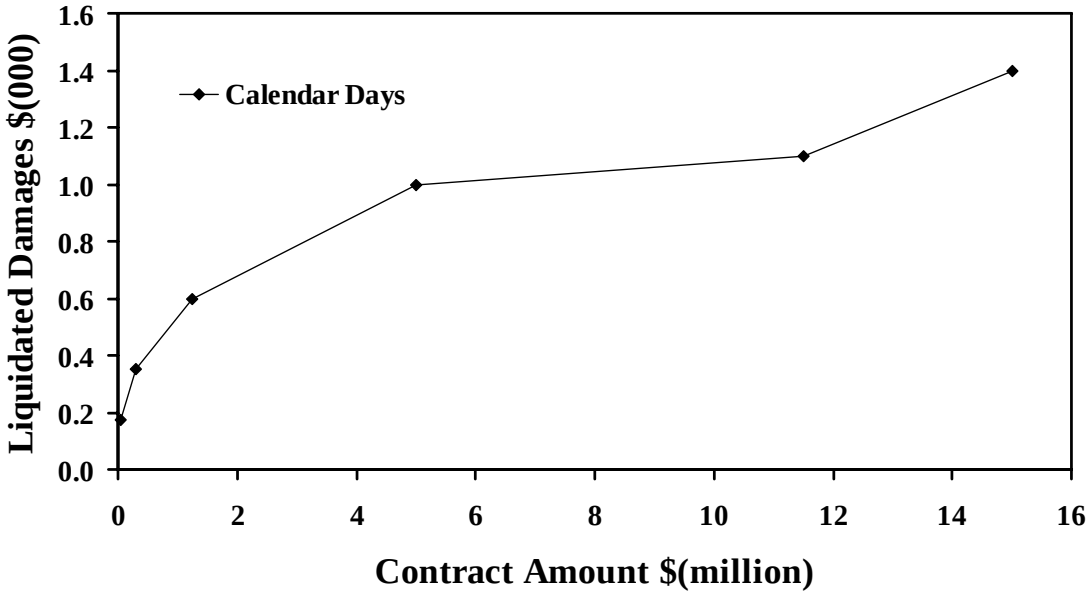

Figure A-32 Virginia DOT Schedule of Liquidated Damages.

WEST VIRGINIA

Contract Value		Daily LD Rate
More Than	To and Including	Daily Charge
$0	$25,000	$120
$25,000	$100,000	$150
$100,000	$500,000	$290
$500,000	$1,000,000	$490
$1,000,000	$2,000,000	$840
$2,000,000	$5,000,000	$1,390
$5,000,000	$10,000,000	$2,220
$10,000,000	---	$3,870

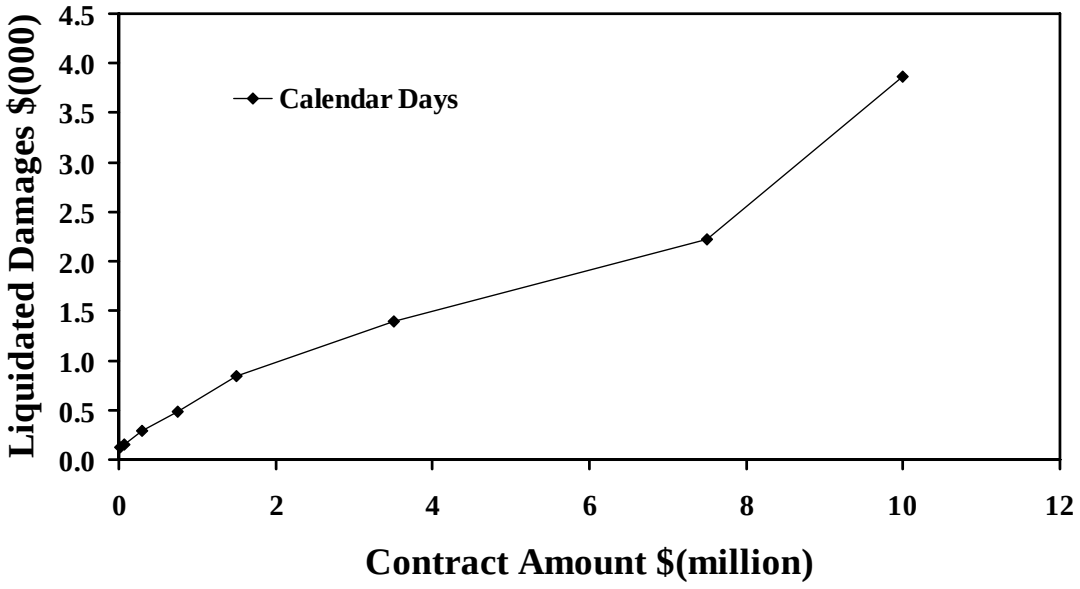

Figure A-33 West Virginia DOT Schedule of Liquidated Damages.

WISCONSIN

Contract Value		Daily LD Rate	
More Than	To and Including	Work Day	Calendar Day
$0	$100,000	$610	$305
$100,000	$300,000	$760	$380
$300,000	$500,000	$1,140	$570
$500,000	$1,000,000	$1,470	$735
$1,000,000	---	$2,230	$1,115

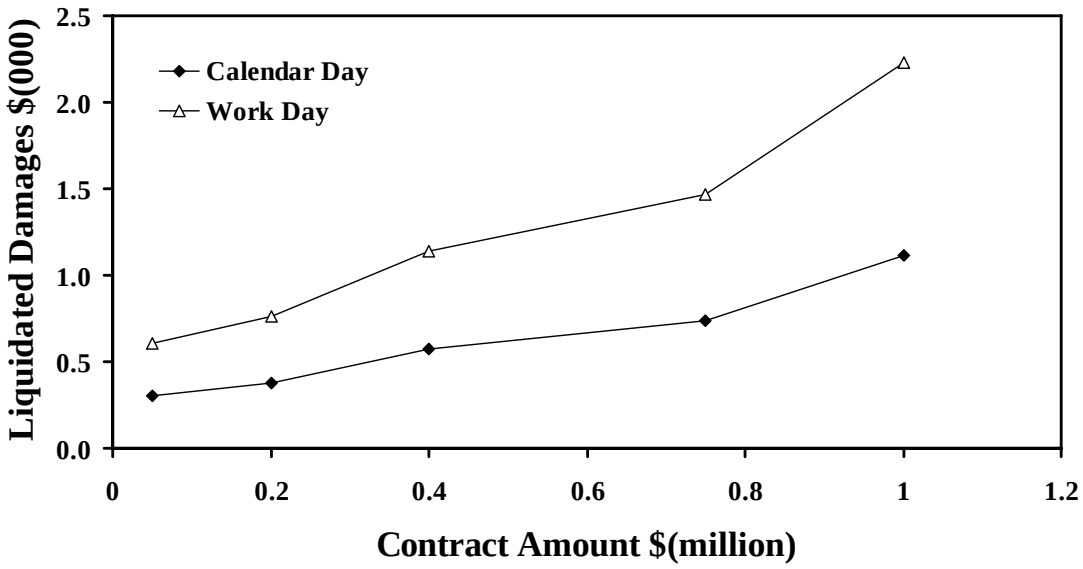

Figure A-34 Wisconsin DOT Schedule of Liquidated Damages.

WYOMING

Contract Value		Daily LD Rate
More Than	To and Including	Working Day
$0	$50,000	$250
$50,000	$100,000	$500
$100,000	$500,000	$750
$500,000	$2,000,000	$1,500
$2,000,000	$5,000,000	$1,800
$5,000,000	$7,500,000	$2,000
$7,500,000	$10,000,000	$2,500
$10,000,000	$15,000,000	$3,000
$15,000,000	$20,000,000	$3,500
$20,000,000	---	$4,000

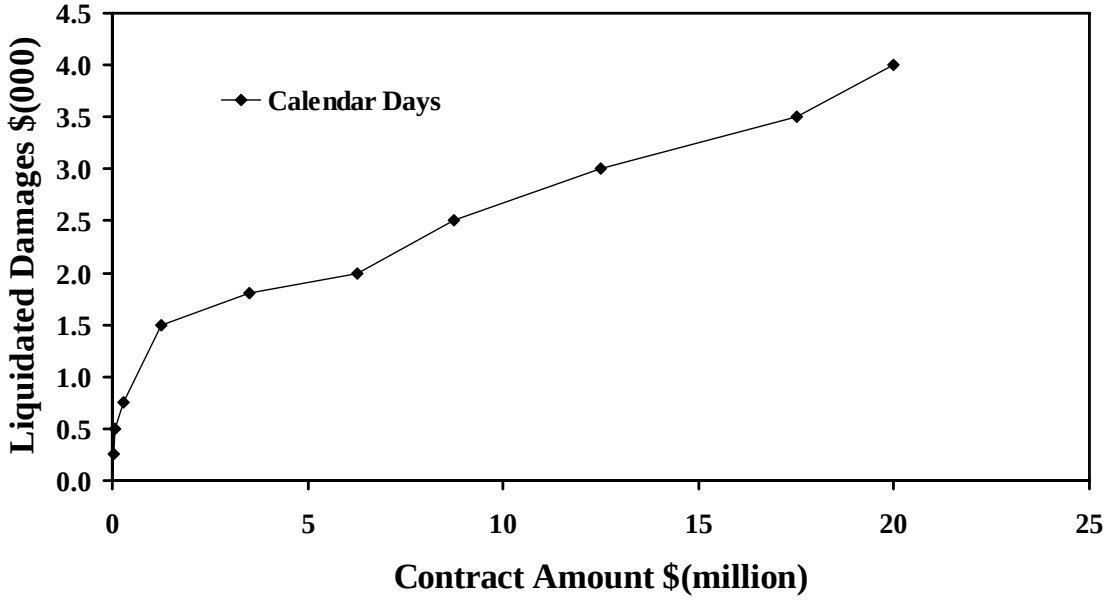

Figure A-35 Wyoming DOT Schedule of Liquidated Damages.

APPENDIX B

COPY OF ELECTRONIC SURVEY SUBMITTED TO SHAs

Evaluation and Assessment of SHA Liquidated Damages Provision

Thank you in advance for your participation.
Completed surveys will be used to evaluate the state-of-the-practice on the use of Liquidated Damages (LDs) by the State Highway Agencies (SHA). This e-survey of LD practices is divided into the following sections:

A. Contractual Principles
B. Current LD Contract Provisions
C. Contract Administration
D. Cost Estimation Practices
E. Legal Issues
F. Miscellaneous

Respondents to the survey will receive a summary of the survey results.

Start Survey!

Evaluation and Assessment of SHA Liquidated Damages Provision

1

Contact Information (To enable follow-up contact if required)

Responding Agency
Responding Individual
Title
Street Address
Unit,Suite, or Apt#
City, State
Zip Code
Telephone Number
Email

A. CONTRACTUAL PRINCIPLES

2

Does your agency stipulate Liquidated Damages (in lieu of recovering actual damages) as a contract provision on state and/or federal funded construction projects?

If your response is "NO", please discontinue survey and submit. Thank you!

YES NO

Please use comment box to provide clarifying remarks

Next

Survey Page 1

Evaluation and Assessment of SHA Liquidated Damages Provision

3

Does your agency have any declarative statements as to the purpose, scope, range, and intent of LD clauses in contractual documents or other agency manuals?

YES NO

Please use comment box to provide clarifying remarks

B. CONTRACT PROVISIONS

4

The duration of contracts subject to Liquidated Damages is specified using which of the following? *[check all that apply]*

- Calendar Days
- Work Days
- Fixed Calendar Date
- Other [please specify]

5

Does your agency assess hourly liquidated damages for working in excess of a typical 8-hour workday?

- Yes
- Yes, but project specific
- No

6

Does the contractual rate stipulated for Liquidated Damages by your agency vary based on project type? [i.e. Bridge, Highway, Maintenance Works, Widening, Buildings etc.]

YES NO

Please use comment box to provide clarifying remarks

7

Does your agency use incremental LD rates based on construction status? [i.e. Substantial completion; Physical Completion; Contract Completion]

YES NO

Please use comment box to provide clarifying remarks

8

Does your agency assess LDs by project phase?[i.e. intermediate phases, milestones, etc.]

YES NO

Please use comment box to provide clarifying remarks

9

Does completion of the project on time waive your agency's right to assess liquidated damages for delays in completing any intermediate phases?

YES NO

Please use comment box to provide clarifying remarks

10

What project delivery system does your agency typically use?

- Design-Bid-Build
- Design-Build
- Construction Management at Risk
- Construction Management at Agency
- Other [please specify]

11

Do the LD rates vary per delivery system?

YES NO

Please use comment box to provide clarifying remarks

12

Does your agency use and assess both Incentive/Disincentive and LD provisions simultaneously on construction contracts?

YES NO

Please use comment box to provide clarifying remarks

13

Is the definition of substantial completion written in the contract?

YES NO

Please use comment box to provide clarifying remarks

Next

Survey Page 2

Evaluation and Assessment of SHA Liquidated Damages Provision

C. COST ANALYSIS PROCEDURES | TECHNIQUES

14

Does your agency follow an established cost estimating technique/methodology in preparing liquidated damage estimates?

YES NO

15

Does your state have a standard project-staffing plan that is used as a framework for resource estimating associated with LD월?

YES NO

Please use comment box to provide clarifying remarks

16

Does your agency consider any factors other than basic engineering and inspection when computing LD rates?

YES NO

Please use comment box to provide clarifying remarks

17

Does your agency have worksheets that are used to calculate the individualized LD rates for specific projects?

YES NO

Please use comment box to provide clarifying remarks

18

How does your agency specify LD rates in contract specifications?

- Table of Average Costs
- Project Specific Cost
- Other [please specify]

19

Which department within your agency develops the liquidated damages rates? *[check all that apply]*

- Accounting
- Construction Bureau
- Engineering Design Bureau
- Administrative Staff
- Other [please specify]

Next

Survey Page 3

Evaluation and Assessment of SHA Liquidated Damages Provision

D. CONTRACT ADMINISTRATION

20

Who makes the determination of substantial completion? [e.g. resident engineer, chief engineer, consultants, etc.]

21

How often are LD provisions waived/reduced during or after construction?

- Never
- Sometime
- Often

22

How are the LDs waived/reduced?

- Granting Time Extensions
- Disregarding Contractual Provisions
- Adjusting Payment Documents during Processing
- Other [please specify]

23

If the LDs are waived, at what level is this decision made?

- State Level (e.g. Division / District / Bureau / etc)
- Local Level (e.g. Project / Resident / Field / etc)

24

Does your agency conduct a cost analysis/audit on selected projects to compare LDs to actual costs incurred? [i.e. a comparison of estimated damages vs. actual]

YES NO

If yes, is it a formalized review or an informal review?

Please use comment box to provide clarifying remarks

Next

Survey Page 4

Evaluation and Assessment of SHA Liquidated Damages Provision

E. LEGAL ISSUES

25

Has your LD provision ever been challenged in court?

YES NO

If yes, what was the verdict?

Next

Evaluation and Assessment of SHA Liquidated Damages Provision

26

What is the level of actual or pending litigation pertaining to liquidated damages for State DOT construction projects over the last decade?

- High (challenged more than 10 times)
- Medium (challenged 5 to 10 times)
- Low (challenged less than 5 times)
- None

27

If a court ruling voids the LD provision in a contract, would your agency pursue recovering the actual costs incurred?

- Yes
- No
- Not sure

28

Is there a legal precedent in your state that dictates how LDs are assessed?

YES NO

Please use comment box to provide clarifying remarks

Next

Evaluation and Assessment of SHA Liquidated Damages Provision

F. MISCELLANEOUS

29

How often does your agency update the schedule of liquidated damages rates being utilized in contracts?

- Every Year
- Every 2 Years
- Every 3 to 4 Years
- Every 5 Years
- We Have Never Updated the LD Rates
- We Use Project Specific Rates

30

Would your state be interested in adopting a model LD provisions?

- Highly Interested
- Moderately Interested
- Low Intrest
- No Interest
- Undecided

Next

Thank you for your time!

If you have any questions, please contact:

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Department of Civil Engineering
238 Harbert Engineering Center
Auburn University, AL 36849-5337
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APPENDIX C

SUMMARY OF SURVEY RESULTS

A Review and Evaluation of ALDOT's Liquidated Damages Provision

Summary of Survey Results

Abstract:
The following document is the summary of results from a survey that was conducted to evaluate the state-of-the-practice on the use of Liquidated Damages (LDs) by State Highway Agencies (SHA) across the nation. The e-survey tool used to evaluated LD practices consisted of 30 questions and was divided into the following sections: A. *Contractual Principles*, B. *Current LD Contract Provisions*, C. *Contract Administration*, D. *Cost Estimation Practices*, E. *Legal Issues*, and F. *Miscellaneous*. A 100% survey response rate was achieved. Fifty-three agencies responded that included all 50 DOTs, the District DOT (Washington, D.C.), the NJ Turnpike Authority, and the Puerto Rico Highway and Transportation Authority (PRHTA).

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Funding Agency:
Alabama Department of Transportation

Responding Agency	Abbreviation
Alabama Department of Transportation	ALDOT
Alaska Department of Transportation	AKDOT
Arkansas State Highway and Transportation Dept.	AHTD
Arizona Department of Transportation	ADOT
California Department of Transportation (Caltrans)	CALTRANS
Colorado Department of Transportation	CDOT
Connecticut Department of Transportation	ConnDOT
Delaware Department of Transportation	DelDOT
District Department of Transportation DDOT (District of Columbia)	DDOT
Florida Department of Transportation	FDOT
Georgia Department. of Transportation	GDOT
Hawaii Department of Transpiration	HDOT
Idaho Transportation Department	ITD
Illinois Department of Transportation	IDOT
Indiana Department of Transportation	INDOT
Iowa Department of Transportation	Iowa DOT
Kansas Department of Transportation	KDOT
Kentucky Department of Transportation	KYTC
Louisiana Department of Transportation & Development	LaDOTD
Maine Department of Transportation	MDOT (Maine)
Maryland Department of Transportation	MDOT (Maryland)
Massachusetts Department of Transportation	MHD
Michigan Department of Transportation	MDOT (Mich.)
Minnesota Department of Transportation	MnDOT
Mississippi Department of Transportation	MDOT (Miss.)
Missouri Department of Transportation	MoDOT
Montana Department of Transportation	MDT
Nebraska Department of Roads	NDOR
Nevada Department of Transportation	NDOT
New Hampshire Department of Transportation	NHDOT
New Jersey Department of Transportation	NJDOT
New Jersey Turnpike Authority	NJTA
New Mexico Department of Transportation	NMDOT
District Department of Transportation DDOT (NY)	NYSDOT
North Carolina Department of Transportation	NCDOT
North Dakota Department of Transportation	NDDOT
Ohio Department of Transportation	ODOT (Ohio)
Oklahoma Department of Transportation	ODOT (Okla.)
Oregon Department of Transportation	ODOT (Oregon)
Pennsylvania Department Of Transportation	PennDOT
Puerto Rico Highway and Transportation Authority	PRHTA
Rhode Island Dept of Transportation	RIDOT
South Carolina Department of Transportation	SCDOT
South Dakota Department of Transportation	SDDOT
Texas Department of Transportation	TxDOT
Tennessee Department of Transportation	TennDOT
Utah Department of Transportation	UDOT
Vermont Agency of Transportation	VDOT (Vermont)
Virginia Department of Transportation	VDOT (Virginia)
Washington State Department of Transportation	WSDOT
West Virginia Dept of Transportation, Division of Highways	WVDOT
Wisconsin Department of Transportation	WisDOT
Wyoming Department of Transportation	WYDOT

A. CONTRACTUAL PRINCIPLES

QUESTION 2: *Does your agency stipulate Liquidated Damages (in lieu of recovering actual damages) as a contract provision on state and/or federal funded construction projects? If your response is "NO", please discontinue survey and submit. Thank you!*

Total Responses	YES	NO	No Response
53	53	0	0
100%	100%	0%	0%

Please use comment box to provide clarifying remarks.

Responding Agency	Response	Comments
ALDOT	Yes	ALDOT specifies LD rates in Article 108.11 of Standard Specifications
AHTD	Yes	For each calendar day or working day, as specified, that work remains uncompleted after the contract time has expired, the sum specified in the proposal and Contract will be deducted from any money due the Contractor, not as a penalty, but as liquidated damages.
CALTRANS	Yes	Estimated rates based on general administrative costs, construction engineering costs, and field office overhead costs applicable to the project.
KDOT	Yes	We use a graduated table that is included in our Std. Specifications.
LaDOTD	Yes	On some projects, Louisiana uses A + B bidding & uses the same daily road user cost used in bidding as the late completion charge.
MDOT (Maine)	Yes	We have a schedule of liquidated damages based on the original contract amount.
NHDOT	Yes	We assess liquidated damages when a Contractor fails to complete the work by the Contract Completion Date. The Completion Date is adjusted for reason beyond the control of the contractor.
NCDOT	Yes	Liquidated damages are stipulated for all contracts.
PennDOT	Yes	We utilize Road Users Liquidated Damages (RULD) which are calculated based on a specific formula.
TennDOT	Yes	On some projects incentive/disincentive would be used in lieu of liquidated damages. The thought is that the administrative costs would be included in the I/D amount.
VDOT (Virginia)	Yes	VDOT has a standard table of Liquidated Damages based on awarded contract amounts.

QUESTION 2 continued: *Does your agency stipulate Liquidated Damages (in lieu of recovering actual damages) as a contract provision on state and/or federal funded construction projects? If your response is "NO", please discontinue survey and submit. Thank you!*

Responding Agency	Response	Comments
WSDOT[1]	Yes	Liquidated Damages may be assessed for failure to open lanes to traffic, these are based on cost to the traveling public. We may also assess liquidated damages for failure to complete project on time.
WSDOT[2]	Yes	See Standard Specification http://www.wsdot.wa.gov/fasc/EngineeringPublications/Manuals/2006SS.htm

Notes:

1. David M. Jones, Assistant Construction Engineer of the WSDOT was the respondent.
2. Craig McDaniel, State Construction Engineer of the WSDOT was the respondent.

A. CONTRACTUAL PRINCIPLES

QUESTION 3 *: Does your agency have any declarative statements as to the purpose, scope, range, and intent of LD clauses in contractual documents or other agency manuals?*

Total Responses	YES	NO	No Response
53	48	4	1
100%	91%	8%	2%

States responding "NO"		
DDOT	Iowa DOT	RIDOT
WYDOT		

Please use comment box to provide clarifying remarks.

Responding Agency	Response	Comments
ALDOT	Yes	Article 108.10 of Standard Specifications states that LDs are not a penalty, but are intended to compensate the State for increased time in administering the contract, supervision, inspection and engineering
ADOT	Yes	Section 108-1.07 Failure to complete on time of our Standard Specification for Highway Construction.
GDOT	Yes	Within our specifications we have such language as follows: For each day that any physical work remains uncompleted after the Required Completion date, the sum per day specified in the following schedule, unless otherwise stated in the proposal, will be deducted from money due or to become due. This deduction is not a penalty, but as Construction Engineering liquidated Damages.
KYTC	Yes	The entire statements---Because the prosecution of work in connection with the construction of road and bridge projects will inconvenience the public, obstruct traffic, and interfere with business, complete the work as quickly as practical. Also, the Department's costs for the administration of the Contract, including inspection, engineering, supervision, and maintaining detours, increases with the time that the Contractor takes to execute the work. When the Department allows the Contractor to continue and to finish the project beyond the Contract time, such permission does not operate as a waiver by the Department of any of its rights under the Contract.
LaDOTD	Yes	"the sum specified in table 108-1 will be deducted from payments for the work, not as a penalty but as stipulated damages."
MDOT (Maryland)	Yes	MD has a general provision for Liquidated Damages
MDT	Yes	The following is from the specification: "This deduction is for liquidated damages for added Department contract administration costs for failure to complete the work on time." There is additional background information in a write up to the Transportation Commission.
MDOT (Mich.)	Yes	C. Assessment Of Liquidated Damages. Sums assessed as Liquidated Damages shall be considered and treated not as a penalty but as fixed, agreed upon and liquidated damages due the Department from the Contractor by reason of inconvenience to the public, added cost of Engineering and supervision, maintenance of detours and other items that have caused an expenditure of public funds resulting from the Contractor's failure to complete the work or open the project to traffic within the time specified in the contract.

***QUESTION 3 continued** : Does your agency have any declarative statements as to the purpose, scope, range, and intent of LD clauses in contractual documents or other agency manuals?*

Responding Agency		Comments
NHDOT	Yes	LD is discussed in our Standard Specifications only (section 108.09). To my knowledge no other information is provided to the contractor.
NJDOT	Yes	NJDOT 2001 Standard Specifications state: "The Contractor and the Department recognize that delay in Completion results in damages to the State in terms of the effect of the delay on the use of the Project, upon the public convenience and economic development of the State, and also results in additional costs to the State for engineering, inspection, and administration of the Contract. Because it is difficult or impossible to accurately estimate the damages incurred; therefore, the parties agree that if the Contractor fails to complete the Contract within the time stated in these Special Provisions, or within such further time as may have been granted according to the provisions of the Contract, the Contractor shall pay the State liquidated damages according to those provided in the Special Provisions. Such liquidated damages shall be paid for each and every day, as hereafter, defined that the Contractor is in default to complete the Contract."
NJTA	Yes	107.07 Failure to Complete on Time. The Contractor and the Authority recognize that delay in completion of the Project will result in damage to the New Jersey Turnpike Authority in terms of the effect of the delay in the use of the Project upon the public convenience and the business reputation, economic status and loss of revenue of the New Jersey Turnpike, and will also result in additional cost to the Authority for engineering, inspection and administration of the Contract. Because some of this damage is difficult or impossible to calculate or estimate, the parties agree that if the Contractor fails to complete the Project and each and every part and appurtenance thereof fully, entirely, and in conformity with the provisions of the Contract within the time stated in the Contract, or within such further extension of time as may have been granted, the Contractor shall pay the Authority liquidated damages in the amounts set forth in the contract agreement in lieu of the above stated actual damage. Such liquidated damages shall be paid for each and every day that he is in default on time to complete the work.
NYSDOT	Yes	We have a liquidated damage provision for failing to complete the overall contract on time. We also have liquidated damage provisions in contracts with Time Related Provisions, i.e., contracts with milestones, Incentive/Disincentive, A+B Bidding, Lane Rental, etc. We also have a liquidated damage provisions in our M&PT specs for repeated failure to comply with the M&PT Provisions.
ODOT (Oklahoma)	Yes	Currently addressed in section 108.09 of specifications and will enhance the language with spec re-write underway
UDOT	Yes	Defined as: A predetermined sum to be assessed the Contractor. This sum is not considered as a penalty, but as liquidated damages due the Department by reason of inconvenience to the public, added cost of engineering and supervision, and other items for extra expenditures of public funds for the Contractor's failure as specified.
VDOT (Vermont)	Yes	We define the term in the Standard Specification. The Section 108.12 Failure to complete Work on Time also states "..not as a penalty but as liquidated damages to defray the cost to the Agency of the administration of the Contract, including but not limited to, the cost of engineering, inspection, supervision, inconvenience to the public, obstruction of traffic, and interference with business"
VDOT (Virginia)	Yes	The Road and Bridge Specifications, Section 108.12 states "The following Schedule of Liquidated Damages, representing the cost of administration, engineering, supervision, inspection and other expenses, will be charged against the Contractor for each calendar day beyond the contract time in which the Contract remains in an incomplete state."
WSDOT	Yes	http://www.wsdot.wa.gov/fasc/EngineeringPublications/ See page 1-50 of the construction manual

QUESTION 3 continued : *Does your agency have any declarative statements as to the purpose, scope, range, and intent of LD clauses in contractual documents or other agency manuals?*

Responding Agency	Response	Comments
IDOT	Yes	Our Standard Specifications explain this as follows: 108.09 Failure to Complete the Work on Time. Time is of the essence to the contract. Should the Contractor fail to complete the work within the working days stipulated in the contract or on or before the completion date stipulated in the contract or within such extended time as may have been allowed, the Contractor shall be liable and shall pay to the Department the amount shown in the following schedule of deductions, not as a penalty but as liquidated damages, for each day of overrun in the contract time or such extended time as may have been allowed. The liquidated damages for failure to complete the contract on time are approximate, due to the impracticality of calculating and proving actual delay costs. This schedule of deductions establishes the cost of delay to account for administration, engineering, inspection, and supervision during periods of extended and delayed performance. The costs of delay represented by this schedule are understood to be a fair and reasonable estimate of the costs that will be borne by the Department during extended and delayed performance by the Contractor of the work, remaining incidental work, correction of work improperly completed, or repair of work damaged I as a result of the Contractor. The liquidated damage amount specified will accrue and be assessed until final completion of the total physical work of the contract even though the work may be substantially complete. The Department will deduct these liquidated damages from any monies due or to become due to the Contractor from the Department. Art. 108.10 Prosecution and Progress 52 Schedule of Deductions for Each Day of Overrun in Contract Time Original Contract Amount Daily Charges From More Than To and Including Calendar Day Work Day $ 0 $ 25,000 $ 300 $ 400 25,000 100,000 375 500 100,000 500,000 550 750 500,000 1,000,000 725 1,000 1,000,000 2,000,000 900 1,250 2,000,000 3,000,000 1,100 1,500 3,000,000 5,000,000 1,300 1,800 5,000,000 7,500,000 1,450 2,000 7,500,000 And over 1,650 2,300 When a completion date is specified, the daily charge shall be made for every day shown on the calendar beyond the specified completion date. When the time limit is specified as working days, the daily charge shall be made for each additional working day, computed as specified in Article 108.04. If contracts are awarded on the basis of a multiple bid, the contract amounts of the individual contracts comprising the multiple bid shall be totaled and the daily charge shall be that required for such total amount.

B. CONTRACT PROVISIONS

QUESTION 4: *The duration of contracts subject to Liquidated Damages is specified using which of the following? [check all that apply]*

Total Responses	Calendar Days	Work Days	Fixed Calendar Date	Other
53	15	38	1	9
100%	28%	72%	2%	17%

Responding Agency	Other [please specify]
LaDOTD	A + B bidding, but b not called stipulated damages
MDOT (Miss.)	We use time units, which are similar to work days
MoDOT	A+B Incentive
NJDOT	Lane Occupancy Charges - applied per hour
PennDOT	Milestone Dates
VDOT (Vermont)	Interim completions for specific items or portions
WSDOT	Opening lanes to traffic

B. CONTRACT PROVISIONS

QUESTION 5: *Does your agency assess hourly liquidated damages for working in excess of a typical 8-hour workday?*

Total Responses	Yes	No	Yes, but project specific
53	0	45	8
100%	0%	85%	15%

Agencies that responded "Yes, but project specific"
ADOT
IDOT
KDOT
LaDOTD
NDOT
NJDOT
TxDOT
VDOT (Virginia)

B. CONTRACT PROVISIONS

QUESTION 6 *: Does the contractual rate stipulated for Liquidated Damages by your agency vary based on project type? [i.e. Bridge, Highway, Maintenance Works, Widening, Buildings etc.]*

Total Responses	Yes	No	No Response
53	6	47	0
100%	11%	89%	0%

Please use comment box to provide clarifying remarks.

Responding Agency	Response	Comments
CALTRANS	Yes	Currently it does, however, our next biannual revised rates will not vary by project-type criteria. They will only vary by bid amount ranges that will be provided in the next version of the Standard Specifications.
CDOT	No	Based on contract value.
FDOT	No	Based on dollar amount of the contract.
GDOT	No	Generally not but in some cases where inconvenience to the traveling public will be greater we increase the LD's.
HDOT	No	Traffic Volume
IDOT	No	See specs for comment regarding this.
INDOT	No	Based on contract amount
KYTC	No	Our rate varies by size of the project. On some large projects involving high traffic volumes, we set up incentive/disincentive clauses to encourage early completion. Lately, we have been mostly specifying extra disincentives, similarly to LD's. This rates are much higher than normal, usually around $10,000 per day.
LaDOTD	No	Louisiana calls them stipulated damages, but cost is the average inspection costs for all construction projects.
MDOT (Maryland)	No	based on the staff required for the dollar value of the contract
MHD	No	No it is based on the project value. Higher PV equals higher LD's.
MDT	No	The rates do not vary by work type, but vary by contract size (e.g. $0-$50,000, $50,001-$100,000, etc.).

***QUESTION 6 continued** : Does the contractual rate stipulated for Liquidated Damages by your agency vary based on project type? [i.e. Bridge, Highway, Maintenance Works, Widening, Buildings etc.]*

Responding Agency	Response	Comments
NJDOT	No	NJDOT 2001 Standard Specifications state: "The Contractor and the Department recognize that delay in Completion results in damages to the State in terms of the effect of the delay on the use of the Project, upon the public convenience and economic development of the State, and also results in additional costs to the State for engineering, inspection, and administration of the Contract. Because it is difficult or impossible to accurately estimate the damages incurred; therefore, the parties agree that if the Contractor fails to complete the Contract within the time stated in these Special Provisions, or within such further time as may have been granted according to the provisions of the Contract, the Contractor shall pay the State liquidated damages according to those provided in the Special Provisions. Such liquidated damages shall be paid for each and every day, as hereafter, defined that the Contractor is in default to complete the Contract."
NHDOT	No	We use a graduated charge based on the contract value.
NCDOT	No	Liquidated damages are based upon estimated CEI cost and road user cost and/or benefit.
NYSDOT	No	Standard Specifications - based on project bid value in a table. Sometimes altered by project specific provisions.
SCDOT	Yes	A+B Bid projects have LDs stipulated as the dollar value of the B-portion
UDOT	No	Based on dollar amount of contract and specified contract time...working day, calendar day, or completion date.
VDOT (Virginia)	No	VDOT has Schedule of LD's based on original contract amount for construction projects, but sometimes uses project specific LD's determined using Road User Impacts.
WYDOT	No	It is not by type but rather by contract dollar size.

Agencies that responded "Yes"
CALTRANS
DDOT
NJTA
ODOT (Ohio)
PRHTA
SCDOT

B. CONTRACT PROVISIONS

QUESTION 7 : *Does your agency use incremental LD rates based on construction status? [i.e. Substantial completion; Physical Completion; Contract Completion]*

Total Responses	Yes	No	No Response
53	15	38	0
100%	28%	72%	0%

Please use comment box to provide clarifying remarks.

Responding Agency	Response	Comments
ADOT	No	It is by original contract amount
CALTRANS	Yes	Standard LDs apply until contract acceptance (completion), Additional LDs based on road user delay costs may also apply if it is a contract utilizing A+B bidding (contractor also bids contract working days). Additional LDs apply if lane closures are continuing after expiration of contract working days.
FDOT	No	LD's begin being assessed when allowable contract time is exceeded.
IDOT	No	See specs for comment regarding this.
Iowa DOT	No	We are considering this
KYTC	Yes	Half rates when the road reopens to through traffic. This encourages the contractor to get the road to where the public has some use of it.
MHD	Yes	Once project is substantially complete and open to traffic the daily rate is reduced in half.
MnDOT	No	we do have a provision for waiving all or a portion of the LD assessment if the work is substantially complete
MoDOT	Yes	not as routine but sometimes the rates may drop after critical milestones or phases of construction
MDT	No	Liquidated damages are assessed when the physical work is complete (time charges are discontinued). Any charges for intermediate milestones are a penalty and are based on the road user impacts.
NJDOT	Yes	Typically NJDOT includes a rate for Substantial Completion and for Contract Completion.
NCDOT	Yes	Substantial completion is used on contracts with significant road user cost.

QUESTION 7 continued: *: Does your agency use incremental LD rates based on construction status? [i.e. Substantial completion; Physical Completion; Contract Completion]*

Responding Agency	Response	Comments
UDOT	Yes	Tabulated LD rates are for Substantial Completion. Contracts also stipulate the smallest (least) daily rate in the table for Substantial Completion to be used for failure to reach Physical Completion within 30 days of Substantial Completion, and $100/day for failure to reach Contract Completion within 30 days of Physical Completion
VDOT (Virginia)	No	Liquidated Damages are based on contract completion. Occasionally, VDOT will set millstone dates during the contract that have Incentive/Disincentive amounts tied to them.
WYDOT	Yes	It is not by type but rather by contract dollar size.

Agencies responding "Yes"
ADOT
DDOT
CALTRANS
HDOT
KDOT
KYTC
MHD
MoDOT
NCDOT
NJDOT
NDOT
PennDOT
UDOT
WSDOT
WYDOT

B. CONTRACT PROVISIONS

QUESTION 8 *: Does your agency assess LDs by project phase? [i.e. intermediate phases, milestones, etc.]*

Total Responses	Yes	No	No Response
53	30	23	0
100%	57%	43%	0%

Please use comment box to provide clarifying remarks.

Responding Agency	Response	Comments
ALDOT	No	The majority of ALDOT projects do not vary from the LDs listed in Article 108.11, but occasionally a project will contain a reduced LD rate for work to be accomplished in a particular phase of work. For example, if the work in that phase is estimated to equal 30% of the total cost of the work, the LD rate would be set at 30% of rate specified for the overall contract. This type of LD assessment would typically be used in a project with an I/D phase followed by a reduced LD rate phase.
CALTRANS	Yes	Yes, in standard special provisions, various project specific milestone assessments by both time and/or by dates
ConnDOT	No	On some projects, not on the majority of projects.
DelDOT[1]	Yes	This is done on a project specific basis. If there is a high road user cost, we may assess damages on interim milestones.
DelDOT[2]		We use user costs typically when tied to a milestone date.
FDOT	No	We do sometimes let contracts with incentive/disincentive clauses tied to milestones but these are not associated with LD's. LD's only begin being assessed when allowable contract time is exceeded.
GDOT	Yes	Not on all projects.
HDOT	Yes	There is a reduced LD amount after partial acceptance.
IDOT	Yes	1. On a project by project basis. 2. Project Specific
KYTC	Yes	This is a rare event.
MDOT (Maine)	No	Not a Standard Specification but added as a Special Provision on some projects.
MDOT (Mich.)	No	Some projects do assess interim LD's. This is a project specific LD issue and not a statewide specification issue.
MnDOT	No	In the past we have assessed LD's on intermediate phases. In the future we plan to assess LD's only on project completion.
MDOT (Miss)	No	Generally no. Rarely, for specific situations, we will have LD for failure to meet an intermediate deadline.

Notes:

1. Natalie Barnhart, Assistant Director, South Construction of DelDOT was the respondent.

2. Tom Greve, Group Engineer, South I Construction of DelDOT was the respondent.

***QUESTION 8 continued** : Does your agency assess LDs by project phase? [i.e. intermediate phases, milestones, etc.]*

Responding Agency	Response	Comments
MoDOT	Yes	In some contracts we have an open to traffic date and a final completion date.
MDT	No	Any charges for intermediate milestones are a penalty and are based on the road user impacts.
NDOT	Yes	Again, we normally call these incentives/disincentives
NJDOT	Yes	NJDOT may include completion dates for intermediate milestones, such as completion of a stage, opening of a ramp or bridge. These are used less frequently.
NHDOT	Yes	We use the standard when assessing LD for intermediate completion dates.
ODOT (Okla.)	No	We use a "disincentive rate" for milestones when needed by project specific specifications
PennDOT	Yes	Milestones and they are classified as Road Users LD
PRHTA	Yes	IF PROJECT IS A COMPLEX ONE (Puerto Rico Highway and Transportation Authority)
TennDOT	Yes	This has been done on a very limited basis. We generally look at I/D clauses on intermediate phases or milestones.
UDOT	No	Not generally, but sometimes on a project-by-project basis
VDOT (Vermont)	Yes	A design may require portions of a project be complete by specific days and liquidated damaged have been applied for failure to meet the interim completion. Example would be opening a bridge to traffic by a certain date.
VDOT (Virginia)	Yes	Used occasionally on specific projects where appropriate milestones can be determined.
WSDOT	Yes	Seldom and project specific
WisDOT	Yes	If added by special provision
WYDOT	Yes	These are established on a project by project basis in a construction requirement.

B. CONTRACT PROVISIONS

QUESTION 9: *Does completion of the project on time waive your agency's right to assess liquidated damages for delays in completing any intermediate phases?*

Total Responses	Yes	No	No Response
53	4	47	2
100%	8%	89%	4%

Please use comment box to provide clarifying remarks.

Responding Agency	Response	Comments
CALTRANS	No	Milestone (by specific date or internal time limit) assessment is completely separate from whole work assessment. However, a project with A+B bidding doesn't assess additional LDs when completion of project is on time.
CDOT	No	LD's can not be charged for intermediate phases. LD's are a charge to recover CDOT CE costs. There would be no lost CE costs at an intermediate phase of a project.
DelDOT	No	It would unless the contract documents specify that interim damages apply. Those damages would be assessed at the time of occurrence, not at the end of the project.
FDOT	No	FDOT doesn't tie LD's to intermediate phases of work so answer is really N/A.
HDOT	No	We have a reduced LD amount until final completion.
INDOT	No	Intermediate is most usually established by special provision to certain contracts.
KYTC	No	Again, it is rare for us to specify intermediate phase milestones to include LD's or other Disincentives.
MDOT (Mich.)	No	Assessment of LD's for intermediate phases is a project specific issue that the statewide specifications do not waive.
MDOT (Miss.)	Yes	We use incentive/disincentive clauses for intermediate completion dates.
MoDOT	No	damages may occur on internal milestones
MDT	No	Since penalties on intermediate milestones are based on road user impacts, this does not affect the assessment of liquidated damages. On select projects, the liquidated damages are included in the milestone incentive/disincentive. If this is done, liquidated damages are not assessed, as this would be assessing the same value twice.
NYSDOT	No	See previous response regarding different types of LD provisions.
ODOT (Okla.)	No	Not if specified by project specific provisions for disincentive rates, see Q8.

QUESTION 9 continued: *Does completion of the project on time waive your agency's right to assess liquidated damages for delays in completing any intermediate phases?*

Responding Agency	Response	Comments
PennDOT	No	Milestones are independent to the Completion of the project
SDDOT	No	Does not apply as we doe not assess based on interim milestones or phases.
TennDOT	No	When specified intermediate phases or milestones would stand on their own.
VDOT (Virginia)	No	Depends on the contract language as noted in question 8. The contract must be structured accordingly.
VDOT (Vermont)	No	Cannot come up with an example, but do not think this would waive our rights to assess on intermediate phases.

B. CONTRACT PROVISIONS

QUESTION 10 *: What project delivery system does your agency typically use?*

Total Responses	Design-Bid-Build	Design-Build	Const. Mgmt at Risk	Const. Mgmt at Agency	Other
52	45	12	3	7	1
100%	87%	23%	6%	16%	8%

Responding Agency	Other [please specify]
ITD	Low Bidder

Responding Agency	Response	Comment
FDOT	DBB	FDOT does many contracts with DB, some CM@risk
PennDOT	DBB, DB	Design Build Best Value
SCDOT	DBB, DB	A+B where A = Line Items B = Time bid. A+B+C where A=Line Items, B = Time Bid for entire project, and C= Bridge Closure Time
UDOT	DBB, DB	CMGC
VDOT (Vermont)	DBB	Agency design, bid and construction oversight.

B. CONTRACT PROVISIONS

QUESTION 11 : *Do the LD rates vary per delivery system? - Please use comment box to provide clarifying remarks*

Total Responses	Yes	No	No Response
53	9	42	2
100%	17%	79%	4%

Please use comment box to provide clarifying remarks.

Responding Agency	Response	Comments
ALDOT	Yes	Article 108.11 specifies LD rates under two headings: Working Day projects and Calendar Day/Date projects.
AHTD	No	Only use Design-Bid-Build. We are currently working towards Design Build.
IDOT	No	We basically only use Design-Bid-Build, but assume it would vary.
INDOT	No	Not by our Standard Specifications. Special Provisions to certain contracts could vary.
MDOT (Maryland)	No	varies by the staff required
MDOT (Mich.)	No	The other delivery systems have not been used enough to provide a comment.
MDOT[1] (Miss.)	No	Not necessarily for delivery systems. On projects we have contracted for CE&I, we will tie the LD to the approximate monthly cost to retain the CE&I contractor.
MDOT[2] (Miss.)		LD rates do vary but it's driven by project specifics more than delivery type. Rate would also vary for CE&I projects.
MoDOT	No	vary with impact to public and cost to MoDOT
ODOT (Oregon)	No	It could by special provision, but probably not because of a specific delivery system.
PennDOT	No	The LD calculations are based on user delays, ADT, and other factors.
UDOT	Yes	I'm not actually sure about this, but suspect at least some Design-Build projects have addressed LDs differently from the Department's standard specifications
WVDOT	No	Presently, this is our only project delivery system (DBB).
WYDOT	No	NA

Notes:

1. Brad Lewis, State Construction Engineer of the MsDOT was the respondent.

2. Billy R. Wilson, Assistant State Construction Engineer of the MsDOT was the respondent.

B. CONTRACT PROVISIONS

QUESTION 12 : *Does your agency use and assess both Incentive/Disincentive and LD provisions simultaneously on construction contracts?*

Total Responses	Yes	No	No Response
53	45	8	0
100%	85%	15%	0%

Please use comment box to provide clarifying remarks.

Responding Agency	Response	Comments
ADOT	Yes	On only one or two projects a year
CALTRANS	Yes	Decisions to use incentives and disincentives is made at the district level, however, justification is needed.
ConnDOT	Yes	Occasionally, but not the norm.
GDOT	Yes	On selected projects.
INDOT	Yes	By Special Provision only.
Iowa DOT	No	Not currently. We used to do this, but have separated the I/D portion.
KYTC	Yes	Technically yes, but it has never came into play. Our LD's are part of the standard specs, and we would have to put in special contract language to make the LD's not apply
LaDOTD	Yes	Louisiana uses the same daily road user cost for late completion, but does not refer to them as LDs.
MDOT (Maine)	No	Occasionally. 1 or 2 projects a year
MHD	No	We currently do not used incentive/disincentive provisions.
MoDOT	Yes	Where applicable
NJDOT	Yes	Incentive/Disincentives are not commonly used. NJDOT uses them only on large projects with very significant traffic impacts.
NJTA	Yes	very few projects
NHDOT	Yes	We don't use I/D clauses in our contracts and when we do, more times than not we don't waive the LD clause of our contracts. We do however try not to penalize a contractor twice for the same delay.
NDDOT	Yes	Sometimes we do not assess both.
ODOT (Okla.)	Yes	We have specific language that states each rate represents different costs and the can be addressed concurrently
PRHTA	Yes	For special projects

***QUESTION 12 continued** : Does your agency use and assess both Incentive/Disincentive and LD provisions simultaneously on construction contracts?*

Responding Agency	Response	Comments
TennDOT	No	Generally no, some projects may have stipulated both.
UDOT	Yes	Sometimes Not that incentives and disincentives are based on user costs (excluding engineering costs) and LDs are based on engineering costs (exclude user costs)
VDOT (Virginia)	Yes	Only a limited number of contracts have Incentive/Disincentive provisions, all contracts have Liquidated Damages
WVDOT	Yes	When I/D clauses are used.

B. CONTRACT PROVISIONS

QUESTION 13: *Is the definition of substantial completion written in the contract?*

Total Responses	Yes	No	No Response
53	36	17	0
100%	68%	32%	0%

Please use comment box to provide clarifying remarks.

Responding Agency	Response	Comments
ALDOT	No	Article 105.15 addresses "Acceptance" but does not specifically define substantial completion.
AHTD	Yes	When all pay items are completed.
ADOT	Yes	See Section 101-1.03 Definitions.
CALTRANS	No	Instead, we have "...in case all the work called for under the contract in all parts and requirements is not finished or completed within the number of working days...and it is therefore agreed the Contractor will pay...the sum set forth..." This requires more than just "substantial completion". I would recommend avoiding use of "substantial completion," because it is a vague, subjective, ambiguous phrase, that would lead to disputes. Would lead to dispute over what is considered essential. Some parts of the contract, such as clean-up, removal of signs, grading, etc could be considered nonessential, and therefore not part of a "substantial completion" requirement.
FDOT	No	FDOT allows partial acceptance only for moveable bridges. All others are based on FDOT determination of Final Acceptance.
IDOT	Yes	We use the date specified in the contract or working days provided with a definition of completion in the standard specs.
INDOT	Yes	In our Standard Specifications.
Iowa DOT	Yes	Article 1108.09 provides conditions for which LDs may be waived.
MDOT (Maine)	No	We got away from "substantially complete" a few years ago since this term is open to interpretation. We only have "complete" now.
MHD	Yes	Substantial completion is when 99% of the work is done.
MnDOT	No	sometimes addressed in the Special Provisions (i.e. ... roadway open to two lanes of traffic..)
MDOT (Miss.)	Yes	Substantial completion is not a part of our standard specifications, however it is defined in the contracts in which it is used.
MoDOT	No	do have provision for partial acceptance
NHDOT	Yes	The Work will be considered substantially complete when all necessary signing, striping, guardrail, and other safety appurtenances have been installed.
NYSDOT	No	We have language that details Final Acceptance and Final Agreement.

QUESTION 13 continued: *Is the definition of substantial completion written in the contract?*

Responding Agency	Response	Comments
ODOT (Oregon)	No	Oregon does not use the term substantial completion. We do have a term called Second Notice which is similar and is defined in our specifications as follows: (g) End of Contract Time - When the Engineer determines that the Work has been completed, except for the items listed below, the Engineer will issue a Second Notification. The Second Notification will list: • The date the time charges stopped; • Final trimming and cleanup tasks (See 00140.90); • Equipment to be removed from the Project Site; • Minor corrective work not involving additional payment to be completed; and • Submittals, including without limitation all required certifications, bills, forms, warranties, certificate of insurance coverage (00170.70(b)), and other documents, required to be provided to the Engineer before Third Notification will issue.
ODOT (Okla.)	Yes	In the contract for I/D provisions. Otherwise it is in the specifications as a general definition
PennDOT	Yes	For the purposes of conducted the Final Inspection
TennDOT	Yes	We define "Acceptance" and "Determination of Time for Completion" of which both are very broad in nature.
VDOT (Vermont)	Yes	"Substantial Completion date shall be the date when, in the opinion of the engineer, the work under the Contract has been sufficiently completed, to enable use of the project or facilities by the Agency for the purpose originally intended" We are careful to apply this consistently for similar scopes of work across the State.
VDOT[1] (Vir.)	Yes	This varies. We do define Substantial Completion on design-build projects, but do not routinely do so on design-bid-build projects.
VDOT[2] (Vir.)		VDOT only occasionally defines substantial completion in a contract
WSDOT	Yes	See page 1-84 of the Standard Specifications
WVDOT	No	And this sometimes causes problems. Substantial completion can vary by District and their opinion.

Notes:

1. Kerry A. Bates, Assistant Director - Innovative Project Delivery of VDOT, was the respondent.
2. Dennis W. Motley, Engineer II of VDOT was the respondent.

C. COST ANALYSIS PROCEDURES/TECHNIQUES

QUESTION 14: *Does your agency follow an established cost estimating technique/methodology in preparing liquidated damage estimates?*

Total Responses	Yes	No	No Response
53	42	11	0
100%	79%	21%	0%

Agencies responding "No"
ALDOT
ADOT
DDOT
InDOT
KYTC
NYSDOT
ODOT (Ohio)
ODOT (Okla.)
PRHTA
RIDOT
WYDOT

C. COST ANALYSIS PROCEDURES/TECHNIQUES

QUESTION 15 : *Does your state have a standard project-staffing plan that is used as a framework for resource estimating associated with LD's?*

Total Responses	Yes	No	No Response
53	10	43	0
100%	19%	81%	0%

Please use comment box to provide clarifying remarks.

Responding Agency	Response	Comments
FDOT	No	FDOT uses the historical Consultant and in-house CEI costs in determining LD rates.
IDOT	Yes	We use actual staffing and time based on past projects.
InDOT	No	Currently developing a plan.
MDOT (Maine)	No	LDs based on actual average charges to past projects.
MDOT (Maryland)	Yes	Staffing plan based on dollar value of contract and inspection requirements
MDOT (Mich.)	Yes	As I understand it, somewhat of a standard staffing plan was used when the LD's were estimated numerous years ago.
MDOT (Miss.)	Yes	generalized project staffing requirements based on contract amounts.
MDT	No	The LD rates are established using historical data, not future projections.
NJDOT	Yes	Road User Cost Manual can be found at: http://www.state.nj.us/transportation/eng/documents/RUCM/index.shtml
NCDOT	No	One component of liquidated damages is CEI cost based upon the estimate contract value.
NDDOT	No	We look at actual engineering and inspection costs to set our LD rates
ODOT (Okla.)	No	Are currently evaluation historical costs on previous projects.
SCDOT	No	Historical Data
WYDOT	No	we used a range of various projects and then obtained the actual costs charged by the department personnel. Used this information to set the damages.

Agencies that responded "Yes"	
ADOT	MDOT (Mich.)
CALTRANS	MDOT (Miss.)
HDOT	NDOT
IDOT	NJDOT
MDOT (Maryland)	PennDOT

C. COST ANALYSIS PROCEDURES/TECHNIQUES

QUESTION 16: *Does your agency consider any factors other than basic engineering and inspection when computing LD rates?*

Total Responses	Yes	No	No Response
53	20	33	0
100%	38%	62%	0%

Please use comment box to provide clarifying remarks.

Responding Agency	Response	Comments
CALTRANS	Yes	also some general administrative costs and all field office overhead costs.
CDOT	Yes	At the time the LD table is calculated the current CE rate is the factor.
ConnDOT	Yes	Supervision also.
FDOT	Yes	Florida Statutes 337 require use of Road User costs and CEI costs for determination of LD rates.
GDOT	Yes	On some major projects.
HDOT	Yes	We also use traffic volume.
IDOT	No	However, for incentive/disincentive clauses we may include user delay costs.
InDOT	Yes	Occasionally estimate user costs for high profile projects.
Iowa DOT	No	Not typically. Occasionally user costs are considered.
LaDOTD	No	Answer is no because we don't refer to them as LDs on A + B projects.
MDOT (Maine)	No	Rarely we include user costs
MDOT (Mich.)	No	To the best of my knowledge and based on discussion with previous staff I do not think so. The rates were calculated numerous years ago and we are in the process of reviewing and updating our rates.
MDOT (Miss.)	No	on some projects we have used road user costs in addition to engineering and inspection costs.
MoDOT[1]	Yes	Traffic volumes.
MoDOT[2]	Yes	impact to public and impact to MoDOT
NDOR	Yes	We calculate our total in-house operational cost for our field offices, materials testing and central construction office.

Notes:

1. David Ahlvers, State Construction & Materials Engineer of MoDOT was the respondent.

2. Al Kladiva, Assistant State Construction & Materials Engineer of MoDOT was the respondent.

QUESTION 16 continued: *Does your agency consider any factors other than basic engineering and inspection when computing LD rates?*

Responding Agency	Response	Comments
NDOT	Yes	we include vehicle and flagger costs as well as consultant staffing costs
NJDOT	Yes	NJDOT includes road user costs, but caps those costs at $10,000/day.
NCDOT	Yes	Road user cost and/or benefit.
NYSDOT	Yes	For normal contract completion, LDs are based on contract bid value as detailed in Standard Specifications. For Time Related Provisions, LDs are based on the calculated/estimated actual user delay or impact costs.
ODOT (Ohio)	No	ODOT's process for determining LDs is as follows: 1. Obtain all projects closed within the last calendar year. 2. Divide them into the different categories by original contract amount. 3. Count the number of projects in each category, and randomly take a sample of each category. 4. From that sample, we need to calculate the number of work days there were for each project. We count all business days and 25% of the weekends. 5. Then determine if there were any days waived from liquidated damages on the project. If so, deduct them from the number of original work days. This will become the actual work days. 6. Then get the Actual Construction Engineering Cost for TMS. 7. Then we multiply this figure by 2.5 in order to arrive at the actual overhead & fringe benefit rate of 150%. (Note: we only bill FHWA for overhead/fringe at a rate of 100% but our true overhead/fringe rate for 2002 was approximately 152%. Therefore, in calculating the liquidated damages we round to 150% to ensure actual costs plus true overhead/fringe cost are accounted for) 8. These costs are then divided by the actual number of work days less waived days to get the actual rate. 9. Then take an average of all sample projects in each category to determine the average amount.
ODOT (Okla.)	No	May use a multiplier to CE&I costs to represent overhead, in the future.
PENNDOT	Yes	Inconvenience to user.
SCDOT	Yes	on A+B projects user delays are included; on A+B+C projects, user delays or detour routes
VDOT (Virginia)	Yes	Sometimes include Road User Impacts as approved by FHWA.

C. COST ANALYSIS PROCEDURES/TECHNIQUES

QUESTION 17 *: Does your agency have worksheets that are used to calculate the individualized LD rates for specific projects?*

Total Responses	Yes	No	No Response
53	14	39	0
100%	26%	74%	0%

Please use comment box to provide clarifying remarks.

Responding Agency	Response	Comments
AHTD	Yes	A chart attached as a Special Provision in all contracts.
CALTRANS	Yes	Currently "Yes", a formula is used by the designer. For the next biannual LD calc revision "No", we will eliminate the formula and use only bid amount ranges for LD rates and show them in the Standard Specifications.
FDOT	No	FDOT uses historical records (spreadsheets) in determining LD rates. These are tabulated and included in the Standard specifications and are updated every two years.
IDOT	Yes	We have a table in our standard specs.
InDOT	Yes	For calculating user costs
MDOT (Maryland)	Yes	chart based on staffing required for dollar value of the contract
MDOT (Miss.)	No	x dollars per day specified in either std specifications or the contract.
MDT	No	LD's are not calculated for specific projects. An Oracle report is used to generate the rate table using historical data.
TennDOT	No	We use actual administrative costs assigned to completed projects over the previous two year period. The projects are sorted based on size and the LD are derived from an average of the projects in a specific dollar range.
SCDOT	Yes	FHWA Program for calculating Impacts
VDOT (Vermont)	No	The LD values are tabulated for project construction costs and included in the Standard Specifications.
WVDOT	No	We look at our cost for this on a 2 year cycle and publish in the contract provisions prior to bid.

C. COST ANALYSIS PROCEDURES/TECHNIQUES

QUESTION 18 *: How does your agency specify LD rates in contract specifications?*

Total Responses	Table of Average Costs	Project Specific Cost	Other
53	30	13	10
100%	57%	25%	19%

Responding Agency	Other [please specify]
AHTD	Table of Daily Charge/Contract Amount
ADOT	Table of Average cost and Project specific
GDOT	by contract amount.
Iowa DOT	LD rate listed on each proposal
NJDOT	stated in contract agreement
NCDOT	Both Table of Avg Cost and Project Specific Cost
NYSDOT	See answer to #16.
PRHTA	Instruction to Bidders
TxDOT	LD Rates per Total Project Cost
WSDOT	Formula

Responding Agency	Response	Comments
MDOT (Mich.)	Table	LD rates are specified by original contract amount
ODOT (Okla.)	Proj. Spec.	will use "table" in future contracts, currently implementing.

C. COST ANALYSIS PROCEDURES/TECHNIQUES

QUESTION 19 *: Which department within your agency develops the liquidated damages rates? [check all that apply]*

Total Responses	Accounting	Construction Bureau	Engineering Design Bureau	Administrative Staff	Other
53	1	32	13	2	9
100%	2%	60%	25%	4%	28%

Please use comment box to provide clarifying remarks.

Responding Agency	Other [please specify]
ADOT	Design & Construction Standards
CDOT	Project Development Branch
DelDOT	Quality Section in charge of maintaining Standards
Iowa DOT	Office of Contracts
MDOT (Miss.)	Audit Division
MDOT (Maine)	Contracts Section
NJDOT	Quality Management Services - Value Management
NCDOT	Traffic Engineering, and Contracting Office
ODOT (Ohio)	We are negotiating with DOJ at this time.
PRHTA	Estimates and Contracting Office

Responding Agency	Response	Comments
CALTRANS	Const., Eng	Construction develops, but Design calcs for proj.
ODOT (Okla.)	Const.	Our contracts and proposal (Office Engineer) division
VDOT (Vermont)	Const.	Specification Committee & FHWA
WSDOT	Eng..	Transportation Data Office, interim LD's

Notes:

3 agencies checked both Construction and Engineering Bureaus: CALTRANS, DDOT, VDOT

1 agency checked both Engineering Bureau and Administrative Staff: MoDOT

D. CONTRACT ADMINISTRATION

QUESTION 20: *Who makes the determination of substantial completion? [e.g. resident engineer, chief engineer, consultants, etc.]*

Total Responses	Resident [Project] Engineer*	Chief Engineer	Consultants	District [Area] Engineer*	Other	No Response
53	42	1	0	10	4	1
100%	79%	2%	0%	19%	8%	2%

Responding Agency	Other [please specify]
CALTRANS	no one determines "substantial completion". The resident engineer determines when all work included in the contract is entirely finished and completed.
MDOT (Maine)	We only have complete or not complete
MoDOT	We do not use substantial completion
NYSDOT	Engineer-in Charge, together with Regional Construction Engineer.

Responding Agency	Response	Comments
MDOT (Maryland)	District	Resident engineer notifies District office.
MDOT (Mich.)	Resident	Project Engineer (This can be the Resident Engineer or a Consultant Engineer, if hired, or the Local Agency Engineer if a local agency project).
VDOT (Vermont)	Resident	Resident Engineer, usually will consult with Regional Construction Engineer. Some Contract documents will specify what must be complete for SC.

Notes:

* 5 agencies checked both Resident and District Engineers: DelDOT, GDOT, NDOT, NHDOT, VDOT

D. CONTRACT ADMINISTRATION

QUESTION 21 *: How often are LD provisions waived/reduced during or after construction?*

Total Responses	Never	Sometimes	Often	No Response
53	1	46	6	0
100%	2%	87%	11%	0%

Notes:

PRHTA responded "Never"

D. CONTRACT ADMINISTRATION

QUESTION 22: *How are the LDs waived/reduced?*

Total Responses	Granting Time Extensions*	Disregarding Contractual Provisions	Adjusting Payment Documents during Processing*	Other	No Response
53	48	0	3	5	0
100%	91%	0%	6%	9%	0%

Responding Agency	Other [please specify]
CALTRANS	by Director Days, grants time ext/partial relief
MDOT (Maine)	Meeting with DOT & FHWA to determine
MHD	When there are extenuating circumstances
MnDOT	based on contract provisions or claim settlement
NDOT	Bargaining tool for claim avoidance

Notes:

* 3 agencies checked both Time Extensions and Payment Adjusting: FDOT, MoDOT, NYSDOT

Responding Agency	Response	Comments
ALDOT	Time Ext.	Time extensions/suspensions often reduce LDs
ASDOT	Time Ext.	By Change Order.
CDOT	Time Ext.	Adjusting Time charges
FDOT	Time/Pmnt	Assessment of actual costs on occasion when differ
IDOT[1]	Time Ext.	Not appropriately applied. Contractor requests ext.
IDOT[2]	Time Ext.	Contractor Claims or special circumstances
KDOT	Time Ext.	very seldom, situations beyond control
LaDOTD	Time Ext.	Must have valid justification for extension.
MDOT (Mich.)	Time Ext.	Processing Contract Modifications
MDOT (Miss.)	Time Ext.	time extension based on actual final quantities
MDT	Time Ext.	Adjusting the time assessments, if justifiable.
NJDOT	Time Ext.	LDs may be included in a claim settlement
NCDOT	Time Ext.	LDs are waived as provided by specifications.
NYSDOT	Time/Pmnt	based on CPM analysis
PENNDOT	Time Ext.	For specific issues outside contractor's control.
VDOT (Vermont)	Time Ext.	Settling claims
WyDOT	Time Ext.	Processing of contract amendments for change

Notes:

1. Roger Drisk, Engineer of Construction of IDOT, was the respondent.
2. Michael Renner, Construction Operations Engineer of IDOT, was the respondent.

D. CONTRACT ADMINISTRATION

QUESTION 23 *: If the LDs are waived, at what level is this decision made?*

Total Responses	State Level[1]	Local Level[2]	No Response[3]
53	40	11	2
100%	75%	21%	4%

Notes:

1. State Level includes: Division / District / Bureau / etc.
2. Local Level includes: Project / Resident / Field / etc.
3. The non-responding agencies were NJTA and NYSDOT

D. CONTRACT ADMINISTRATION

QUESTION 24: *Does your agency conduct a cost analysis/audit on selected projects to compare LDs to actual costs incurred? [i.e. a comparison of estimated damages vs. actual]*

Total Responses	Yes	No	No Response
53	12	41	0
100%	23%	77%	0%

If yes, is it a formalized review or informal review? Please use comment box to provide clarifying remarks.

Responding Agency	Response	Comments
ADOT	Yes	Informal review by our Specifications Engineer.
CALTRANS	No	Has not been needed to be done. Probably would if requested by our Legal Division.
ConnDOT	Yes	Formalized
IDOT[1]	No	However, actual costs in the past are what are used to determine the LD's
ODOT (Ohio)	No	Time adjustments of up to 14 days are at the local level, anything above that is at the State level.
MDOT (Maine)	Yes	Average of all projects
MNDOT	Yes	formal review
MDT	Yes	An informal review may be performed.
ODOT (Okla.)	Yes	Currently, trying to formalize has been informal in the past
SCDOT	Yes	Informal
VDOT (Virginia)	Yes	Occasionally do informal reviews, normally at Local level (Residency)
WyDOT	Yes	Only when updating the specifications for liquidated damages. Usually at time of new spec book development.

Agencies that responded "Yes"
AHTD
AKDOT
ConnDOT
MDOT (Maryland)
MDOT (Maine)
MNDOT
MODOT
MDT
ODOT (Okla.)
SCDOT
VDOT (Virginia)
WYDOT

Notes:

1. Roger Drisk, Engineer of Construction of IDOT, was the respondent.

2. Michael Renner, Construction Operations Engineer of IDOT, was the respondent.

E. LEGAL ISSUES

QUESTION 25 *: Has your LD provision ever been challenged in court?*

Total Responses	Yes	No	No Response
53	11	42	0
100%	21%	79%	0%

If yes, what was the verdict?

Responding Agency	Response	Comments
ALDOT	Yes	Two suits were settled out of court. Others are still on-going.
CALTRANS	Yes	Re. our standard LD provision: Challenged in arbitration. Verdict for the State. Re. LD provisions edited at district (local) level: challenged in arbitration and some verdicts for the Contractor due to district level failures in editing.
IDOT	Yes	Not on the State level. A Local Agency, using our specs, was taken to court. The judge ruled the damages were excessive.
Iowa DOT	Yes	The daily rate was challenged on a County project. The County lost because they had established an arbitrary rate.
LaDOTD	No	No, But presently having first case challenging our daily road user cost used for late completion.
MDOT (Maryland)	Yes	both ways, but as long as we could prove that the cost was strictly for the salaries of the staff we usually win
MDOT (Mich.)	Yes	From what I understand it has always been upheld in the courts.
MoDOT	Yes	[No comment supplied]
MDT	Yes	The provision is currently being challenged. The outcome has yet to be determined.
NYSDOT	Yes	[No comment supplied]
PennDOT	Yes	upheld due to the reasonable basis of our calculations
SCDOT	Yes	Amount of LD was challenged and we had to reduce out actual cost incurred. This was not on an A+B project, in which case we would have included our user delays etc. in the LD
VDOT (Virginia)	No	Not for design-build projects.

E. LEGAL ISSUES

QUESTION 26 *: What is the level of actual or pending litigation pertaining to liquidated damages for State DOT construction projects over the last decade?*

Total Responses	High[1]	Medium[2]	Low[3]	None
11	0	1	10	0
100%	0%	9%	91%	0%

Notes:

1. High = challenged more than 10 times
2. Medium = challenged 5 to 10 times
3. Low = challenged less than 5 times

Responding Agency	Level
ALDOT	Medium
CALTRANS	Low
Iowa DOT	Low
MDOT (Maryland)	Low
MDOT (Mich.)	Low
MoDOT	Low
MDT	Low
NYSDOT	Low
ODOT (Okla.)	Low
PennDOT	Low
SCDOT	Low

E. LEGAL ISSUES

QUESTION 27 *: If a court ruling voids the LD provision in a contract, would your agency pursue recovering the actual costs incurred?*

Total Responses	Yes	No	Not Sure	No Response
11	4	2	5	0
100%	36%	18%	45%	0%

Responding Agency	Response
MoDOT	Yes
IDOT	Yes
PennDOT	Yes
SCDOT	Yes
CALTRANS	No
NYSDOT	No
ALDOT	Not sure
Iowa DOT	Not sure
MDOT (Maryland)	Not sure
MDOT (Mich.)	Not sure
MDT	Not sure
ODOT (Okla.)	Not sure

E. LEGAL ISSUES

***QUESTION 28** : Is there a legal precedent in your state that dictates how LDs are assessed?*

Total Responses	Yes	No	No Response
11	6	5	0
100%	55%	45%	0%

Please use comment box to provide clarifying remarks.

Responding Agency	Response	Comments
CALTRANS	Yes	PCC 10226 - cannot be "manifestly unreasonable" and are deducted from costs owed to the contractor.
MDOT (Maryland)	Yes	[No Comment]
MDOT (Mich.)	Yes	As I understand it, the Court enforced MDOT's liquidated damages clause over a decade ago in a court case.
MDT	No	LDs are assessed per CFR.
NYSDOT	Yes	I believe so.
PennDOT	Yes	[No Comment]
ODOT (Okla.)	No	Not that I am aware of
SCDOT	Yes	Only recoup actual damages of contested

F. MISCELLANEOUS

Question 29 *: How often does your agency update the schedule of liquidated damages rates being utilized in contracts?*

Total Responses	Every Year	Every 2 Years	Every 3 to 4 Years	Every 5 Years	Never	Use Project Specific Rates	No Response
53	1	22	11	8	3	6	2
100%	2%	42%	21%	15%	6%	11%	4%

F. MISCELLANEOUS

QUESTION 30 *: Would your state be interested in adopting a model LD provisions?*

Total Responses	Highly Interested	Moderately Interested	Low Interest	No Interest	Undecided	No Response
53	4	24	4	5	16	0
100%	8%	45%	8%	9%	30%	0%

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APPENDIX D:

HISTORICAL PROJECT DATA USED FOR CALCULATIONS

represents an outlier based on E&I as a percentage of Contract Value

represents an outlier identified by both

represents an outlier based on Dollars used per day

OUTLIER ANALYSIS

	%	Log %
Average	10.251%	-1.271
stdev	11.350%	0.653
# of stdev		2
upper	108.649%	0.04
lower	0.265%	-2.58

	Log %
Average	4.073
stdev	0.339
# of stdev	2
upper	4.75
lower	3.40

Data Used for LD calculations

CPMS Proj #	Size	Original Contract Amt	C/W	Code Description	Completion Date	Days Used	E&I Amt	Daily E&I	% E&I to CV	Log % E&I	outlier (2stdev)	Contract $$ per Day	Log $perDay	outlier (2stdev)
100042754	2	$113,898	W	Unclassified	12/16/2003	46	$139,219.59	$3,026.51	122.2318%	0.08718	1	$2,476.04	3.3938	1
100043023	2	$139,798	W	Unclassified	10/27/2003	30	$175.00	$5.83	0.1252%	-2.90246	1	$4,659.93	3.6684	0
100041521	2	$144,143	W	Traffic Striping, Pave	12/19/2003	36	$158,638.53	$4,406.63	110.0564%	0.04162	1	$4,003.97	3.6025	0
100042967	2	$149,624	W	Unclassified	7/13/2003	15	$10.25	$0.68	0.0069%	-4.16428	1	$9,974.93	3.9989	0
100041176	3	$211,856	W	Unclassified	1/22/2003	34	$503.48	$14.81	0.2377%	-2.62406	1	$6,231.06	3.7946	0
100042464	3	$214,089	W	Unclassified	7/22/2003	12	$175.00	$14.58	0.0817%	-3.08756	1	$17,840.75	4.2514	0
100044609	3	$351,144	W	Unclassified	1/4/2005	47	$136.96	$2.91	0.0390%	-3.40889	1	$7,471.15	3.8734	0
100045875	3	$356,040	W	Unclassified	10/15/2005	45	$259.70	$5.77	0.0729%	-3.13703	1	$7,912.00	3.8983	0
100044442	3	$390,052	W	Unclassified	1/11/2005	43	$810.55	$18.85	0.2078%	-2.68234	1	$9,070.98	3.9577	0
100044379	3	$435,548	W	Unclassified	11/19/2004	18	$393.32	$21.85	0.0903%	-3.04429	1	$24,197.11	4.3838	0
100044462	3	$466,325	W	Unclassified	8/30/2004	27	$25.28	$0.94	0.0054%	-4.26591	1	$17,271.30	4.2373	0
100039279	4	$538,995	W	Unclassified	9/30/2003	35	$360.68	$10.31	0.0669%	-3.17446	1	$15,399.86	4.1875	0
100037723	4	$616,788	W	Unclassified	10/25/2004	28	$460.51	$16.45	0.0747%	-3.12690	1	$22,028.14	4.3430	0
100033867	4	$630,342	W	Unclassified	4/28/2004	28	$1,301.77	$46.49	0.2065%	-2.68504	1	$22,512.21	4.3524	0
100042902	4	$670,163	W	Unclassified	12/15/2003	36	$275.00	$7.64	0.0410%	-3.38685	1	$18,615.64	4.2699	0
100042821	4	$750,169	W	Unclassified	4/19/2004	28	$24.91	$0.89	0.0033%	-4.47879	1	$26,791.75	4.4280	0
100041093	4	$779,863	W	Unclassified	8/1/2003	47	$887.82	$18.89	0.1138%	-2.94369	1	$16,592.83	4.2199	0
100044286	4	$872,517	W	Unclassified	3/21/2005	73	$245.46	$3.36	0.0281%	-3.55079	1	$11,952.29	4.0775	0
100040399	4	$888,226	W	Bridge Replacement	12/2/2003	175	$811.37	$4.64	0.0913%	-3.03930	1	$5,075.58	3.7055	0
100044404	4	$902,751	W	Unclassified	9/15/2004	49	$251.74	$5.14	0.0279%	-3.55462	1	$18,423.49	4.2654	0
100045674	4	$929,845	W	Unclassified	11/8/2005	21	$783.04	$37.29	0.0842%	-3.07463	1	$44,278.33	4.6462	0
100043347	5	$1,041,696	W	Unclassified	1/13/2004	45	$306.82	$6.82	0.0295%	-3.53086	1	$23,148.80	4.3645	0
100044403	5	$1,202,136	W	Unclassified	8/21/2004	37	$720.03	$19.46	0.0599%	-3.22260	1	$32,490.16	4.5118	0
100044278	5	$1,212,634	W	Unclassified	5/25/2004	40	$425.00	$10.63	0.0350%	-3.45534	1	$30,315.85	4.4817	0
100044381	5	$1,239,266	W	Unclassified	3/3/2005	36	$1,281.04	$35.58	0.1034%	-2.98560	1	$34,424.06	4.5369	0
100042706	5	$1,246,226	W	Unclassified	4/9/2004	65	$251.74	$3.87	0.0202%	-3.69464	1	$19,172.71	4.2827	0
100042943	5	$1,264,798	W	Unclassified	9/10/2003	42	$8.15	$0.19	0.0006%	-5.19086	1	$30,114.24	4.4788	0
100042773	5	$1,345,930	W	Unclassified	10/10/2003	61	$575.00	$9.43	0.0427%	-3.36935	1	$22,064.43	4.3437	0
100045489	5	$1,397,290	W	Unclassified	6/16/2005	36	$272.16	$7.56	0.0195%	-3.71046	1	$38,813.61	4.5890	0
100045702	5	$1,491,355	W	Unclassified	11/8/2005	58	$307.13	$5.30	0.0206%	-3.68626	1	$25,713.02	4.4102	0
100044284	5	$1,594,928	W	Unclassified	2/25/2005	58	$2,960.24	$51.04	0.1856%	-2.73141	1	$27,498.76	4.4393	0
100044924	5	$1,654,514	W	Unclassified	10/27/2005	45	$2,430.93	$54.02	0.1469%	-2.83290	1	$36,766.98	4.5655	0
100042825	6	$2,036,155	W	Unclassified	10/22/2004	57	$232.92	$4.09	0.0114%	-3.94160	1	$35,722.02	4.5529	0
100042867	6	$2,480,870	W	Unclassified	5/5/2004	70	$1,340.70	$19.15	0.0540%	-3.26727	1	$35,441.00	4.5495	0
100004693	6	$4,591,964	W	Grade Drain Base Pa	4/5/2005	343	$5,185.32	$15.12	0.1129%	-2.94722	1	$13,387.65	4.1267	0
100009927	8	$17,017,062	W	Grade Drain Base Pa	5/13/2003	360	$528.69	$1.47	0.0031%	-4.50768	1	$47,269.62	4.6746	0
100016578	8	$20,486,034	W	Unclassified	8/23/2004	454	$29,057.99	$64.00	0.1418%	-2.84819	1	$45,123.42	4.6544	0
100044610	1	$45,291	W	Unclassified	11/9/2004	20	$371.11	$18.56	0.8194%	-2.08651	0	$2,264.55	3.3550	1
100040994	1	$48,444	W	Unclassified	5/5/2004	21	$13,305.90	$633.61	27.4666%	-0.56120	0	$2,306.86	3.3630	1
100040270	1	$70,439	W	Unclassified	6/16/2003	47	$13,804.63	$293.72	19.5980%	-0.70779	0	$1,498.70	3.1757	1
100042603	1	$75,908	W	Bridge Replacement	7/22/2003	34	$2,790.20	$82.06	3.6758%	-1.43465	0	$2,232.59	3.3488	1
100044606	1	$81,584	W	Unclassified	1/14/2005	45	$1,243.99	$27.64	1.5248%	-1.81679	0	$1,812.98	3.2584	1
100045876	1	$84,072	W	Unclassified	11/24/2005	34	$265.24	$7.80	0.3155%	-2.50101	0	$2,472.71	3.3932	1
100041065	1	$87,575	W	Intersection Improve	1/23/2004	39	$47,737.68	$1,224.04	54.5106%	-0.26352	0	$2,245.51	3.3513	1
100041966	1	$98,313	W	Bridge Culvert and C	4/30/2003	45	$1,875.21	$41.67	1.9074%	-1.71956	0	$2,184.73	3.3394	1
100043217	2	$107,176	W	Grade Drain Base Pa	12/11/2003	45	$4,448.28	$98.85	4.1504%	-1.38191	0	$2,381.69	3.3769	1
100042619	2	$108,577	W	Grade Drain Base Pa	7/22/2003	73	$24,993.76	$342.38	23.0194%	-0.63791	0	$1,487.36	3.1724	1
100042410	2	$116,162	W	Unclassified	8/17/2004	63	$13,191.87	$209.39	11.3564%	-0.94476	0	$1,843.84	3.2657	1
100041942	2	$133,200	W	Bridge Replacement	4/23/2003	58	$33,199.70	$572.41	24.9247%	-0.60337	0	$2,296.55	3.3611	1
100043076	2	$134,945	W	Unclassified	3/12/2004	57	$65,237.81	$1,144.52	48.3440%	-0.31566	0	$2,367.46	3.3743	1
100044031	2	$135,572	W	Unclassified	10/27/2004	60	$9,404.18	$156.74	6.9367%	-1.15885	0	$2,259.53	3.3540	1
100042150	3	$255,531	W	Bridge Replacement	10/29/2003	118	$46,963.58	$398.00	18.3788%	-0.73568	0	$2,165.52	3.3356	1
100043005	3	$287,552	W	Unclassified	4/20/2004	120	$33,951.19	$282.93	11.8070%	-0.92786	0	$2,396.27	3.3795	1
100043077	3	$314,444	W	Unclassified	9/7/2004	175	$10,800.24	$61.72	3.4347%	-1.46411	0	$1,796.82	3.2545	1
100042782	3	$329,683	W	Grade Drain Base Pa	6/22/2004	151	$27,537.78	$182.37	8.3528%	-1.07817	0	$2,183.33	3.3391	1
100012131	4	$830,581	W	Bridge Replacement	1/13/2003	426	$84,263.91	$197.80	10.1452%	-0.99374	0	$1,949.72	3.2900	1
100005166	6	$4,394,989	W	Grade Drain Base Pa	9/3/2004	26	$741,209.19	$28,508.05	16.8649%	-0.77302	0	$169,038.04	5.2280	1
100045696	7	$5,450,000	W	Bridge Replacement	12/4/2004	34	$335,513.35	$9,868.04	6.1562%	-1.21069	0	$160,294.12	5.2049	1
100009931	8	$24,440,147	W	Grade Drain Base Pa	11/18/2003	400	$1,980,667.79	$4,951.67	8.1042%	-1.09129	0	$61,100.37	4.7860	1
100033212	8	$24,759,806	W	Erosion Control, Rip	9/11/2003	400	$3,889,615.74	$9,724.04	15.7094%	-0.80384	0	$61,899.52	4.7917	1
100002787	8	$55,601,668	W	Bridge Replacement	8/1/2003	300	$566,336.83	$1,887.79	1.0186%	-1.99201	0	$185,338.89	5.2680	1
100045960	1	$48,654	W	Unclassified	11/14/2005	19	$3,688.84	$194.15	7.5818%	-1.12023	0	$2,560.74	3.4084	0
100044324	1	$58,376	W	Unclassified	10/19/2005	18	$13,765.74	$764.76	23.5812%	-0.62743	0	$3,243.11	3.5110	0
100042217	1	$66,558	W	Pavement Rehab, R	7/14/2003	18	$3,622.12	$201.23	5.4421%	-1.26424	0	$3,697.67	3.5679	0
100043541	1	$67,278	W	Bridge Replacement	12/11/2003	22	$1,534.27	$69.74	2.2805%	-1.64197	0	$3,058.09	3.4855	0
100043268	1	$77,088	W	Unclassified	2/4/2004	13	$10,053.25	$773.33	13.0413%	-0.88468	0	$5,929.85	3.7730	0
100042890	1	$79,250	W	Unclassified	10/14/2003	24	$1,884.21	$78.51	2.3776%	-1.62387	0	$3,302.08	3.5188	0
100043067	1	$81,437	W	Unclassified	1/14/2004	27	$2,484.57	$92.02	3.0509%	-1.51557	0	$3,016.19	3.4795	0
100043209	1	$86,245	W	Bridge Replacement	9/30/2003	27	$9,326.45	$345.42	10.8139%	-0.96602	0	$3,194.26	3.5044	0
100043241	1	$87,079	W	Bridge Replacement	2/18/2004	32	$25,614.75	$800.46	29.4155%	-0.53142	0	$2,721.22	3.4348	0
100047122	1	$87,650	W	Unclassified	11/21/2005	5	$754.97	$150.99	0.8613%	-2.06482	0	$17,530.00	4.2438	0
100042687	1	$91,294	W	Unclassified	9/26/2003	27	$65,596.04	$2,429.48	71.8514%	-0.14356	0	$3,381.26	3.5291	0
100043205	1	$94,286	W	Unclassified	8/16/2004	33	$2,272.46	$68.86	2.4102%	-1.61795	0	$2,857.15	3.4559	0
100044182	1	$96,000	W	Bridge Replacement	6/24/2004	15	$6,155.85	$410.39	6.4123%	-1.19298	0	$6,400.00	3.8062	0
100042232	1	$96,579	W	Bridge Replacement	5/5/2003	32	$18,316.25	$572.38	18.9650%	-0.72205	0	$3,018.09	3.4797	0
100043558	2	$104,417	W	Unclassified	4/7/2004	39	$2,378.89	$61.00	2.2783%	-1.64240	0	$2,677.36	3.4277	0
100042887	2	$108,993	W	Unclassified	4/28/2004	21	$5,236.05	$249.34	4.8040%	-1.31839	0	$5,190.14	3.7152	0
100037162	2	$112,153	W	Pavement Rehab, R	4/30/2003	18	$7,952.43	$441.80	7.0907%	-1.14931	0	$6,230.72	3.7945	0
100043899	2	$112,621	W	Unclassified	5/13/2004	21	$3,515.61	$167.41	3.1216%	-1.50562	0	$5,362.90	3.7294	0
100043237	2	$112,910	W	Bridge Replacement	12/8/2003	18	$15,631.29	$868.41	13.8440%	-0.85874	0	$6,272.78	3.7975	0
100044180	2	$117,891	W	Pavement Rehab, R	2/8/2005	27	$7,088.83	$262.55	6.0130%	-1.22091	0	$4,366.33	3.6401	0
100042888	2	$118,768	W	Unclassified	3/10/2004	46	$2,089.98	$45.43	1.7597%	-1.75456	0	$2,581.91	3.4119	0
100037225	2	$119,474	W	Pavement Rehab, R	7/18/2005	26	$50,099.05	$1,926.89	41.9330%	-0.37744	0	$4,595.15	3.6623	0
100042600	2	$119,560	W	Bridge Culvert and C	6/6/2003	34	$3,804.71	$111.90	3.1823%	-1.49726	0	$3,516.47	3.5461	0
100043573	2	$126,926	W	Unclassified	12/10/2003	36	$5,429.44	$150.82	4.2776%	-1.36880	0	$3,525.72	3.5472	0
100044142	2	$127,918	W	Unclassified	6/1/2004	32	$6,458.64	$201.83	5.0490%	-1.29679	0	$3,997.44	3.6018	0
100042786	2	$130,171	W	Bridge Replacement	7/7/2003	21	$2,670.94	$127.19	2.0519%	-1.68785	0	$6,198.62	3.7923	0
100043236	2	$136,494	W	Unclassified	8/23/2004	44	$35,601.03	$809.11	26.0825%	-0.58365	0	$3,102.14	3.4917	0
100043473	2	$137,053	W	Unclassified	5/19/2004	31	$2,316.54	$74.73	1.6903%	-1.77205	0	$4,421.06	3.6455	0
100042785	2	$140,028	W	Unclassified	9/4/2003	26	$6,668.84	$256.49	4.7625%	-1.32216	0	$5,385.69	3.7312	0
100042817	2	$144,272	W	Bridge Replacement	10/1/2003	27	$7,200.83	$266.70	4.9911%	-1.30180	0	$5,343.41	3.7278	0
100043756	2	$144,644	W	Bridge Replacement	6/24/2004	30	$10,929.95	$364.33	7.5564%	-1.12168	0	$4,821.47	3.6832	0
100041320	2	$145,973	W	Pavement Rehab, R	9/5/2003	53	$25,199.24	$475.46	17.2629%	-0.76289	0	$2,754.21	3.4400	0
100043240	2	$146,868	W	Bridge Replacement	11/12/2003	40	$5,862.70	$146.57	3.9918%	-1.39883	0	$3,671.70	3.5649	0
100041201	2	$148,370	W	Bridge Culvert and C	7/11/2003	51	$12,464.24	$244.40	8.4008%	-1.07568	0	$2,909.22	3.4638	0
100042221	2	$151,742	W	Pavement Rehab, R	6/25/2003	36	$13,989.74	$388.60	9.2194%	-1.03530	0	$4,215.06	3.6248	0

CPMS Proj #	Size	Original Contract Amt	C/W	Code Description	Completion Date	Days Used	E&I Amt	Daily E&I	% E&I to CV	Log % E&I	outlier (2stdev)	Contract $$ per Day	Log $perDay	outlier (2stdev)
100047187	2	$151,844	W	Unclassified	11/22/2005	28	$10,036.76	$358.46	6.6099%	-1.17980	0	$5,423.00	3.7342	0
100038988	2	$155,000	W	Unclassified	8/31/2004	20	$21,446.84	$1,072.34	13.8367%	-0.85897	0	$7,750.00	3.8893	0
100042274	2	$155,475	W	Unclassified	5/16/2003	42	$1,828.87	$43.54	1.1763%	-1.92948	0	$3,701.79	3.5684	0
100043620	2	$157,943	W	Pavement Rehab, Re	8/27/2004	27	$4,362.64	$161.58	2.7622%	-1.55875	0	$5,849.74	3.7671	0
100042091	2	$158,691	W	Pavement Rehab, Re	9/8/2003	35	$5,225.47	$149.30	3.2929%	-1.48243	0	$4,534.03	3.6565	0
100042081	2	$159,996	W	Pavement Rehab, Re	6/12/2003	14	$7,466.56	$533.33	4.6667%	-1.33099	0	$11,428.29	4.0580	0
100038606	2	$161,456	W	Intersection Improve	6/24/2003	39	$85,475.26	$2,191.67	52.9403%	-0.27621	0	$4,139.90	3.6170	0
100042276	2	$161,535	W	Pavement Rehab, Re	7/24/2003	33	$555.60	$16.84	0.3440%	-2.46350	0	$4,895.00	3.6898	0
100042644	2	$162,424	W	Bridge Replacement	1/12/2004	20	$31,260.02	$1,563.00	19.2459%	-0.71566	0	$8,121.20	3.9096	0
100043602	2	$167,778	W	Pavement Rehab, Re	8/10/2004	29	$11,831.77	$407.99	7.0520%	-1.15169	0	$5,785.45	3.7623	0
100044534	2	$168,779	W	Grade Drain Base Pa	8/14/2004	40	$25,516.95	$637.92	15.1186%	-0.82049	0	$4,219.48	3.6253	0
100042262	2	$169,336	W	Bridge Replacement	8/28/2003	29	$5,348.18	$184.42	3.1583%	-1.50054	0	$5,839.17	3.7664	0
100043568	2	$169,687	W	Bridge Replacement	6/14/2004	52	$9,593.09	$184.48	5.6534%	-1.24769	0	$3,263.21	3.5136	0
100043017	2	$174,668	W	Bridge Replacement	12/10/2003	27	$5,861.21	$217.08	3.3556%	-1.47423	0	$6,469.19	3.8108	0
100042831	2	$175,151	W	Unclassified	6/3/2004	32	$14,223.73	$444.49	8.1208%	-1.09040	0	$5,473.47	3.7383	0
100043412	2	$175,610	W	Unclassified	10/4/2004	50	$39,561.47	$791.23	22.5280%	-0.64728	0	$3,512.20	3.5456	0
100043211	2	$176,187	W	Unclassified	5/20/2004	44	$22,115.22	$502.62	12.5521%	-0.90128	0	$4,004.25	3.6025	0
100044321	2	$177,365	W	Unclassified	1/20/2005	46	$484.75	$10.54	0.2733%	-2.56335	0	$3,855.76	3.5861	0
100041562	2	$180,807	W	Pavement Rehab, Re	8/27/2003	15	$23,649.76	$1,576.65	13.0801%	-0.88339	0	$12,053.80	4.0811	0
100041345	2	$182,460	W	Pavement Rehab, Re	4/23/2003	25	$8,190.01	$327.60	4.4887%	-1.34788	0	$7,298.40	3.8632	0
100042292	2	$183,010	W	Grade Drain Base Pa	7/16/2003	52	$46,333.00	$891.02	25.3172%	-0.59658	0	$3,519.42	3.5465	0
100043559	2	$183,320	W	Pavement Rehab, Re	5/17/2004	12	$16,627.39	$1,385.62	9.0701%	-1.04239	0	$15,276.67	4.1840	0
100007785	2	$188,905	W	Bridge Replacement	6/24/2003	58	$36,742.85	$633.50	19.4504%	-0.71107	0	$3,256.98	3.5128	0
100043220	2	$191,591	W	Unclassified	6/1/2004	37	$4,203.71	$113.61	2.1941%	-1.65874	0	$5,178.14	3.7142	0
100039408	2	$192,758	W	Pavement Rehab, Re	1/21/2003	22	$4,334.42	$197.02	2.2486%	-1.64808	0	$8,761.73	3.9426	0
100042840	2	$194,566	W	Pavement Rehab, Re	6/25/2003	17	$12,438.03	$731.65	6.3927%	-1.19432	0	$11,445.06	4.0586	0
100042820	2	$195,339	W	Unclassified	4/27/2004	68	$33,696.61	$495.54	17.2503%	-0.76320	0	$2,872.63	3.4583	0
100042756	2	$195,554	W	Unclassified	12/19/2003	14	$28,389.01	$2,027.79	14.5172%	-0.83812	0	$13,968.14	4.1451	0
100042618	2	$198,515	W	Bridge Replacement	6/10/2003	66	$47,740.63	$723.34	24.0489%	-0.61891	0	$3,007.80	3.4782	0
100043539	3	$202,178	W	Grade Drain Base Pa	8/16/2004	45	$10,140.42	$225.34	5.0156%	-1.29968	0	$4,492.84	3.6525	0
100045351	3	$205,940	W	Unclassified	8/12/2005	12	$9,907.48	$825.62	4.8109%	-1.31778	0	$17,161.67	4.2346	0
100043386	3	$209,756	W	Bridge Replacement	2/10/2004	31	$17,560.84	$566.48	8.3720%	-1.07717	0	$6,766.32	3.8304	0
100044390	3	$211,032	W	Unclassified	11/19/2004	17	$32,223.07	$1,895.47	15.2693%	-0.81618	0	$12,413.65	4.0939	0
100043569	3	$212,837	W	Bridge Replacement	10/14/2004	64	$16,829.03	$262.95	7.9070%	-1.10199	0	$3,325.58	3.5219	0
100042730	3	$214,953	W	Unclassified	9/16/2003	15	$740.99	$49.40	0.3447%	-2.46253	0	$14,330.20	4.1563	0
100041377	3	$216,106	W	Grade Drain Base Pa	2/3/2004	87	$3,544.29	$40.74	1.6401%	-1.78514	0	$2,483.98	3.3951	0
100040881	3	$219,699	W	Traffic Striping, Pave	6/22/2004	43	$137,604.06	$3,200.09	62.6330%	-0.20320	0	$5,109.28	3.7084	0
100041375	3	$220,330	W	Grade Drain Base Pa	5/1/2003	69	$22,203.62	$321.79	10.0774%	-0.99665	0	$3,193.19	3.5042	0
100044313	3	$221,852	W	Pavement Rehab, Re	6/10/2004	30	$14,042.19	$468.07	6.3295%	-1.19863	0	$7,395.07	3.8689	0
100041522	3	$222,371	W	Signals, Markings, S	3/8/2004	63	$54,780.11	$869.53	24.6346%	-0.60846	0	$3,529.70	3.5477	0
100007548	3	$223,340	W	Grade Drain Base Pa	8/31/2004	82	$29,501.65	$359.78	13.2093%	-0.87912	0	$2,723.66	3.4352	0
100041577	3	$223,533	W	Unclassified	3/12/2004	77	$2,814.06	$36.55	1.2589%	-1.90001	0	$2,903.03	3.4629	0
100041791	3	$226,647	W	Bridge Replacement	2/13/2003	34	$12,467.02	$366.68	5.5006%	-1.25959	0	$6,666.09	3.8239	0
100043669	3	$228,380	W	Unclassified	3/25/2004	36	$37,960.28	$1,054.45	16.6215%	-0.77933	0	$6,343.89	3.8024	0
100041096	3	$231,458	W	Unclassified	7/21/2003	25	$46,413.52	$1,856.54	20.0527%	-0.69783	0	$9,258.32	3.9665	0
100041995	3	$233,333	W	Pavement Rehab, Re	3/21/2003	24	$14,629.38	$609.56	6.2697%	-1.20275	0	$9,722.21	3.9878	0
100043788	3	$234,752	W	Grade Drain Base Pa	9/13/2004	51	$24,922.74	$488.68	10.6166%	-0.97401	0	$4,602.98	3.6630	0
100042935	3	$235,406	W	Unclassified	9/18/2003	45	$13,850.41	$307.79	5.8836%	-1.23035	0	$5,231.24	3.7186	0
100043675	3	$236,715	W	Bridge Replacement	3/31/2004	30	$15,522.66	$517.42	6.5575%	-1.18326	0	$7,890.50	3.8971	0
100043466	3	$237,379	W	Unclassified	6/10/2004	18	$11,011.64	$611.76	4.6388%	-1.33359	0	$13,187.72	4.1202	0
100037209	3	$237,717	W	Unclassified	6/9/2004	27	$23,725.79	$878.73	9.9807%	-1.00084	0	$8,804.33	3.9447	0
100044769	3	$238,666	W	Unclassified	12/16/2004	26	$18,275.90	$702.92	7.6575%	-1.11591	0	$9,179.46	3.9628	0
100044823	3	$239,446	W	Unclassified	3/7/2005	10	$8,614.92	$861.49	3.5979%	-1.44396	0	$23,944.60	4.3792	0
100044027	3	$239,488	W	Unclassified	8/28/2004	91	$20,694.43	$227.41	8.6411%	-1.06343	0	$2,631.74	3.4202	0
100043069	3	$239,789	W	Bridge Replacement	12/19/2003	54	$22,495.56	$416.58	9.3814%	-1.02773	0	$4,440.54	3.6474	0
100045528	3	$240,000	W	Structure Removal	7/18/2005	88	$39,031.49	$443.54	16.2631%	-0.78880	0	$2,727.27	3.4357	0
100043234	3	$241,385	W	Unclassified	8/20/2004	60	$52,841.40	$880.69	21.8909%	-0.65974	0	$4,023.08	3.6046	0
100042096	3	$241,998	W	Roadway Widening,	7/14/2003	13	$7,913.49	$608.73	3.2701%	-1.48544	0	$18,615.23	4.2699	0
100042961	3	$242,184	W	Unclassified	10/6/2003	51	$5,957.17	$116.81	2.4598%	-1.60911	0	$4,748.71	3.6766	0
100043107	3	$244,290	W	Bridge Replacement	11/29/2004	26	$2,514.43	$96.71	1.0293%	-1.98747	0	$9,395.77	3.9729	0
100042792	3	$244,318	W	Unclassified	8/12/2003	31	$16,084.32	$518.85	6.5834%	-1.18155	0	$7,881.23	3.8966	0
100046011	3	$245,724	W	Pavement Rehab, Re	11/23/2005	6	$24,613.62	$4,102.27	10.0168%	-0.99927	0	$40,954.00	4.6123	0
100042970	3	$248,084	W	Unclassified	5/24/2004	70	$4,009.11	$57.27	1.6160%	-1.79155	0	$3,544.06	3.5495	0
100041576	3	$249,041	W	Intersection Improve	3/18/2004	30	$28,931.25	$964.38	11.6171%	-0.93490	0	$8,301.37	3.9191	0
100043019	3	$251,805	W	Bridge Replacement	5/3/2004	40	$2,467.99	$61.70	0.9801%	-2.00872	0	$6,295.13	3.7990	0
100041911	3	$257,757	W	Pavement Rehab, Re	9/10/2003	15	$6,380.58	$425.37	2.4754%	-1.60635	0	$17,183.80	4.2351	0
100042822	3	$259,589	W	Unclassified	11/3/2003	18	$98,984.16	$5,499.12	38.1311%	-0.41872	0	$14,421.61	4.1590	0
100042874	3	$260,282	W	Bridge Replacement	6/28/2004	90	$30,909.14	$343.43	11.8753%	-0.92536	0	$2,892.02	3.4612	0
100042809	3	$262,131	W	Unclassified	5/20/2004	23	$2,015.97	$87.65	0.7691%	-2.11403	0	$11,397.00	4.0568	0
100042620	3	$263,000	W	Grade Drain Base Pa	10/3/2003	57	$33,605.43	$589.57	12.7777%	-0.89355	0	$4,614.04	3.6641	0
100043616	3	$263,087	W	Pavement Rehab, Re	6/12/2004	15	$4,035.90	$269.06	1.5341%	-1.81416	0	$17,539.13	4.2440	0
100043101	3	$263,288	W	Unclassified	11/25/2003	72	$48,799.76	$677.77	18.5347%	-0.73201	0	$3,656.78	3.5631	0
100045258	3	$264,254	W	Unclassified	11/16/2005	17	$11,573.93	$680.82	4.3799%	-1.35854	0	$15,544.35	4.1916	0
100042634	3	$265,144	W	Pavement Rehab, Re	8/13/2003	15	$9,960.28	$664.02	3.7566%	-1.42521	0	$17,676.27	4.2474	0
100041959	3	$268,366	W	Pavement Rehab, Re	6/12/2003	16	$7,042.28	$440.14	2.6241%	-1.58101	0	$16,772.88	4.2246	0
100041994	3	$272,107	W	Unclassified	2/4/2003	45	$11,432.47	$254.05	4.2015%	-1.37660	0	$6,046.82	3.7815	0
100043468	3	$272,975	W	Pavement Rehab, Re	5/10/2004	9	$20,503.65	$2,278.18	7.5112%	-1.12429	0	$30,330.56	4.4819	0
100046048	3	$276,475	W	Pavement Rehab, Re	9/9/2005	9	$16,520.98	$1,835.66	5.9756%	-1.22362	0	$30,719.44	4.4874	0
100041968	3	$282,755	W	Unclassified	1/22/2004	88	$9,402.96	$106.85	3.3255%	-1.47815	0	$3,213.13	3.5069	0
100045670	3	$283,035	W	Unclassified	9/12/2005	28	$17,627.77	$629.56	6.2281%	-1.20564	0	$10,108.39	4.0047	0
100042886	3	$283,596	W	Unclassified	6/25/2004	43	$22,236.31	$517.12	7.8408%	-1.10564	0	$6,595.26	3.8192	0
100046022	3	$284,219	W	Unclassified	7/1/2005	15	$16,688.79	$1,112.59	5.8718%	-1.23123	0	$18,947.93	4.2776	0
100043782	3	$285,707	W	Unclassified	2/25/2005	21	$1,090.94	$51.95	0.3818%	-2.41812	0	$13,605.10	4.1337	0
100007564	3	$288,692	W	Grade Drain Base Pa	8/11/2004	64	$3,651.72	$57.06	1.2649%	-1.89794	0	$4,510.81	3.6543	0
100042356	3	$289,464	W	Bridge Replacement	7/10/2003	84	$26,889.30	$320.11	9.2893%	-1.03202	0	$3,446.00	3.5373	0
100039813	3	$290,375	W	Signals, Markings, S	12/1/2004	56	$34,188.21	$610.50	11.7738%	-0.92908	0	$5,185.27	3.7148	0
100041953	3	$290,744	W	Pavement Rehab, Re	4/23/2003	16	$3,404.99	$212.81	1.1711%	-1.93139	0	$18,171.50	4.2594	0
100042365	3	$293,225	W	Unclassified	1/9/2004	72	$2,594.86	$36.04	0.8849%	-2.05309	0	$4,072.57	3.6099	0
100041807	3	$294,610	W	Pavement Rehab, Re	6/24/2003	16	$11,128.28	$695.52	3.7773%	-1.42282	0	$18,413.13	4.2651	0
100042534	3	$294,741	W	Bridge Replacement	2/23/2004	58	$3,801.11	$65.54	1.2896%	-1.88953	0	$5,081.74	3.7060	0
100043384	3	$295,264	W	Unclassified	12/12/2003	56	$17,422.43	$311.11	5.9006%	-1.22910	0	$5,272.57	3.7220	0
100043218	3	$298,537	W	Unclassified	11/13/2003	67	$29,326.34	$437.71	9.8234%	-1.00774	0	$4,455.78	3.6489	0
100042692	3	$298,800	W	Unclassified	6/21/2004	29	$8,722.46	$300.77	2.9192%	-1.53474	0	$10,303.45	4.0130	0
100044714	3	$299,817	W	Pavement Rehab, Re	8/18/2005	26	$2,108.74	$81.11	0.7033%	-2.15283	0	$11,531.42	4.0619	0
100042841	3	$305,219	W	Roadway Widening,	10/15/2003	12	$12,032.48	$1,002.71	3.9422%	-1.40426	0	$25,434.92	4.4054	0
100044945	3	$305,908	W	Pavement Rehab, Re	6/8/2005	9	$12,297.88	$1,366.43	4.0201%	-1.39576	0	$33,989.78	4.5313	0
100042598	3	$308,405	W	Bridge Replacement	12/15/2003	52	$3,595.69	$69.15	1.1659%	-1.93334	0	$5,930.87	3.7731	0
100042120	3	$308,991	W	Bridge Replacement	2/19/2003	48	$59,036.10	$1,229.92	19.1061%	-0.71883	0	$6,437.31	3.8087	0
100043064	3	$309,491	W	Unclassified	7/23/2004	90	$58,666.07	$651.85	18.9557%	-0.72226	0	$3,438.79	3.5364	0
100042946	3	$310,121	W	Unclassified	11/4/2003	21	$58,181.37	$2,770.54	18.7609%	-0.72675	0	$14,767.67	4.1693	0
100045809	3	$310,129	W	Unclassified	11/4/2005	30	$3,480.43	$116.01	1.1223%	-1.94991	0	$10,337.63	4.0144	0
100041508	3	$311,691	W	Bridge Replacement	2/5/2003	81	$73,532.32	$907.81	23.5914%	-0.62725	0	$3,848.04	3.5852	0
100040633	3	$312,908	W	Bridge Replacement	8/5/2003	58	$17,644.89	$304.22	5.6390%	-1.24880	0	$5,394.97	3.7320	0
100043651	3	$314,483	W	Bridge Replacement	4/14/2004	44	$39,714.29	$902.60	12.6284%	-0.89865	0	$7,147.34	3.8541	0
100042408	3	$315,811	W	Pavement Rehab, Re	1/26/2004	41	$17,605.16	$429.39	5.5746%	-1.25379	0	$7,702.71	3.8866	0
100041515	3	$317,392	W	Signals, Markings, S	12/1/2003	82	$138,453.95	$1,688.46	43.6224%	-0.36029	0	$3,870.63	3.5878	0

CPMS Proj #	Size	Original Contract Amt	C/W	Code Description	Completion Date	Days Used	E&I Amt	Daily E&I	% E&I to CV	Log % E&I	outlier (2stdev)	Contract $$ per Day	Log $perDay	outlier (2stdev)
100043167	3	$318,762	W	Pavement Rehab, R	5/6/2004	45	$10,357.80	$230.17	3.2494%	-1.48820	0	$7,083.60	3.8503	0
100041466	3	$319,972	W	Bridge Replacement	1/27/2003	110	$40,077.20	$364.34	12.5252%	-0.90221	0	$2,908.84	3.4637	0
100041948	3	$323,375	W	Bridge Replacement	6/30/2003	107	$7,483.16	$69.94	2.3141%	-1.63562	0	$3,022.20	3.4803	0
100042837	3	$325,823	W	Unclassified	11/20/2003	15	$24,207.03	$1,613.80	7.4295%	-1.12904	0	$21,721.53	4.3369	0
100042085	3	$326,931	W	Roadway Widening,	9/14/2005	30	$19,724.09	$657.47	6.0331%	-1.21946	0	$10,897.70	4.0373	0
100041532	3	$328,558	W	Unclassified	12/19/2003	81	$12,085.69	$149.21	3.6784%	-1.43434	0	$4,056.27	3.6081	0
100039977	3	$328,896	W	Bridge Replacement	11/19/2003	67	$8,273.36	$123.48	2.5155%	-1.59938	0	$4,908.90	3.6910	0
100043212	3	$329,007	W	Unclassified	9/10/2004	46	$16,177.99	$351.70	4.9172%	-1.30828	0	$7,152.33	3.8544	0
100041950	3	$329,636	W	Grade Drain Base Pa	5/14/2003	88	$39,724.86	$451.42	12.0511%	-0.91897	0	$3,745.86	3.5736	0
100043021	3	$329,820	W	Unclassified	7/1/2004	42	$9,282.31	$221.01	2.8144%	-1.55062	0	$7,852.86	3.8950	0
100042366	3	$330,342	W	Unclassified	2/9/2004	75	$2,589.15	$34.52	0.7838%	-2.10581	0	$4,404.56	3.6439	0
100038734	3	$334,071	W	Intersection Improve	1/16/2004	65	$98,091.24	$1,509.10	29.3624%	-0.53221	0	$5,139.55	3.7109	0
100042293	3	$335,401	W	Roadway Widening,	9/4/2003	27	$14,828.97	$549.22	4.4213%	-1.35445	0	$12,422.26	4.0942	0
100042098	3	$336,033	W	Pavement Rehab, R	6/11/2003	22	$11,172.62	$507.85	3.3249%	-1.47823	0	$15,274.23	4.1840	0
100042129	3	$341,299	W	Grade Drain Base Pa	1/22/2004	68	$37,671.05	$553.99	11.0376%	-0.95713	0	$5,019.10	3.7006	0
100044566	3	$342,278	W	Unclassified	10/18/2004	27	$15,938.02	$590.30	4.6565%	-1.33194	0	$12,676.96	4.1030	0
100043349	3	$346,084	W	Pavement Rehab, R	11/13/2003	27	$6,893.51	$255.32	1.9919%	-1.70074	0	$12,817.93	4.1078	0
100043201	3	$346,106	W	Pavement Rehab, R	11/21/2003	12	$7,199.82	$599.99	2.0802%	-1.68189	0	$28,842.17	4.4600	0
100045090	3	$347,057	W	Unclassified	5/20/2005	27	$32,593.16	$1,207.15	9.3913%	-1.02727	0	$12,853.96	4.1090	0
100042976	3	$347,580	W	Bridge Replacement	5/17/2004	39	$7,032.88	$180.33	2.0234%	-1.69392	0	$8,912.31	3.9500	0
100041467	3	$350,165	W	Bridge Replacement	3/21/2003	88	$31,086.81	$353.26	8.8778%	-1.05170	0	$3,979.15	3.5998	0
100042348	3	$351,970	W	Bridge Replacement	11/11/2003	66	$12,281.28	$186.08	3.4893%	-1.45726	0	$5,332.88	3.7270	0
100042688	3	$352,181	W	Unclassified	10/23/2003	36	$34,906.76	$969.63	9.9116%	-1.00386	0	$9,782.81	3.9905	0
100044763	3	$353,009	W	Pavement Rehab, R	4/29/2005	24	$10,614.65	$442.28	3.0069%	-1.52188	0	$14,708.71	4.1676	0
100045228	3	$358,358	W	Pavement Rehab, R	5/17/2005	22	$24,451.82	$1,111.45	6.8233%	-1.16601	0	$16,289.00	4.2119	0
100044912	3	$359,143	W	Unclassified	6/21/2005	40	$3,624.06	$90.60	1.0091%	-1.99607	0	$8,978.58	3.9532	0
100045552	3	$359,460	W	Unclassified	8/10/2005	9	$11,878.20	$1,319.80	3.3045%	-1.48090	0	$39,940.00	4.6014	0
100042998	3	$361,957	W	Unclassified	7/27/2004	75	$18,426.79	$245.69	5.0909%	-1.29321	0	$4,826.09	3.6836	0
100043355	3	$363,030	W	Pavement Rehab, R	11/19/2003	97	$24,741.55	$255.07	6.8153%	-1.16652	0	$3,742.58	3.5732	0
100041518	3	$363,906	W	Unclassified	9/1/2005	128	$61,175.69	$477.94	16.8108%	-0.77441	0	$2,843.02	3.4538	0
100041494	3	$365,025	W	Bridge Replacement	4/29/2003	61	$19,711.58	$323.14	5.4001%	-1.26760	0	$5,984.02	3.7770	0
100042400	3	$367,484	W	Pavement Rehab, R	7/21/2003	30	$20,110.22	$670.34	5.4724%	-1.26182	0	$12,249.47	4.0881	0
100044947	3	$368,419	W	Pavement Rehab, R	3/2/2005	32	$15,238.00	$476.19	4.1361%	-1.38341	0	$11,513.09	4.0612	0
100042810	3	$369,179	W	Grade Drain Base Pa	9/30/2003	57	$20,619.95	$361.75	5.5854%	-1.25295	0	$6,476.82	3.8114	0
100044948	3	$371,966	W	Unclassified	6/1/2005	22	$10,842.07	$492.82	2.9148%	-1.53539	0	$16,907.55	4.2281	0
100042856	3	$372,598	W	Bridge Replacement	12/16/2003	127	$32,547.83	$256.28	8.7354%	-1.05872	0	$2,933.84	3.4674	0
100043866	3	$374,192	W	Unclassified	4/19/2005	42	$25,890.62	$616.44	6.9191%	-1.15995	0	$8,909.33	3.9498	0
100042312	3	$375,675	W	Unclassified	8/18/2003	23	$32,526.73	$1,414.21	8.6582%	-1.06257	0	$16,333.70	4.2131	0
100045204	3	$377,698	W	Unclassified	6/17/2005	19	$10,137.80	$533.57	2.6841%	-1.57120	0	$19,878.84	4.2984	0
100045608	3	$384,917	W	Unclassified	9/9/2005	36	$71,026.95	$1,972.97	18.4525%	-0.73394	0	$10,692.14	4.0291	0
100041520	3	$387,544	W	Intersection Improve	1/8/2004	94	$126,445.97	$1,345.17	32.6275%	-0.48642	0	$4,122.81	3.6152	0
100042076	3	$388,616	W	Unclassified	6/2/2004	18	$30,317.18	$1,684.29	7.8013%	-1.10783	0	$21,589.78	4.3342	0
100045666	3	$389,274	W	Unclassified	9/30/2005	40	$29,477.09	$736.93	7.5723%	-1.12077	0	$9,731.85	3.9882	0
100042689	3	$392,264	W	Unclassified	8/7/2003	30	$39,863.28	$1,328.78	10.1624%	-0.99301	0	$13,075.47	4.1165	0
100044409	3	$395,833	W	Unclassified	1/6/2005	52	$5,825.57	$112.03	1.4717%	-1.83217	0	$7,612.17	3.8815	0
100043755	3	$399,016	W	Unclassified	11/15/2004	60	$15,554.94	$259.25	3.8983%	-1.40912	0	$6,650.27	3.8228	0
100043407	3	$402,433	W	Unclassified	9/15/2004	143	$14,734.37	$103.04	3.6613%	-1.43636	0	$2,814.22	3.4494	0
100043467	3	$403,231	W	Pavement Rehab, R	12/12/2003	40	$12,200.82	$305.02	3.0258%	-1.51916	0	$10,080.78	4.0035	0
100041901	3	$403,338	W	Pavement Rehab, R	4/11/2003	52	$16,413.92	$315.65	4.0695%	-1.39046	0	$7,756.50	3.8897	0
100042599	3	$405,954	W	Roadway Widening,	8/4/2003	27	$34,612.45	$1,281.94	8.5262%	-1.06924	0	$15,035.33	4.1771	0
100042479	3	$408,540	W	Pavement Rehab, R	6/25/2003	43	$17,810.79	$414.20	4.3596%	-1.36055	0	$9,500.93	3.9778	0
100041799	3	$408,647	W	Roadway Widening,	3/11/2005	46	$78,170.25	$1,699.35	19.1290%	-0.71831	0	$8,883.63	3.9486	0
100043625	3	$413,489	W	Pavement Rehab, R	9/26/2004	17	$9,381.14	$551.83	2.2688%	-1.64421	0	$24,322.88	4.3860	0
100042249	3	$413,713	W	Grade Drain Base Pa	5/9/2003	58	$23,608.06	$407.04	5.7064%	-1.24364	0	$7,132.98	3.8533	0
100043472	3	$414,426	W	Grade Drain Base Pa	12/13/2004	130	$38,841.57	$298.78	9.3724%	-1.02815	0	$3,187.89	3.5035	0
100043562	3	$414,778	W	Unclassified	11/15/2004	27	$56,643.34	$2,097.90	13.6563%	-0.86467	0	$15,362.15	4.1865	0
100040940	3	$416,079	W	Bridge Replacement	1/9/2003	99	$94,879.33	$958.38	22.8032%	-0.64200	0	$4,202.82	3.6235	0
100043357	3	$417,213	W	Unclassified	10/12/2004	128	$16,868.71	$131.79	4.0432%	-1.39328	0	$3,259.48	3.5131	0
100041960	3	$417,998	W	Pavement Rehab, R	9/15/2003	40	$27,717.94	$692.95	6.6311%	-1.17841	0	$10,449.95	4.0191	0
100044399	3	$419,439	W	Unclassified	11/19/2004	21	$38,040.04	$1,811.43	9.0693%	-1.04243	0	$19,973.29	4.3004	0
100040107	3	$419,689	W	Grade Drain Base Pa	5/9/2003	71	$57,689.81	$812.53	13.7458%	-0.86183	0	$5,911.11	3.7717	0
100042833	3	$419,997	W	Unclassified	3/22/2004	57	$78,136.29	$1,370.81	18.6040%	-0.73039	0	$7,368.37	3.8674	0
100042648	3	$421,955	W	Bridge Replacement	6/26/2003	55	$8,136.74	$147.94	1.9283%	-1.71482	0	$7,671.91	3.8849	0
100043606	3	$422,405	W	Unclassified	11/9/2004	40	$11,812.45	$295.31	2.7965%	-1.55339	0	$10,560.13	4.0237	0
100041936	3	$422,501	W	Pavement Rehab, R	5/13/2003	40	$34,121.15	$853.03	8.0760%	-1.09280	0	$10,562.53	4.0238	0
100042944	3	$424,795	W	Unclassified	9/18/2003	23	$30,103.65	$1,308.85	7.0866%	-1.14956	0	$18,469.35	4.2665	0
100042368	3	$427,158	W	Pavement Rehab, R	9/6/2005	19	$28,105.78	$1,479.25	6.5797%	-1.18179	0	$22,482.00	4.3518	0
100044776	3	$428,249	W	Unclassified	9/10/2004	31	$15,696.72	$506.35	3.6653%	-1.43589	0	$13,814.48	4.1403	0
100043013	3	$428,554	W	Bridge Replacement	10/10/2003	48	$76,920.89	$1,602.52	17.9489%	-0.74596	0	$8,928.21	3.9508	0
100042396	3	$429,646	W	Unclassified	11/13/2003	60	$28,016.84	$466.95	6.5209%	-1.18569	0	$7,160.77	3.8550	0
100043400	3	$432,027	W	Unclassified	1/30/2004	42	$23,003.18	$547.69	5.3245%	-1.27372	0	$10,286.36	4.0123	0
100041150	3	$435,783	W	Unclassified	3/25/2003	50	$38,872.10	$777.44	8.9201%	-1.04963	0	$8,715.66	3.9403	0
100041958	3	$435,798	W	Pavement Rehab, R	8/1/2003	44	$33,233.04	$755.30	7.6258%	-1.11772	0	$9,904.50	3.9958	0
100042790	3	$436,693	W	Unclassified	8/24/2003	21	$39,652.91	$1,888.23	9.0803%	-1.04190	0	$20,794.90	4.3180	0
100043150	3	$438,986	W	Grade Drain Base Pa	5/25/2004	57	$142,868.32	$2,506.46	32.5451%	-0.48751	0	$7,701.51	3.8866	0
100045136	3	$445,608	W	Unclassified	8/26/2005	22	$13,542.34	$615.56	3.0391%	-1.51726	0	$20,254.91	4.3065	0
100042347	3	$448,544	W	Pavement Rehab, R	6/26/2003	32	$15,876.60	$496.14	3.5396%	-1.45105	0	$14,017.00	4.1467	0
100043165	3	$448,581	W	Pavement Rehab, R	5/19/2004	25	$7,202.03	$288.08	1.6055%	-1.79439	0	$17,943.24	4.2539	0
100042092	3	$449,713	W	Pavement Rehab, R	8/8/2003	44	$33,990.38	$772.51	7.5582%	-1.12158	0	$10,220.75	4.0095	0
100043044	3	$450,413	W	Unclassified	9/3/2004	88	$22,530.04	$256.02	5.0021%	-1.30085	0	$5,118.33	3.7091	0
100042643	3	$456,094	W	Pavement Rehab, R	9/9/2003	23	$11,054.46	$480.63	2.4237%	-1.61552	0	$19,830.17	4.2973	0
100041822	3	$457,250	W	Roadway Widening,	8/22/2003	50	$115,645.12	$2,312.90	25.2914%	-0.59703	0	$9,145.00	3.9612	0
100043878	3	$460,240	W	Unclassified	3/31/2004	14	$5,696.45	$406.89	1.2377%	-1.90738	0	$32,874.29	4.5169	0
100042532	3	$461,259	W	Bridge Replacement	11/9/2004	110	$6,624.60	$60.22	1.4362%	-1.84279	0	$4,193.26	3.6226	0
100041961	3	$463,238	W	Pavement Rehab, R	7/11/2003	47	$22,522.33	$479.20	4.8619%	-1.31319	0	$9,856.13	3.9937	0
100043110	3	$465,985	W	Unclassified	8/5/2004	52	$15,583.59	$299.68	3.3442%	-1.47570	0	$8,961.25	3.9524	0
100044569	3	$466,916	W	Roadway Widening,	11/10/2004	24	$16,105.43	$671.06	3.4493%	-1.46227	0	$19,454.83	4.2890	0
100044770	3	$467,428	W	Unclassified	5/10/2005	24	$11,121.42	$463.39	2.3793%	-1.62355	0	$19,476.17	4.2895	0
100042263	3	$468,790	W	Unclassified	10/15/2004	97	$46,014.78	$474.38	9.8156%	-1.00808	0	$4,832.89	3.6842	0
100040563	3	$468,934	W	Bridge Replacement	4/28/2004	123	$61,809.17	$502.51	13.1808%	-0.88006	0	$3,812.47	3.5812	0
100045665	3	$470,491	W	Unclassified	12/15/2005	53	$18,409.96	$347.36	3.9129%	-1.40750	0	$8,877.19	3.9483	0
100044709	3	$472,515	W	Unclassified	12/15/2004	24	$57,859.55	$2,410.81	12.2450%	-0.91204	0	$19,688.13	4.2942	0
100041372	3	$473,596	W	Unclassified	9/11/2003	150	$68,038.15	$453.59	14.3663%	-0.84266	0	$3,157.31	3.4993	0
100042519	3	$478,433	W	Unclassified	11/14/2003	68	$16,101.51	$236.79	3.3655%	-1.47295	0	$7,035.78	3.8473	0
100037311	3	$483,371	W	Unclassified	11/29/2004	94	$210,801.98	$2,242.57	43.6108%	-0.36041	0	$5,142.24	3.7112	0
100042082	3	$489,982	W	Pavement Rehab, R	4/1/2003	35	$29,866.21	$853.32	6.0954%	-1.21500	0	$13,999.49	4.1461	0
100044885	3	$491,271	W	Unclassified	6/21/2005	29	$6,398.58	$220.64	1.3025%	-1.88524	0	$16,940.38	4.2289	0
100045584	3	$496,254	W	Unclassified	9/30/2005	40	$27,672.03	$691.80	5.5762%	-1.25366	0	$12,406.35	4.0936	0
100042384	3	$497,257	W	Bridge Replacement	11/19/2003	90	$63,830.01	$709.22	12.8364%	-0.89156	0	$5,525.08	3.7423	0
100045093	4	$500,427	W	Pavement Rehab, R	9/15/2005	40	$18,290.60	$457.27	3.6550%	-1.43711	0	$12,510.68	4.0973	0
100044705	4	$503,411	W	Pavement Rehab, R	9/23/2005	50	$35,975.70	$719.51	7.1464%	-1.14591	0	$10,068.22	4.0030	0
100045399	4	$503,989	W	Unclassified	8/10/2005	12	$12,628.22	$1,052.35	2.5057%	-1.60108	0	$41,999.08	4.6232	0
100039411	4	$504,233	W	Pavement Rehab, R	5/27/2004	65	$20,876.77	$321.18	4.1403%	-1.38297	0	$7,757.43	3.8897	0
100042476	4	$505,293	W	Bridge Replacement	6/16/2004	67	$91,191.98	$1,361.07	18.0473%	-0.74359	0	$7,541.69	3.8775	0
100045450	4	$506,277	W	Unclassified	8/15/2005	120	$3,975.57	$33.13	0.7853%	-2.10499	0	$4,218.98	3.6252	0
100043358	4	$506,633	W	Unclassified	9/2/2004	129	$44,051.13	$341.48	8.6949%	-1.06074	0	$3,927.39	3.5941	0

CPMS Proj #	Size	Original Contract Amt	C/W	Code Description	Completion Date	Days Used	E&I Amt	Daily E&I	% E&I to CV	Log % E&I	outlier (2stdev)	Contract $$ per Day	Log $perDay	outlier (2stdev)
100042056	4	$507,344	W	Pavement Rehab, R	9/22/2003	55	$38,536.26	$700.66	7.5957%	-1.11943	0	$9,224.44	3.9649	0
100042601	4	$508,552	W	Unclassified	10/16/2003	75	$16,600.36	$221.34	3.2642%	-1.48622	0	$6,780.69	3.8313	0
100044147	4	$511,591	W	Unclassified	10/28/2005	34	$49,797.73	$1,464.64	9.7339%	-1.01171	0	$15,046.79	4.1774	0
100042515	4	$512,615	W	Unclassified	9/9/2003	34	$4,903.29	$144.21	0.9565%	-2.01930	0	$15,076.91	4.1783	0
100044393	4	$514,218	W	Unclassified	5/27/2005	27	$135,950.13	$5,035.19	26.4382%	-0.57777	0	$19,045.11	4.2798	0
100043065	4	$515,054	W	Grade Drain Base Pa	5/5/2004	80	$66,394.15	$829.93	12.8907%	-0.88972	0	$6,438.18	3.8088	0
100043224	4	$515,905	W	Unclassified	7/22/2004	87	$10,020.29	$115.18	1.9423%	-1.71169	0	$5,929.94	3.7731	0
100044696	4	$518,183	W	Unclassified	4/29/2005	60	$5,276.05	$87.93	1.0182%	-1.99217	0	$8,636.38	3.9363	0
100046032	4	$518,186	W	Pavement Rehab, R	11/16/2005	44	$14,167.23	$321.98	2.7340%	-1.56320	0	$11,776.95	4.0710	0
100042731	4	$524,341	W	Unclassified	1/30/2004	30	$44,040.34	$1,468.01	8.3992%	-1.07576	0	$17,478.03	4.2425	0
100044936	4	$526,352	W	Pavement Rehab, R	6/22/2005	40	$20,782.21	$519.56	3.9483%	-1.40358	0	$13,158.80	4.1192	0
100042851	4	$527,893	W	Unclassified	8/19/2003	32	$6,930.52	$216.58	1.3129%	-1.88178	0	$16,496.66	4.2174	0
100041956	4	$529,139	W	Roadway Widening,	2/6/2004	31	$19,392.64	$625.57	3.6649%	-1.43593	0	$17,069.00	4.2322	0
100042097	4	$529,141	W	Pavement Rehab, R	10/10/2003	14	$6,882.46	$491.60	1.3007%	-1.88583	0	$37,795.79	4.5774	0
100042500	4	$533,948	W	Bridge Replacement	5/7/2004	117	$6,545.14	$55.94	1.2258%	-1.91158	0	$4,563.66	3.6593	0
100043476	4	$534,236	W	Bridge Replacement	3/23/2004	78	$4,555.36	$58.40	0.8527%	-2.06921	0	$6,849.18	3.8356	0
100045189	4	$536,883	W	Unclassified	8/24/2005	15	$20,982.42	$1,398.83	3.9082%	-1.40802	0	$35,792.20	4.5538	0
100044492	4	$537,946	W	Unclassified	9/7/2004	50	$33,332.40	$666.65	6.1962%	-1.20787	0	$10,758.92	4.0318	0
100042291	4	$542,158	W	Unclassified	4/25/2004	25	$30,023.81	$1,200.95	5.5378%	-1.25666	0	$21,686.32	4.3362	0
100042635	4	$543,018	W	Bridge Replacement	5/11/2004	94	$16,312.15	$173.53	3.0040%	-1.52230	0	$5,776.79	3.7617	0
100042966	4	$543,140	W	Bridge Replacement	7/23/2004	87	$13,222.22	$151.98	2.4344%	-1.61361	0	$6,242.99	3.7954	0
100041243	4	$543,440	W	Bridge Replacement	7/16/2003	86	$21,520.16	$250.23	3.9600%	-1.40231	0	$6,319.07	3.8007	0
100041818	4	$544,648	W	Pavement Rehab, R	4/30/2003	23	$64,159.49	$2,789.54	11.7800%	-0.92886	0	$23,680.35	4.3744	0
100044539	4	$553,529	W	Pavement Rehab, R	12/22/2004	36	$23,023.26	$639.54	4.1594%	-1.38097	0	$15,375.81	4.1868	0
100042394	4	$553,684	W	Pavement Rehab, R	9/5/2003	40	$40,261.57	$1,006.54	7.2716%	-1.13837	0	$13,842.10	4.1412	0
100041647	4	$557,314	W	Roadway Widening,	1/24/2003	48	$26,440.66	$550.85	4.7443%	-1.32383	0	$11,610.71	4.0649	0
100011660	4	$557,793	W	Unclassified	7/12/2004	77	$13,301.31	$172.74	2.3846%	-1.62258	0	$7,244.06	3.8600	0
100042743	4	$558,532	W	Unclassified	2/18/2004	55	$22,372.97	$406.78	4.0057%	-1.39732	0	$10,155.13	4.0067	0
100042083	4	$558,678	W	Unclassified	1/21/2004	82	$50,503.26	$615.89	9.0398%	-1.04384	0	$6,813.15	3.8333	0
100041327	4	$560,897	W	Grade Drain Base Pa	12/3/2003	116	$72,429.32	$624.39	12.9131%	-0.88897	0	$4,835.32	3.6844	0
100039079	4	$566,362	W	Lighting	12/19/2003	120	$191,783.81	$1,598.20	33.8624%	-0.47028	0	$4,719.68	3.6739	0
100045600	4	$567,897	W	Unclassified	6/9/2005	27	$2,579.64	$95.54	0.4542%	-2.34271	0	$21,033.22	4.3229	0
100042685	4	$570,159	W	Unclassified	9/8/2003	33	$52,607.95	$1,594.18	9.2269%	-1.03494	0	$17,277.55	4.2375	0
100042783	4	$570,721	W	Unclassified	10/29/2003	43	$89,913.26	$2,091.01	15.7543%	-0.80260	0	$13,272.58	4.1230	0
100008420	4	$572,297	W	Pavement Rehab, R	5/24/2003	122	$182,173.45	$1,493.23	31.8320%	-0.49714	0	$4,690.96	3.6713	0
100041317	4	$573,495	W	Bridge Replacement	5/16/2005	29	$57,163.89	$1,971.17	9.9676%	-1.00141	0	$19,775.69	4.2961	0
100042066	4	$576,071	W	Roadway Widening,	8/6/2003	44	$18,305.81	$416.04	3.1777%	-1.49789	0	$13,092.52	4.1170	0
100044697	4	$576,263	W	Unclassified	2/22/2005	39	$79,305.07	$2,033.46	13.7620%	-0.86132	0	$14,775.97	4.1696	0
100041094	4	$576,967	W	Unclassified	6/25/2003	25	$75,690.97	$3,027.64	13.1188%	-0.88211	0	$23,078.68	4.3632	0
100039015	4	$578,185	W	Pavement Rehab, R	3/14/2003	50	$46,354.03	$927.08	8.0172%	-1.09598	0	$11,563.70	4.0631	0
100041424	4	$581,991	W	Grade Drain Base Pa	3/25/2004	98	$134,731.08	$1,374.81	23.1500%	-0.63545	0	$5,938.68	3.7737	0
100042852	4	$582,421	W	Unclassified	2/4/2004	32	$131,040.93	$4,095.03	22.4993%	-0.64783	0	$18,200.66	4.2601	0
100043203	4	$587,064	W	Pavement Rehab, R	4/21/2004	45	$19,917.66	$442.61	3.3928%	-1.46945	0	$13,045.87	4.1155	0
100045776	4	$588,958	W	Unclassified	10/4/2005	36	$16,830.95	$467.53	2.8578%	-1.54398	0	$16,359.94	4.2138	0
100045448	4	$590,128	W	Pavement Rehab, R	12/6/2005	45	$26,411.87	$586.93	4.4756%	-1.34915	0	$13,113.96	4.1177	0
100044568	4	$590,257	W	Roadway Widening,	9/1/2005	21	$28,849.48	$1,373.78	4.8876%	-1.31090	0	$28,107.48	4.4488	0
100044913	4	$593,733	W	Unclassified	5/16/2005	42	$26,015.85	$619.43	4.3817%	-1.35835	0	$14,136.50	4.1503	0
100044309	4	$596,210	W	Pavement Rehab, R	11/19/2004	24	$32,074.57	$1,336.44	5.3797%	-1.26924	0	$24,842.08	4.3952	0
100044815	4	$597,002	W	Pavement Rehab, R	3/10/2005	35	$26,349.29	$752.84	4.4136%	-1.35521	0	$17,057.20	4.2319	0
100043572	4	$597,512	W	Unclassified	11/6/2004	114	$61,399.39	$538.59	10.2758%	-0.98818	0	$5,241.33	3.7194	0
100042789	4	$598,083	W	Unclassified	1/12/2004	50	$78,142.52	$1,562.85	13.0655%	-0.88387	0	$11,961.66	4.0778	0
100043674	4	$598,344	W	Unclassified	8/31/2004	77	$16,498.82	$214.27	2.7574%	-1.55950	0	$7,770.70	3.8905	0
100042748	4	$599,346	W	Unclassified	5/5/2003	18	$124,470.70	$6,915.04	20.7678%	-0.68261	0	$33,297.00	4.5224	0
100039207	4	$602,343	W	Unclassified	8/18/2004	126	$50,247.18	$398.79	8.3420%	-1.07873	0	$4,780.50	3.6795	0
100041954	4	$602,761	W	Pavement Rehab, R	11/6/2003	60	$31,166.47	$519.44	5.1706%	-1.28646	0	$10,046.02	4.0020	0
100042119	4	$603,000	W	Grade Drain Base Pa	6/2/2003	87	$35,747.08	$410.89	5.9282%	-1.22708	0	$6,931.03	3.8408	0
100045700	4	$608,154	W	Unclassified	11/1/2005	24	$77,719.56	$3,238.32	12.7796%	-0.89348	0	$25,339.75	4.4038	0
100043611	4	$609,659	W	Unclassified	10/28/2004	33	$14,901.18	$451.55	2.4442%	-1.61187	0	$18,474.52	4.2666	0
100044852	4	$614,434	W	Unclassified	6/24/2005	45	$27,050.18	$601.12	4.4025%	-1.35631	0	$13,654.09	4.1353	0
100039944	4	$614,755	W	Unclassified	2/18/2005	93	$98,044.20	$1,054.24	15.9485%	-0.79728	0	$6,610.27	3.8202	0
100040742	4	$617,513	W	Bridge Replacement	11/10/2004	114	$171,604.38	$1,505.30	27.7896%	-0.55612	0	$5,416.78	3.7337	0
100045968	4	$618,947	W	Unclassified	10/28/2005	30	$13,635.94	$454.53	2.2031%	-1.65697	0	$20,631.57	4.3145	0
100043200	4	$621,197	W	Pavement Rehab, R	9/28/2004	31	$14,767.60	$476.37	2.3773%	-1.62392	0	$20,038.61	4.3019	0
100042854	4	$621,625	W	Unclassified	6/16/2004	117	$5,389.95	$46.07	0.8671%	-2.06194	0	$5,313.03	3.7253	0
100039831	4	$622,068	W	Signals, Markings, S	6/15/2004	93	$90,643.90	$974.67	14.5714%	-0.83650	0	$6,688.90	3.8254	0
100044988	4	$627,448	W	Pavement Rehab, R	3/17/2005	22	$37,412.73	$1,700.58	5.9627%	-1.22456	0	$28,520.36	4.4552	0
100041912	4	$627,487	W	Pavement Rehab, R	2/26/2003	52	$45,189.24	$869.02	7.2016%	-1.14257	0	$12,067.06	4.0816	0
100042636	4	$629,146	W	Pavement Rehab, R	10/17/2003	77	$14,461.94	$187.82	2.2987%	-1.63852	0	$8,170.73	3.9123	0
100044185	4	$629,972	W	Unclassified	3/9/2005	58	$17,062.33	$294.18	2.7084%	-1.56728	0	$10,861.59	4.0359	0
100044391	4	$633,007	W	Unclassified	9/20/2004	24	$52,378.24	$2,182.43	8.2745%	-1.08226	0	$26,375.29	4.4212	0
100044384	4	$633,210	W	Unclassified	10/2/2005	24	$1,917.17	$79.88	0.3028%	-2.51889	0	$26,383.75	4.4213	0
100046196	4	$641,233	W	Unclassified	11/23/2005	62	$9,179.56	$148.06	1.4315%	-1.84419	0	$10,342.47	4.0146	0
100041893	4	$643,479	W	Bridge Replacement	3/3/2003	85	$24,148.47	$284.10	3.7528%	-1.42564	0	$7,570.34	3.8791	0
100042686	4	$644,642	W	Unclassified	2/17/2004	35	$53,424.22	$1,526.41	8.2874%	-1.08158	0	$18,418.34	4.2653	0
100042865	4	$644,959	W	Unclassified	4/22/2004	81	$9,103.10	$112.38	1.4114%	-1.85034	0	$7,962.46	3.9010	0
100043619	4	$647,239	W	Pavement Rehab, R	8/31/2004	41	$18,941.64	$461.99	2.9265%	-1.53365	0	$15,786.32	4.1983	0
100044290	4	$647,817	W	Unclassified	1/4/2005	21	$51,708.51	$2,462.31	7.9820%	-1.09789	0	$30,848.43	4.4892	0
100042552	4	$654,732	W	Pavement Rehab, R	1/14/2004	79	$22,693.02	$287.25	3.4660%	-1.46017	0	$8,287.75	3.9184	0
100042963	4	$654,958	W	Roadway Widening,	7/16/2004	59	$17,199.34	$291.51	2.6260%	-1.58070	0	$11,100.98	4.0454	0
100044380	4	$656,077	W	Unclassified	8/30/2004	24	$55,343.93	$2,306.00	8.4356%	-1.07388	0	$27,336.54	4.4367	0
100043431	4	$656,670	W	Unclassified	5/28/2004	43	$39,565.86	$920.14	6.0252%	-1.22003	0	$15,271.40	4.1839	0
100043615	4	$656,717	W	Unclassified	12/27/2004	41	$24,301.43	$592.72	3.7004%	-1.43175	0	$16,017.49	4.2046	0
100044747	4	$657,306	W	Pavement Rehab, R	3/10/2005	40	$36,111.90	$902.80	5.4939%	-1.26012	0	$16,432.65	4.2157	0
100044814	4	$661,897	W	Pavement Rehab, R	9/6/2005	43	$53,223.06	$1,237.75	8.0410%	-1.09469	0	$15,392.95	4.1873	0
100042948	4	$663,120	W	Unclassified	11/25/2003	30	$47,718.62	$1,590.62	7.1961%	-1.14290	0	$22,104.00	4.3445	0
100040303	4	$664,299	W	Pavement Rehab, R	3/12/2003	75	$68,825.33	$917.67	10.3606%	-0.98462	0	$8,857.32	3.9473	0
100044239	4	$667,798	W	Unclassified	6/22/2004	26	$91,356.67	$3,513.72	13.6803%	-0.86390	0	$25,684.54	4.4097	0
100041898	4	$668,831	W	Pavement Rehab, R	4/16/2003	28	$16,493.65	$589.06	2.4660%	-1.60800	0	$23,886.82	4.3782	0
100039050	4	$672,113	W	Bridge Replacement	10/24/2003	153	$34,143.31	$223.16	5.0800%	-1.29414	0	$4,392.90	3.6428	0
100044704	4	$672,248	W	Pavement Rehab, R	11/15/2005	39	$24,068.64	$617.14	3.5803%	-1.44608	0	$17,237.13	4.2365	0
100043074	4	$672,725	W	Pavement Rehab, R	3/12/2004	84	$16,233.97	$193.26	2.4132%	-1.61741	0	$8,008.63	3.9036	0
100043540	4	$673,058	W	Roadway Widening,	6/15/2005	70	$19,281.98	$275.46	2.8648%	-1.54290	0	$9,615.11	3.9830	0
100044157	4	$673,132	W	Unclassified	3/22/2005	45	$48,176.01	$1,070.58	7.1570%	-1.14527	0	$14,958.49	4.1749	0
100042801	4	$675,854	W	Unclassified	2/2/2004	26	$81,442.43	$3,132.40	12.0503%	-0.91900	0	$25,994.38	4.4149	0
100045681	4	$677,450	W	Unclassified	10/31/2005	33	$18,122.81	$549.18	2.6752%	-1.57265	0	$20,528.79	4.3124	0
100042753	4	$678,124	W	Unclassified	11/18/2003	41	$68,825.68	$1,678.68	10.1494%	-0.99356	0	$16,539.61	4.2185	0
100042849	4	$679,512	W	Unclassified	2/20/2004	38	$131,451.71	$3,459.26	19.3450%	-0.71343	0	$17,881.89	4.2524	0
100044370	4	$680,161	W	Unclassified	2/21/2005	60	$29,204.50	$486.74	4.2938%	-1.36716	0	$11,336.02	4.0545	0
100041472	4	$681,548	W	Unclassified	3/22/2003	60	$34,546.62	$575.78	5.0688%	-1.29509	0	$11,359.13	4.0553	0
100041322	4	$682,351	W	Pavement Rehab, R	1/11/2003	69	$37,249.06	$539.84	5.4589%	-1.26289	0	$9,889.14	3.9952	0
100044466	4	$683,617	W	Unclassified	5/3/2005	48	$176,131.55	$3,669.41	25.7647%	-0.58898	0	$14,242.02	4.1536	0
100042696	4	$683,761	W	Unclassified	10/6/2004	82	$36,477.89	$444.85	5.3349%	-1.27287	0	$8,338.55	3.9211	0
100042527	4	$684,334	W	Unclassified	3/24/2004	117	$9,765.71	$83.47	1.4270%	-1.84556	0	$5,849.01	3.7671	0
100042746	4	$687,522	W	Unclassified	7/31/2003	33	$61,286.26	$1,857.16	8.9141%	-1.04992	0	$20,834.00	4.3188	0
100042776	4	$687,710	W	Unclassified	6/29/2005	39	$108,085.98	$2,771.44	15.7168%	-0.80364	0	$17,633.59	4.2463	0
100040438	4	$689,439	W	Roadway Widening,	5/7/2003	55	$30,884.39	$561.53	4.4796%	-1.34876	0	$12,535.25	4.0981	0

CPMS Proj #	Size	Original Contract Amt	C/W	Code Description	Completion Date	Days Used	E&I Amt	Daily E&I	% E&I to CV	Log % E&I	outlier (2stdev)	Contract $$ per Day	Log $perDay	outlier (2stdev)
100038235	4	$692,065	W	Grade Drain Base Pa	9/30/2003	82	$31,398.20	$382.90	4.5369%	-1.34324	0	$8,439.82	3.9263	0
100042690	4	$698,455	W	Unclassified	1/7/2004	60	$63,207.16	$1,053.45	9.0496%	-1.04337	0	$11,640.92	4.0660	0
100037740	4	$699,724	W	Unclassified	6/23/2004	113	$159,305.99	$1,409.79	22.7670%	-0.64269	0	$6,192.25	3.7918	0
100042958	4	$703,523	W	Pavement Rehab, Re	12/17/2003	74	$3,157.80	$42.67	0.4489%	-2.34789	0	$9,507.07	3.9780	0
100044939	4	$704,297	W	Unclassified	12/14/2005	55	$12,243.89	$222.62	1.7385%	-1.75984	0	$12,805.40	4.1074	0
100041790	4	$705,248	W	Pavement Rehab, Re	3/24/2004	34	$14,283.00	$420.09	2.0252%	-1.69352	0	$20,742.59	4.3169	0
100041112	4	$707,541	W	Unclassified	2/19/2003	43	$70,728.65	$1,644.85	9.9964%	-1.00016	0	$16,454.44	4.2163	0
100041376	4	$714,000	W	Grade Drain Base Pa	8/23/2004	171	$119,873.78	$701.02	16.7890%	-0.77497	0	$4,175.44	3.6207	0
100042803	4	$714,395	W	Unclassified	5/26/2004	57	$56,256.02	$986.95	7.8746%	-1.10377	0	$12,533.25	4.0981	0
100042420	4	$715,822	W	Unclassified	3/17/2004	97	$4,036.38	$41.61	0.5639%	-2.24881	0	$7,379.61	3.8680	0
100041998	4	$719,568	W	Roadway Widening,	8/22/2003	27	$19,703.59	$729.76	2.7383%	-1.56253	0	$26,650.67	4.4257	0
100044423	4	$722,889	W	Unclassified	11/17/2004	42	$32,767.12	$780.17	4.5328%	-1.34363	0	$17,211.64	4.2358	0
100043560	4	$723,005	W	Unclassified	3/4/2005	117	$153,154.97	$1,309.02	21.1831%	-0.67401	0	$6,179.53	3.7910	0
100043250	4	$724,778	W	Roadway Widening,	12/22/2005	30	$49,034.67	$1,634.49	6.7655%	-1.16970	0	$24,159.27	4.3831	0
100041061	4	$727,561	W	Unclassified	2/11/2003	43	$173,678.40	$4,039.03	23.8713%	-0.62212	0	$16,920.02	4.2284	0
100042787	4	$729,489	W	Unclassified	4/21/2003	47	$55,583.65	$1,182.63	7.6195%	-1.11807	0	$15,521.04	4.1909	0
100041957	4	$736,744	W	Roadway Widening,	11/10/2003	43	$41,288.98	$960.21	5.6043%	-1.25148	0	$17,133.58	4.2338	0
100004276	4	$736,978	W	Grade Drain Base Pa	7/17/2003	93	$16,117.16	$173.30	2.1869%	-1.66017	0	$7,924.49	3.8990	0
100044938	4	$737,774	W	Roadway Widening,	12/20/2005	61	$4,187.30	$68.64	0.5676%	-2.24599	0	$12,094.66	4.0826	0
100046245	4	$737,860	W	Unclassified	10/6/2005	30	$33,334.54	$1,111.15	4.5177%	-1.34508	0	$24,595.33	4.3909	0
100045558	4	$738,681	W	Unclassified	9/14/2005	55	$16,359.68	$297.45	2.2147%	-1.65468	0	$13,430.56	4.1281	0
100044291	4	$743,758	W	Unclassified	11/19/2004	21	$31,183.60	$1,484.93	4.1927%	-1.37751	0	$35,417.05	4.5492	0
100043463	4	$747,312	W	Unclassified	7/28/2004	29	$60,669.40	$2,092.05	8.1183%	-1.09053	0	$25,769.38	4.4111	0
100044360	4	$747,724	W	Unclassified	4/15/2005	40	$65,823.06	$1,645.58	8.8031%	-1.05536	0	$18,693.10	4.2717	0
100044364	4	$755,222	W	Unclassified	3/23/2005	31	$69,480.05	$2,241.29	9.2000%	-1.03621	0	$24,362.00	4.3867	0
100003839	4	$762,000	W	Structure Removal	12/1/2003	81	$90,940.03	$1,122.72	11.9344%	-0.92320	0	$9,407.41	3.9735	0
100039932	4	$762,847	W	Unclassified	3/4/2004	120	$11,623.41	$96.86	1.5237%	-1.81710	0	$6,357.06	3.8033	0
100040625	4	$762,882	W	Bridge Replacement	10/21/2003	129	$91,271.76	$707.53	11.9641%	-0.92212	0	$5,913.81	3.7719	0
100040436	4	$764,026	W	Pavement Rehab, Re	10/24/2003	88	$110,817.48	$1,259.29	14.5044%	-0.83850	0	$8,682.11	3.9386	0
100042823	4	$775,192	W	Unclassified	11/14/2003	34	$6,202.00	$182.41	0.8001%	-2.09688	0	$22,799.76	4.3579	0
100039238	4	$775,831	W	Unclassified	6/9/2003	44	$198,972.56	$4,522.10	25.6464%	-0.59097	0	$17,632.52	4.2463	0
100042350	4	$780,804	W	Bridge Replacement	1/23/2004	90	$43,123.10	$479.15	5.5229%	-1.25783	0	$8,675.60	3.9383	0
100042327	4	$790,421	W	Unclassified	9/19/2003	58	$64,145.29	$1,105.95	8.1153%	-1.09069	0	$13,627.95	4.1344	0
100043000	4	$793,618	W	Grade Drain Base Pa	5/25/2004	132	$46,128.79	$349.46	5.8125%	-1.23564	0	$6,012.26	3.7790	0
100042135	4	$796,718	W	Unclassified	3/1/2004	104	$111,035.84	$1,067.65	13.9367%	-0.85584	0	$7,660.75	3.8843	0
100043912	4	$797,100	W	Unclassified	7/26/2004	92	$72,950.23	$792.94	9.1520%	-1.03849	0	$8,664.13	3.9377	0
100041795	4	$797,979	W	Unclassified	2/14/2003	43	$76,736.90	$1,784.58	9.6164%	-1.01699	0	$18,557.65	4.2685	0
100042788	4	$799,920	W	Unclassified	8/20/2003	50	$98,419.55	$1,968.39	12.3037%	-0.90997	0	$15,998.40	4.2041	0
100044368	4	$804,938	W	Unclassified	6/22/2005	64	$182,248.80	$2,847.64	22.6413%	-0.64510	0	$12,577.16	4.0996	0
100033471	4	$805,577	W	Unclassified	5/28/2004	107	$262,280.02	$2,451.22	32.5580%	-0.48734	0	$7,528.76	3.8767	0
100041144	4	$816,420	W	Unclassified	4/28/2004	98	$13,834.50	$141.17	1.6945%	-1.77095	0	$8,330.82	3.9207	0
100042311	4	$817,448	W	Unclassified	10/28/2003	31	$114,354.06	$3,688.84	13.9892%	-0.85421	0	$26,369.29	4.4211	0
100042745	4	$821,875	W	Unclassified	4/6/2004	45	$124,789.62	$2,773.10	15.1835%	-0.81863	0	$18,263.89	4.2616	0
100041471	4	$824,054	W	Bridge Replacement	10/20/2003	117	$26,753.82	$228.67	3.2466%	-1.48857	0	$7,043.20	3.8478	0
100041109	4	$825,137	W	Unclassified	2/18/2003	45	$57,399.28	$1,275.54	6.9563%	-1.15762	0	$18,336.38	4.2633	0
100044415	4	$826,488	W	Unclassified	7/23/2004	33	$85,927.26	$2,603.86	10.3967%	-0.98311	0	$25,045.09	4.3987	0
100041469	4	$828,352	W	Bridge Replacement	9/25/2003	130	$3,520.33	$27.08	0.4250%	-2.37163	0	$6,371.94	3.8043	0
100041153	4	$829,016	W	Unclassified	10/20/2003	45	$60,251.85	$1,338.93	7.2679%	-1.13859	0	$18,422.58	4.2654	0
100044385	4	$831,864	W	Unclassified	10/19/2005	40	$130,587.08	$3,264.68	15.6981%	-0.80415	0	$20,796.60	4.3180	0
100042681	4	$832,564	W	Unclassified	12/8/2004	62	$112,912.74	$1,821.17	13.5620%	-0.86767	0	$13,428.45	4.1280	0
100033237	4	$832,940	W	Grade Drain Base Pa	1/12/2005	48	$143,102.83	$2,981.31	17.1804%	-0.76497	0	$17,352.92	4.2394	0
100045654	4	$837,644	W	Unclassified	11/30/2005	30	$132,132.58	$4,404.42	15.7743%	-0.80205	0	$27,921.47	4.4459	0
100009106	4	$839,658	W	Lighting	11/25/2003	63	$259,125.48	$4,113.10	30.8608%	-0.51059	0	$13,327.90	4.1248	0
100040909	4	$840,432	W	Intersection Improve	3/16/2005	51	$110,883.46	$2,174.19	13.1936%	-0.87964	0	$16,479.06	4.2169	0
100044367	4	$846,885	W	Unclassified	11/4/2004	51	$144,614.36	$2,835.58	17.0760%	-0.76761	0	$16,605.59	4.2203	0
100042059	4	$847,074	W	Unclassified	6/26/2003	103	$11,356.19	$110.25	1.3406%	-1.87269	0	$8,224.02	3.9151	0
100042732	4	$859,284	W	Unclassified	9/10/2004	45	$66,291.48	$1,473.14	7.7147%	-1.11268	0	$19,095.20	4.2809	0
100042774	4	$860,441	W	Unclassified	5/11/2004	79	$150,456.30	$1,904.51	17.4860%	-0.75731	0	$10,891.66	4.0371	0
100044383	4	$860,943	W	Unclassified	6/20/2005	50	$73,678.95	$1,473.58	8.5579%	-1.06763	0	$17,218.86	4.2360	0
100042349	4	$865,060	W	Roadway Widening,	10/25/2004	39	$33,635.66	$862.45	3.8882%	-1.41025	0	$22,181.03	4.3460	0
100042695	4	$865,337	W	Unclassified	12/10/2003	45	$88,464.48	$1,965.88	10.2231%	-0.99042	0	$19,229.71	4.2840	0
100041922	4	$870,599	W	Unclassified	2/25/2005	90	$53,891.27	$598.79	6.1901%	-1.20830	0	$9,673.32	3.9856	0
100045096	4	$871,044	W	Unclassified	11/10/2005	52	$137,128.61	$2,637.09	15.7430%	-0.80291	0	$16,750.85	4.2240	0
100044908	4	$882,456	W	Pavement Rehab, Re	5/11/2005	40	$8,506.56	$212.66	0.9640%	-2.01594	0	$22,061.40	4.3436	0
100040941	4	$883,714	W	Unclassified	9/1/2004	203	$50,596.56	$249.24	5.7254%	-1.24219	0	$4,353.27	3.6388	0
100041103	4	$884,249	W	Unclassified	6/24/2003	36	$64,391.12	$1,788.64	7.2820%	-1.13775	0	$24,562.47	4.3903	0
100044156	4	$886,121	W	Unclassified	11/10/2005	30	$45,516.52	$1,517.22	5.1366%	-1.28932	0	$29,537.37	4.4704	0
100043617	4	$889,267	W	Pavement Rehab, Re	8/19/2005	53	$15,452.26	$291.55	1.7376%	-1.76004	0	$16,778.62	4.2248	0
100044398	4	$892,392	W	Unclassified	12/6/2004	30	$53,496.21	$1,783.21	5.9947%	-1.22223	0	$29,746.40	4.4734	0
100042806	4	$893,585	W	Unclassified	3/31/2004	94	$80,105.37	$852.18	8.9645%	-1.04747	0	$9,506.22	3.9780	0
100045243	4	$894,898	W	Pavement Rehab, Re	9/8/2005	29	$35,279.38	$1,216.53	3.9423%	-1.40425	0	$30,858.55	4.4894	0
100040088	4	$895,854	W	Intersection Improve	7/14/2003	31	$46,056.07	$1,485.68	5.1410%	-1.28895	0	$28,898.52	4.4609	0
100042729	4	$899,870	W	Unclassified	9/2/2004	44	$82,677.02	$1,879.02	9.1877%	-1.03679	0	$20,451.59	4.3107	0
100042321	4	$900,972	W	Unclassified	9/8/2004	40	$69,054.84	$1,726.37	7.6645%	-1.11552	0	$22,524.30	4.3527	0
100042819	4	$903,856	W	Pavement Rehab, Re	7/8/2004	54	$53,984.02	$999.70	5.9726%	-1.22383	0	$16,738.07	4.2237	0
100042045	4	$905,077	W	Unclassified	8/28/2003	43	$21,698.93	$504.63	2.3975%	-1.62025	0	$21,048.30	4.3232	0
100045603	4	$906,270	W	Unclassified	10/28/2005	45	$190,916.43	$4,242.59	21.0662%	-0.67641	0	$20,139.33	4.3040	0
100044376	4	$907,217	W	Unclassified	4/4/2005	75	$40,888.61	$545.18	4.5070%	-1.34611	0	$12,096.23	4.0826	0
100043208	4	$909,494	W	Pavement Rehab, Re	4/19/2004	72	$16,597.43	$230.52	1.8249%	-1.73876	0	$12,631.86	4.1015	0
100042750	4	$909,712	W	Unclassified	3/26/2004	41	$150,750.88	$3,676.85	16.5713%	-0.78064	0	$22,188.10	4.3461	0
100042869	4	$916,469	W	Unclassified	9/27/2004	45	$3,039.52	$67.54	0.3317%	-2.47931	0	$20,365.98	4.3089	0
100039821	4	$919,217	W	Signals, Markings, S	9/29/2004	86	$106,170.65	$1,234.54	11.5501%	-0.93741	0	$10,688.57	4.0289	0
100044137	4	$931,167	W	Unclassified	7/28/2004	30	$23,280.32	$776.01	2.5001%	-1.60204	0	$31,038.90	4.4919	0
100042799	4	$932,116	W	Unclassified	8/25/2005	40	$21,063.62	$526.59	2.2598%	-1.64594	0	$23,302.90	4.3674	0
100041545	4	$942,919	W	Bridge Repair, Bridge	8/4/2003	172	$9,951.44	$57.86	1.0554%	-1.97659	0	$5,482.09	3.7389	0
100039976	4	$943,131	W	Grade Drain Base Pa	2/3/2005	82	$39,210.69	$478.18	4.1575%	-1.38117	0	$11,501.60	4.0608	0
100045715	4	$945,941	W	Unclassified	8/22/2005	39	$107,493.61	$2,756.25	11.3637%	-0.94448	0	$24,254.90	4.3848	0
100042798	4	$946,201	W	Unclassified	8/25/2005	40	$15,559.87	$389.00	1.6445%	-1.78398	0	$23,655.03	4.3739	0
100042363	4	$946,397	W	Pavement Rehab, Re	10/9/2003	48	$66,074.99	$1,376.56	6.9817%	-1.15604	0	$19,716.60	4.2948	0
100044946	4	$951,977	W	Unclassified	7/27/2005	64	$29,726.65	$464.48	3.1226%	-1.50548	0	$14,874.64	4.1724	0
100042844	4	$954,813	W	Unclassified	5/27/2004	31	$207,397.23	$6,690.23	21.7212%	-0.66312	0	$30,800.42	4.4886	0
100043772	4	$955,263	W	Bridge Replacement	11/8/2004	93	$176,920.62	$1,902.37	18.5206%	-0.73234	0	$10,271.65	4.0116	0
100042631	4	$955,495	W	Bridge Replacement	4/9/2004	118	$23,853.38	$202.15	2.4964%	-1.60268	0	$8,097.42	3.9083	0
100041095	4	$959,018	W	Unclassified	2/11/2003	34	$100,211.55	$2,947.40	10.4494%	-0.98091	0	$28,206.41	4.4503	0
100044236	4	$960,184	W	Unclassified	3/10/2005	39	$133,373.26	$3,419.83	13.8904%	-0.85729	0	$24,620.10	4.3913	0
100040777	4	$963,018	W	Grade Drain Base Pa	7/11/2003	120	$38,797.92	$323.32	4.0288%	-1.39483	0	$8,025.15	3.9045	0
100032853	4	$972,995	W	Grade Drain Base Pa	5/7/2004	97	$344,981.71	$3,556.51	35.4557%	-0.45031	0	$10,030.88	4.0013	0
100045711	4	$973,681	W	Unclassified	11/9/2005	28	$122,160.96	$4,362.89	12.5463%	-0.90148	0	$34,774.32	4.5413	0
100041100	4	$976,650	W	Unclassified	4/16/2003	49	$161,727.45	$3,300.56	16.5594%	-0.78096	0	$19,931.63	4.2995	0
100043884	4	$977,195	W	Roadway Widening,	1/4/2005	44	$23,977.58	$544.95	2.4537%	-1.61018	0	$22,208.98	4.3465	0
100043612	4	$977,302	W	Unclassified	3/3/2005	63	$27,248.11	$432.51	2.7881%	-1.55469	0	$15,512.73	4.1907	0
100044989	4	$977,980	W	Pavement Rehab, Re	9/7/2005	55	$29,711.04	$540.20	3.0380%	-1.51741	0	$17,781.45	4.2500	0
100043928	4	$982,575	W	Pavement Rehab, Re	7/8/2005	44	$43,478.13	$988.14	4.4249%	-1.35409	0	$22,331.25	4.3489	0
100040692	4	$988,477	W	Unclassified	5/27/2003	58	$237,270.21	$4,090.87	24.0036%	-0.61972	0	$17,042.71	4.2315	0
100042705	4	$993,079	W	Unclassified	2/19/2004	33	$50,940.16	$1,543.64	5.1295%	-1.28992	0	$30,093.30	4.4785	0
100044910	4	$998,463	W	Unclassified	6/8/2005	63	$48,449.46	$769.04	4.8524%	-1.31404	0	$15,848.62	4.2000	0

CPMS Proj #	Size	Original Contract Amt	C/W	Code Description	Completion Date	Days Used	E&I Amt	Daily E&I	% E&I to CV	Log % E&I	outlier (2stdev)	Contract $$ per Day	Log $perDay	outlier (2stdev)
100044270	5	$1,748,275	W	Unclassified	7/27/2005	74	$210,802.93	$2,848.69	12.0578%	-0.91873	0	$23,625.34	4.3734	0
100037541	5	$1,751,177	W	Unclassified	9/27/2005	200	$425,818.48	$2,129.09	24.3161%	-0.61411	0	$8,755.89	3.9423	0
100042923	5	$1,755,556	W	Unclassified	1/20/2004	41	$165,219.03	$4,029.73	9.4112%	-1.02635	0	$42,818.44	4.6316	0
100003750	5	$1,765,072	W	Unclassified	3/15/2005	200	$260,597.45	$1,302.99	14.7641%	-0.83079	0	$8,825.36	3.9457	0
100044237	5	$1,769,249	W	Unclassified	8/18/2004	61	$40,919.58	$670.81	2.3128%	-1.63586	0	$29,004.08	4.4625	0
100045768	5	$1,778,925	W	Unclassified	11/2/2005	51	$81,105.73	$1,590.31	4.5593%	-1.34111	0	$34,880.88	4.5426	0
100044377	5	$1,780,853	W	Unclassified	8/3/2005	35	$122,691.59	$3,505.47	6.8895%	-1.16181	0	$50,881.51	4.7066	0
100042795	5	$1,796,938	W	Unclassified	8/29/2005	53	$13,022.79	$245.71	0.7247%	-2.13983	0	$33,904.49	4.5303	0
100044366	5	$1,809,537	W	Unclassified	4/21/2005	35	$146,260.11	$4,178.86	8.0827%	-1.09244	0	$51,701.06	4.7135	0
100042802	5	$1,810,795	W	Unclassified	1/26/2005	63	$168,078.24	$2,667.91	9.2820%	-1.03236	0	$28,742.78	4.4585	0
100003521	5	$1,810,932	W	Unclassified	4/3/2003	191	$437,413.35	$2,290.12	24.1540%	-0.61701	0	$9,481.32	3.9769	0
100044428	5	$1,829,460	W	Unclassified	1/14/2005	72	$264,948.35	$3,679.84	14.4823%	-0.83916	0	$25,409.17	4.4050	0
100041536	5	$1,830,032	W	Pavement Rehab, Re	3/5/2003	70	$91,792.73	$1,311.32	5.0159%	-1.29965	0	$26,143.31	4.4174	0
100044288	5	$1,850,076	W	Unclassified	11/1/2005	76	$291,774.16	$3,839.13	15.7709%	-0.80214	0	$24,343.11	4.3864	0
100044597	5	$1,855,460	W	Unclassified	4/23/2005	65	$92,475.27	$1,422.70	4.9840%	-1.30243	0	$28,545.54	4.4555	0
100007789	5	$1,856,838	W	Grade Drain Base Pa	11/9/2004	175	$577,370.17	$3,299.26	31.0943%	-0.50732	0	$10,610.50	4.0257	0
100042808	5	$1,886,542	W	Unclassified	6/30/2004	72	$209,548.26	$2,910.39	11.1075%	-0.95438	0	$26,201.97	4.4183	0
100044363	5	$1,894,851	W	Unclassified	2/15/2005	59	$127,830.33	$2,166.62	6.7462%	-1.17094	0	$32,116.12	4.5067	0
100042827	5	$1,915,418	W	Unclassified	10/18/2004	65	$161,631.18	$2,486.63	8.4384%	-1.07374	0	$29,467.97	4.4694	0
100003305	5	$1,944,489	W	Bridge Replacement	6/19/2003	222	$931,009.34	$4,193.74	47.8794%	-0.31985	0	$8,758.96	3.9425	0
100038300	5	$1,952,120	W	Erosion Control, Rip	12/5/2003	106	$294,146.08	$2,774.96	15.0680%	-0.82194	0	$18,416.23	4.2652	0
100038732	5	$1,956,115	W	Grade Drain Base Pa	12/17/2003	104	$370,508.55	$3,562.58	18.9410%	-0.72260	0	$18,808.80	4.2744	0
100008800	5	$1,958,707	W	Grade Drain Base Pa	2/17/2004	117	$279,592.80	$2,389.68	14.2744%	-0.84544	0	$16,741.09	4.2238	0
100041132	5	$1,992,223	W	Unclassified	6/9/2004	52	$177,137.71	$3,406.49	8.8915%	-1.05103	0	$38,311.98	4.5833	0
100033033	6	$2,009,535	W	Bridge Repair, Bridg	4/9/2003	139	$1,441,019.89	$10,367.05	71.7091%	-0.14443	0	$14,457.09	4.1601	0
100037219	6	$2,033,934	W	Bridge Replacement	12/14/2005	151	$515,875.47	$3,416.39	25.3634%	-0.59579	0	$13,469.76	4.1294	0
100040704	6	$2,121,496	W	Unclassified	1/28/2003	78	$216,505.05	$2,775.71	10.2053%	-0.99117	0	$27,198.67	4.4345	0
100012283	6	$2,217,991	W	Bridge Replacement	5/22/2003	250	$635,381.75	$2,541.53	28.6467%	-0.54293	0	$8,871.96	3.9480	0
100003443	6	$2,233,037	W	Bridge Replacement	6/25/2003	213	$521,740.08	$2,449.48	23.3646%	-0.63144	0	$10,483.74	4.0205	0
100042531	6	$2,234,565	W	Unclassified	5/12/2005	89	$413,596.60	$4,647.15	18.5090%	-0.73262	0	$25,107.47	4.3998	0
100044369	6	$2,335,505	W	Unclassified	10/17/2005	42	$81,692.04	$1,945.05	3.4978%	-1.45620	0	$55,607.26	4.7451	0
100033138	6	$2,424,189	W	Unclassified	6/28/2004	194	$245,508.52	$1,265.51	10.1274%	-0.99450	0	$12,495.82	4.0968	0
100008878	6	$2,455,928	W	Unclassified	10/26/2004	279	$610,552.80	$2,188.36	24.8604%	-0.60449	0	$8,802.61	3.9446	0
100003259	6	$2,459,812	W	Bridge Repair, Bridg	4/12/2005	171	$712,486.44	$4,166.59	28.9651%	-0.53813	0	$14,384.87	4.1579	0
100044362	6	$2,477,298	W	Unclassified	1/10/2005	75	$199,399.06	$2,658.65	8.0491%	-1.09426	0	$33,030.64	4.5189	0
100038700	6	$2,498,479	W	Unclassified	4/29/2005	185	$388,209.82	$2,098.43	15.5378%	-0.80861	0	$13,505.29	4.1305	0
100042813	6	$2,508,010	W	Unclassified	3/24/2004	57	$154,567.99	$2,711.72	6.1630%	-1.21021	0	$44,000.18	4.6435	0
100040878	6	$2,605,521	W	Traffic Striping, Pave	7/26/2005	105	$515,612.80	$4,910.60	19.7892%	-0.70357	0	$24,814.49	4.3947	0
100045170	6	$2,716,333	W	Unclassified	12/6/2005	65	$67,954.80	$1,045.46	2.5017%	-1.60176	0	$41,789.74	4.6211	0
100038111	6	$2,851,977	W	Pavement Rehab, Re	10/25/2004	80	$440,739.36	$5,509.24	15.4538%	-0.81096	0	$35,649.71	4.5521	0
100002775	6	$2,888,100	W	Unclassified	9/28/2004	232	$523,708.20	$2,257.36	18.1333%	-0.74152	0	$12,448.71	4.0951	0
100039713	6	$2,894,190	W	Unclassified	9/12/2005	213	$672,459.83	$3,157.09	23.2348%	-0.63386	0	$13,587.75	4.1331	0
100008432	6	$2,925,424	W	Grade Drain Base Pa	1/13/2005	231	$669,899.06	$2,900.00	22.8992%	-0.64018	0	$12,664.17	4.1026	0
100038286	6	$2,968,171	W	Grade Drain Base Pa	5/21/2003	190	$670,014.90	$3,526.39	22.5733%	-0.64640	0	$15,621.95	4.1937	0
100004085	6	$3,061,380	W	Grade Drain Base Pa	10/15/2004	267	$851,236.75	$3,188.15	27.8057%	-0.55587	0	$11,465.84	4.0594	0
100003776	6	$3,080,221	W	Bridge Replacement	2/18/2003	372	$229,251.30	$616.27	7.4427%	-1.12827	0	$8,280.16	3.9180	0
100007682	6	$3,433,409	W	Pavement Rehab, Re	6/25/2004	392	$1,162,911.19	$2,966.61	33.8705%	-0.47018	0	$8,758.70	3.9424	0
100003969	6	$3,458,036	W	Grade Drain Base Pa	11/2/2004	309	$767,959.73	$2,485.31	22.2080%	-0.65349	0	$11,191.06	4.0489	0
100003469	6	$3,488,000	W	Grade Drain Base Pa	5/18/2004	273	$619,178.46	$2,268.05	17.7517%	-0.75076	0	$12,776.56	4.1064	0
100003753	6	$3,530,086	W	Bridge Replacement	12/8/2003	240	$742,522.49	$3,093.84	21.0341%	-0.67708	0	$14,708.69	4.1676	0
100039712	6	$3,654,052	W	Unclassified	2/15/2005	282	$857,772.53	$3,041.75	23.4746%	-0.62940	0	$12,957.63	4.1125	0
100013198	6	$3,666,947	W	Unclassified	9/2/2003	300	$518,236.73	$1,727.46	14.1326%	-0.84978	0	$12,223.16	4.0872	0
100005175	6	$3,727,782	W	Grade Drain Base Pa	1/7/2003	154	$676,074.69	$4,390.10	18.1361%	-0.74146	0	$24,206.38	4.3839	0
100008718	6	$3,779,732	W	Unclassified	8/25/2005	392	$988,886.51	$2,522.67	26.1629%	-0.58231	0	$9,642.17	3.9841749	0
100003873	6	$3,932,357	W	Grade Drain Base Pa	10/7/2003	232	$710,379.41	$3,061.98	18.0650%	-0.74316	0	$16,949.81	4.229165	0
100007703	6	$3,954,675	W	Grade Drain Base Pa	6/30/2004	163	$625,872.55	$3,839.71	15.8261%	-0.80062	0	$24,261.81	4.3849232	0
100013061	6	$4,022,113	W	Unclassified	10/28/2003	175	$565,220.69	$3,229.83	14.0528%	-0.85224	0	$22,983.50	4.3614162	0
100001739	6	$4,071,161	W	Unclassified	9/12/2005	214	$580,226.32	$2,711.34	14.2521%	-0.84612	0	$19,024.12	4.2793045	0
100004849	6	$4,166,720	W	Unclassified	7/20/2005	300	$990,921.16	$3,303.07	23.7818%	-0.62376	0	$13,889.07	4.1426731	0
100004277	6	$4,569,048	W	Unclassified	10/24/2005	225	$1,175,716.94	$5,225.41	25.7322%	-0.58952	0	$20,306.88	4.3076432	0
100005168	6	$4,608,340	W	Pavement Rehab, Re	5/6/2003	225	$744,365.72	$3,308.29	16.1526%	-0.79176	0	$20,481.51	4.311362	0
100009855	6	$4,665,913	W	Grade Drain Base Pa	7/14/2003	234	$720,717.20	$3,079.99	15.4464%	-0.81117	0	$19,939.80	4.2997208	0
100016530	6	$4,681,805	W	Grade Drain Base Pa	9/22/2005	211	$829,601.51	$3,931.76	17.7197%	-0.75154	0	$22,188.65	4.3461309	0
100042751	6	$4,686,809	W	Unclassified	7/12/2004	136	$83,151.15	$611.41	1.7742%	-1.75101	0	$34,461.83	4.5373383	0
100004692	6	$4,920,650	W	Unclassified	6/8/2004	311	$38,956.22	$125.26	0.7917%	-2.10145	0	$15,822.03	4.1992621	0
100008292	7	$5,022,376	W	Unclassified	7/21/2003	323	$2,150,531.98	$6,657.99	42.8190%	-0.36836	0	$15,549.15	4.1917067	0
100001605	7	$5,337,717	W	Unclassified	8/24/2004	260	$869,570.61	$3,344.50	16.2911%	-0.78805	0	$20,529.68	4.3123822	0
100004688	7	$5,367,554	W	Unclassified	11/25/2003	345	$962,745.29	$2,790.57	17.9364%	-0.74627	0	$15,558.13	4.1919573	0
100001666	7	$5,379,592	W	Unclassified	8/31/2005	226	$731,117.41	$3,235.03	13.5906%	-0.86676	0	$23,803.50	4.3766409	0
100005176	7	$5,394,947	W	Grade Drain Base Pa	4/25/2003	274	$1,314,206.24	$4,796.37	24.3599%	-0.61332	0	$19,689.59	4.2942366	0
100038011	7	$5,712,375	W	Unclassified	9/20/2005	280	$1,284,017.09	$4,585.78	22.4778%	-0.64825	0	$20,401.34	4.3096587	0
100007457	7	$5,784,901	W	Unclassified	12/8/2003	504	$2,202,617.42	$4,370.27	38.0753%	-0.41936	0	$11,477.98	4.0598654	0
100040092	7	$5,831,711	W	Grade Drain Base Pa	1/13/2005	225	$1,653,095.42	$7,347.09	28.3467%	-0.54750	0	$25,918.72	4.4136135	0
100026220	7	$5,940,775	W	Grade Drain Base Pa	8/24/2004	360	$1,150,528.10	$3,195.91	19.3666%	-0.71295	0	$16,502.15	4.2175406	0
100004225	7	$6,259,451	W	Grade Drain Base Pa	2/4/2003	279	$930,278.50	$3,334.33	14.8620%	-0.82792	0	$22,435.31	4.350932	0
100033297	7	$6,506,591	W	Unclassified	9/16/2005	303	$1,081,642.25	$3,569.78	16.6238%	-0.77927	0	$21,473.90	4.3319109	0
100032727	7	$7,048,554	W	Unclassified	11/10/2005	198	$429,204.78	$2,167.70	6.0893%	-1.21544	0	$35,598.76	4.5514348	0
100033156	7	$7,238,991	W	Pavement Rehab, Re	3/16/2004	240	$686,273.50	$2,859.47	9.4802%	-1.02318	0	$30,162.46	4.4794668	0
100033157	7	$7,506,951	W	Unclassified	4/20/2005	235	$881,600.80	$3,751.49	11.7438%	-0.93019	0	$31,944.47	4.5043957	0
100032014	7	$7,716,156	W	Pavement Rehab, Re	4/29/2003	225	$378,318.32	$1,681.41	4.9029%	-1.30954	0	$34,294.03	4.5352185	0
100016521	7	$7,755,946	W	Grade Drain Base Pa	5/27/2004	420	$2,741,116.45	$6,526.47	35.3421%	-0.45171	0	$18,466.54	4.2663855	0
100004985	7	$7,772,659	W	Grade Drain Base Pa	8/4/2004	396	$1,470,022.53	$3,712.18	18.9127%	-0.72325	0	$19,627.93	4.2928744	0
100008439	7	$7,896,112	W	Unclassified	5/21/2003	414	$1,585,671.05	$3,830.12	20.0817%	-0.69720	0	$19,072.73	4.280413	0
100002568	7	$8,395,121	W	Grade Drain Base Pa	5/25/2004	368	$1,614,296.45	$4,386.68	19.2290%	-0.71604	0	$22,812.83	4.3581791	0
100009919	7	$8,695,276	W	Grade Drain Base Pa	8/13/2004	297	$228,652.84	$769.87	2.6296%	-1.58011	0	$29,277.02	4.4665269	0
100004521	7	$8,928,205	W	Grade Drain Base Pa	7/19/2003	324	$352,216.94	$1,087.09	3.9450%	-1.40395	0	$27,556.19	4.4402191	0
100033214	7	$9,004,494	W	Pavement Rehab, Re	1/13/2003	244	$845,934.11	$3,466.94	9.3946%	-1.02712	0	$36,903.66	4.5670695	0
100032090	7	$9,105,522	W	Traffic Striping, Pave	2/7/2003	478	$1,265,832.14	$2,648.18	13.9018%	-0.85693	0	$19,049.21	4.279877	0
100009948	7	$9,647,732	W	Grade Drain Base Pa	3/24/2004	334	$1,023,170.26	$3,063.38	10.6053%	-0.97448	0	$28,885.43	4.4606788	0
100032096	7	$9,744,072	W	Unclassified	4/30/2003	378	$1,361,089.14	$3,600.76	13.9684%	-0.85485	0	$25,777.97	4.4112487	0
100004224	7	$9,752,654	W	Grade Drain Base Pa	12/12/2003	305	$1,327,561.17	$4,352.66	13.6123%	-0.86607	0	$31,975.91	4.504823	0
100016531	8	$10,529,621	W	Grade Drain Base Pa	9/10/2004	371	$1,769,702.62	$4,770.09	16.8069%	-0.77451	0	$28,381.73	4.4530388	0
100004942	8	$10,730,938	W	Unclassified	4/29/2005	304	$410,860.10	$1,351.51	3.8287%	-1.41694	0	$35,299.14	4.5477641	0
100009921	8	$12,466,740	W	Grade Drain Base Pa	8/31/2004	447	$1,208,652.20	$2,703.92	9.6950%	-1.01345	0	$27,889.80	4.4454454	0
100004752	8	$12,846,920	W	Unclassified	11/12/2003	402	$1,578,999.85	$3,927.86	12.2909%	-0.91042	0	$31,957.51	4.504573	0
100009945	8	$12,924,031	W	Grade Drain Base Pa	8/27/2003	391	$1,346,599.32	$3,443.99	10.4193%	-0.98216	0	$33,053.79	4.5192212	0
100032588	8	$12,997,911	W	Bridge Replacement	6/11/2003	272	$893,326.01	$3,284.29	6.8728%	-1.16286	0	$47,786.44	4.6793047	0
100009942	8	$13,858,327	W	Grade Drain Base Pa	4/18/2003	421	$1,851,409.09	$4,397.65	13.3595%	-0.87421	0	$32,917.64	4.5174287	0
100009947	8	$16,959,487	W	Grade Drain Base Pa	11/26/2003	452	$2,024,967.75	$4,480.02	11.9400%	-0.92299	0	$37,520.99	4.5742743	0
100009925	8	$19,415,331	W	Grade Drain Base Pa	4/2/2004	420	$2,588,764.84	$6,163.73	13.3336%	-0.87505	0	$46,226.98	4.6648955	0

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APPENDIX E

GUIDELINES FOR CALCULATING LDS

(DEVELOPED PROCEDURE PRIOR TO HIRING ERS CONSULTANTS)

The procedure herein, was the original developed procedure prior to hiring a statistical consultant to review our work. This procedure is **NOT** to be used for the development of a schedule of liquidated damages to be included in the standard specification for construction projects. The procedure found in Appendix E has been superseded by the procedure outlined in Appendix G.

STEPWISE PROCEDURE FOR DEVELOPING LIQUIDATED DAMAGE (LD) RATES BIENNIALLY

INTRODUCTION:
The procedure described below is a suggested State Highway Agency (SHA) methodology for developing contractual Liquidated Damage (LD) rates from historical project cost data.

The discussion that follows has two distinct purposes. One purpose serves the needs of the practitioner as they follow the detailed steps, using their own data, in order to develop a working schedule of LD rates. In addressing their needs within the discussion, the steps are enumerated, sequenced, and illustrated with a parallel example (*shown by black boxes and blue writing*) so that the process can be more easily replicated by them.

The other purpose serves the needs of SHA administrators as they use the prototype method as a detailed template on which to base policy. Their needs require that the rationale and underlying principles of each subsequent step be fully explained. This explanation provides administrators with information to assure themselves they are in compliance with agency obligations imposed through oversight by the federal government and the courts, as well as, demonstrate the informed, reasonable and prudent exercise of their discretion in evaluating, modifying and adopting administrative policies as detailed here.

The enumerated steps in the procedure are grouped into six major parts, each of these parts is further enumerated into sequential steps, and on occasion these steps are then further divided into multiple tasks. The six major parts of the procedure are as follows:

- *Part 1: Collecting and Organizing Project Data*
- *Part 2: Improving Data Quality (removing projects with atypical data values)*
- *Part 3: Classification of Remaining Projects in the Sample Set by Contract Monetary Value.*
- *Part 4: Establishing Contract Monetary Ranges for LD Schedule*
- *Part 5: Determining Liquidated Damage (LD) Rates*
- *Part 6: Utilizing Alternative Method due to Limited Sample Sizes*

Figure E-15, at the end of this procedure, provides a flow chart summarizing the requiste steps detailed herein.

SUGGESTED SOFTWARE: MICROSOFT EXCEL | MINITAB 14.1

PART 1: COLLECTING AND ORGANIZING PROJECT DATA

***Purpose*:** The purpose of this part is to identify the data set that will be used throughout the remainder of the procedure and to collect all the requisite project data required for analysis. This part contains the following three major steps:

- *Step 1: Identify Time Period*
- *Step 2: Project Selection*
- *Step 3: Collect Requisite Project Data.*

The collection and organization of the project data begins here:

***STEP 1*: *Identify Time Period*:** As a minimum, identify the most current three (3) previous years of *complete* project data. Additional years of historical data can be included in the analysis if deemed appropriate by the practitioner conducting the analysis.

The time period used for analysis in the example provided includes the years 2003, 2004, and 2005.

STEP 2*: *Project Selection

Identify and select all projects with completion dates occurring in any of the years identified during Step 1.

A total of 856 projects were completed in the years 2003, 2004, and 2005 were identified and selected in the ALDOT mainframe database.

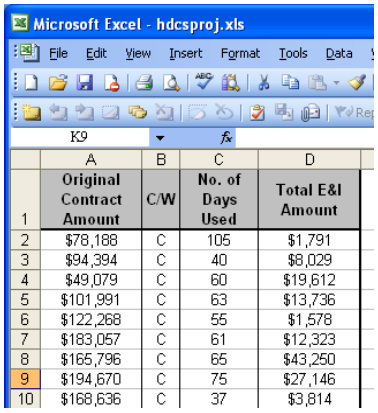
STEP 3*: *Collect Requisite Project Data

For each individual project, the following project characteristics should be collected:

(1) Original contract amount ($),
(2) Contract time provision (e.g. calendar day or work day (C/W)),
(3) Total engineering and inspection (E&I) costs ($), and
(4) Number of days used to complete project (days).

Once all the project data has been obtained from the ALDOT mainframe, import the data into a spreadsheet format.

Figure E-1 shows a screen capture of data used throughout the example provided in these guidelines.



	A	B	C	D
1	Original Contract Amount	C/W	No. of Days Used	Total E&I Amount
2	$78,188	C	105	$1,791
3	$94,394	C	40	$8,029
4	$49,079	C	60	$19,612
5	$101,991	C	63	$13,736
6	$122,268	C	55	$1,578
7	$183,057	C	61	$12,323
8	$165,796	C	65	$43,250
9	$194,670	C	75	$27,146
10	$168,636	C	37	$3,814

Figure E-1 Screen Capture Illustrating Example Required Data for Further Analysis.

PART 2: IMPROVING DATA QUALITY

***Purpose*:** Part 2 focuses on describing the procedure used to improve the quality of the data set by organizing project data collected and removing projects with atypical data values using proper statistical techniques. Part 2 consists of the following steps:

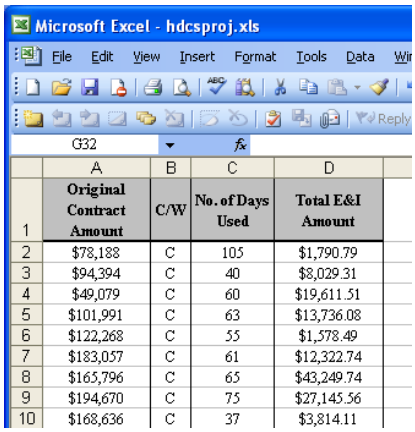
- *Step 1*: *Sort/Organize Data by 'Contract Type'*
- *Step 2*: *Calculate Standardizing Variables for Each Selected Project*
- *Step 3*: *Calculate the Lognormal Location (Mean) and Scale (Standard Deviation) Parameters for both Standardizing Variables for the Select Projects*
- *Step 4*: *Removal of Projects within the Data Set that Exceed ±2 Standard Deviations from Typical Values of Either Standardizing Variable.*

The improvement in quality of the project data set begins here:

STEP 1*: *Sort/Organize Data by 'Contract Type'

All project data contained in the data set needs to be sorted by 'contract type' (C/W day projects). The calendar day and work day projects should be separated and organized in two separate worksheets in a spreadsheet program.

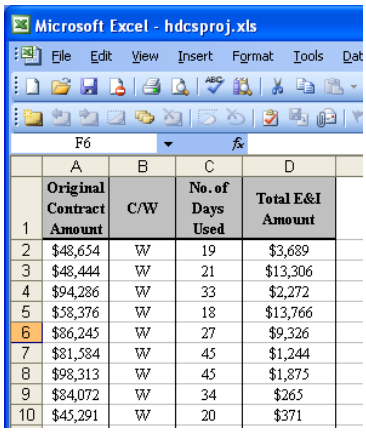
Figure E-2(a) and E-2(b) illustrates the two separate spreadsheets for calendar and work day projects, respectively.



Microsoft Excel - hdcsproj.xls

	A	B	C	D
1	Original Contract Amount	C/W	No. of Days Used	Total E&I Amount
2	$78,188	C	105	$1,790.79
3	$94,394	C	40	$8,029.31
4	$49,079	C	60	$19,611.51
5	$101,991	C	63	$13,736.08
6	$122,268	C	55	$1,578.49
7	$183,057	C	61	$12,322.74
8	$165,796	C	65	$43,249.74
9	$194,670	C	75	$27,145.56
10	$168,636	C	37	$3,814.11

(a) Calendar Day Projects



Microsoft Excel - hdcsproj.xls

	A	B	C	D
1	Original Contract Amount	C/W	No. of Days Used	Total E&I Amount
2	$48,654	W	19	$3,689
3	$48,444	W	21	$13,306
4	$94,286	W	33	$2,272
5	$58,376	W	18	$13,766
6	$86,245	W	27	$9,326
7	$81,584	W	45	$1,244
8	$98,313	W	45	$1,875
9	$84,072	W	34	$265
10	$45,291	W	20	$371

(b) Work Day Projects

Figure E-2 Screen Capture Illustrating Separation of Project Data.

If either 'Contract Time Provision' data set contains less than 30 projects, proceed to Part 6 and perform the described alternative rate calculation procedure.

STEP 2*: *Calculate Standardizing Variables for Each Selected Project

***Purpose*:** The purpose of Step 2 is to calculate the standardizing variables to be used during outlier analysis to identify atypical data within the data set. The two standardized values that were selected as performance measures independent of project size were (1) '*total E&I amount as a percent of the original contract amount (%E&I)*' and (2) '*contract dollars placed per day ($/day)*'. There are two tasks required to complete Step 2.

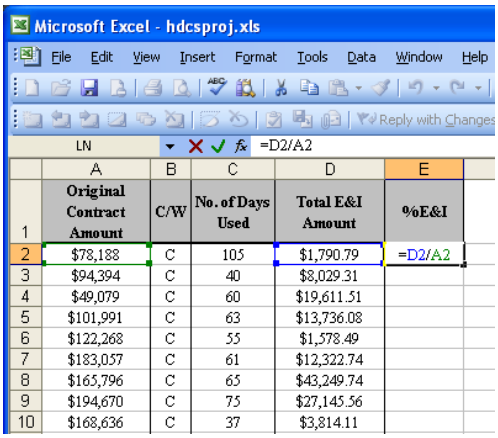
***Task 1*:** Calculate '*total E&I amount as a percent of the original contract amount (%E&I)*' for all calendar day and work day projects in a new column using equation E-1 below:

$$\%EI = \frac{E\&I}{CV} \qquad \text{(E-1)}$$

where,

$\%EI$ = total E&I as a percent of the original contract amount (%),
$E\&I$ = total E&I for the project ($), and
CV = original contract amount ($).

Figure E-3 is a screen capture displaying the spreadsheet representation of Equation E-1 shown in cell 'E2'.



	A	B	C	D	E
1	Original Contract Amount	C/W	No. of Days Used	Total E&I Amount	%E&I
2	$78,188	C	105	$1,790.79	=D2/A2
3	$94,394	C	40	$8,029.31	
4	$49,079	C	60	$19,611.51	
5	$101,991	C	63	$13,736.08	
6	$122,268	C	55	$1,578.49	
7	$183,057	C	61	$12,322.74	
8	$165,796	C	65	$43,249.74	
9	$194,670	C	75	$27,145.56	
10	$168,636	C	37	$3,814.11	

Figure E-3 Spreadsheet Calculation of %E&I.

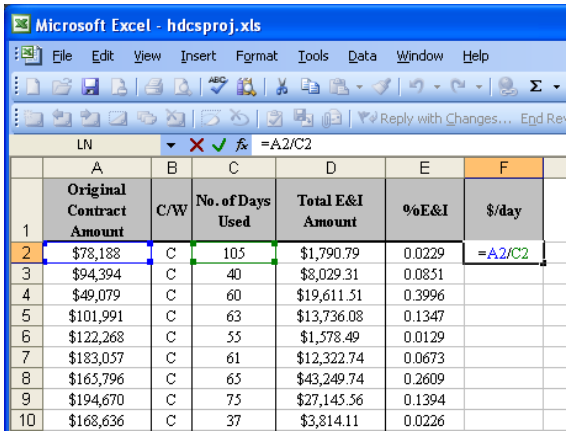
***Task 2*:** Calculate '*dollars placed per day ($/day)*' in a new column using Equation E-2 below:

$$\$/day = \frac{CV}{d} \qquad \text{(E-2)}$$

where,

$/day	=	dollars placed per day ($/day),
d	=	total number of days used for the project (days), and
CV	=	original contract amount ($).

Figure E-4 below shows the spreadsheet representation of Equation E-2, displayed in cell 'F2'.



	A	B	C	D	E	F
1	Original Contract Amount	C/W	No. of Days Used	Total E&I Amount	%E&I	$/day
2	$78,188	C	105	$1,790.79	0.0229	=A2/C2
3	$94,394	C	40	$8,029.31	0.0851	
4	$49,079	C	60	$19,611.51	0.3996	
5	$101,991	C	63	$13,736.08	0.1347	
6	$122,268	C	55	$1,578.49	0.0129	
7	$183,057	C	61	$12,322.74	0.0673	
8	$165,796	C	65	$43,249.74	0.2609	
9	$194,670	C	75	$27,145.56	0.1394	
10	$168,636	C	37	$3,814.11	0.0226	

Figure E-4 Spreadsheet Calculation of $/day.

STEP 3: Calculate the Lognormal Location (Mean) and Scale (Standard Deviation) Parameters for both Standardizing Variables for the Select Projects

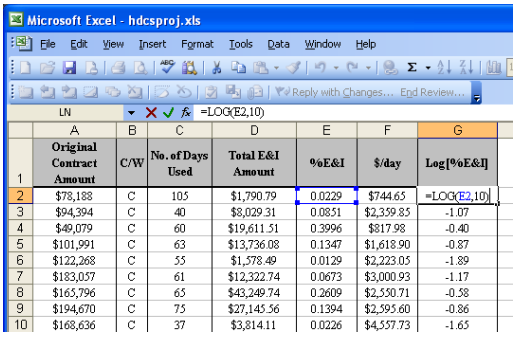
***Purpose*:** The purpose of Step 3 is to transform the data in order to realize a symmetrical distribution about the mean and set truncation limits for the purpose of removing unusual values (i.e. atypical projects or erroneous data) from the project data set. There are three tasks within this step that need to be performed.

***Task 1*:** Calculate the log of '**%E&I**' and '**$/day'** values for each project in another column using equation E-3 and E-4 respectively:

$$\text{Log [\%E\&I]} = \log(\textbf{[\%E\&I]}, 10) \quad \text{(E-3)}$$

$$\text{Log[\$/day]} = \log(\textbf{[\$/day],}\ 10) \quad \text{(E-4)}$$

The screen capture displayed in Figure E-5 below shows the newly created columns entitled 'Log[%E&I]' and 'Log[$/day]' along with the spreadsheet formulas shown in cell 'G2'and 'H2', respectively. The spreadsheet equation is represented as '**=log(value, base)**' where the '**value**' is the cell containing the '**%E&I**' or '**$/day**' value and the '**base**' equals '**10**'.

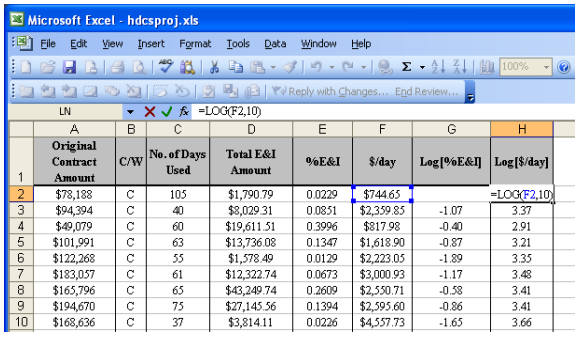

Microsoft Excel - hdcsproj.xls

File Edit View Insert Format Tools Data Window Help

=LOG(E2,10)

	A	B	C	D	E	F	G
1	Original Contract Amount	C/W	No. of Days Used	Total E&I Amount	%E&I	$/day	Log[%E&I]
2	$78,188	C	105	$1,790.79	0.0229	$744.65	=LOG(E2,10)
3	$94,394	C	40	$8,029.31	0.0851	$2,359.85	-1.07
4	$49,079	C	60	$19,611.51	0.3996	$817.98	-0.40
5	$101,991	C	63	$13,736.08	0.1347	$1,618.90	-0.87
6	$122,268	C	55	$1,578.49	0.0129	$2,223.05	-1.89
7	$183,057	C	61	$12,322.74	0.0673	$3,000.93	-1.17
8	$165,796	C	65	$43,249.74	0.2609	$2,550.71	-0.58
9	$194,670	C	75	$27,145.56	0.1394	$2,595.60	-0.86
10	$168,636	C	37	$3,814.11	0.0226	$4,557.73	-1.65

(a) Log[%E&I]


Microsoft Excel - hdcsproj.xls

File Edit View Insert Format Tools Data Window Help

=LOG(F2,10)

	A	B	C	D	E	F	G	H
1	Original Contract Amount	C/W	No. of Days Used	Total E&I Amount	%E&I	$/day	Log[%E&I]	Log[$/day]
2	$78,188	C	105	$1,790.79	0.0229	$744.65		=LOG(F2,10)
3	$94,394	C	40	$8,029.31	0.0851	$2,359.85	-1.07	3.37
4	$49,079	C	60	$19,611.51	0.3996	$817.98	-0.40	2.91
5	$101,991	C	63	$13,736.08	0.1347	$1,618.90	-0.87	3.21
6	$122,268	C	55	$1,578.49	0.0129	$2,223.05	-1.89	3.35
7	$183,057	C	61	$12,322.74	0.0673	$3,000.93	-1.17	3.48
8	$165,796	C	65	$43,249.74	0.2609	$2,550.71	-0.58	3.41
9	$194,670	C	75	$27,145.56	0.1394	$2,595.60	-0.86	3.41
10	$168,636	C	37	$3,814.11	0.0226	$4,557.73	-1.65	3.66

(b) Log[$/day]

Figure E-5 Calculation of Lognormal Values of Standardizing Variables.

***Task 2*:** Calculate the mean and standard deviations of the '**Log[%E&I]**' and '**Log[$/day]**' values using Equations E-5 through E-8, respectively.

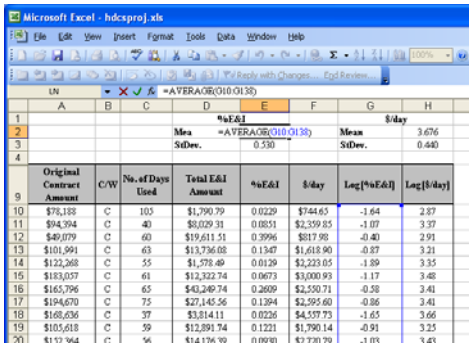
$$\text{Mean Log[\%E\&I]} = \text{AVERAGE}(\textbf{[all Log[\%E\&I] values]}) \quad \text{(E-5)}$$

$$\text{Standard Deviation Log[\%E\&I]} = \text{STDEVP}\ (\textbf{[all Log[\%E\&I] values]}) \quad \text{(E-6)}$$

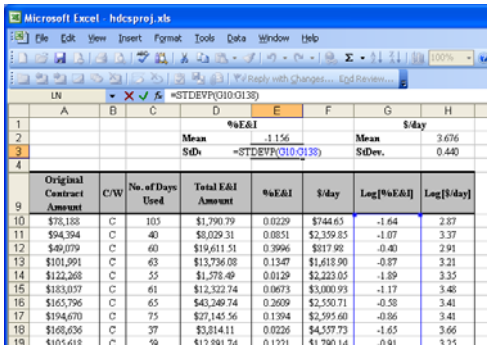
$$\text{Mean Log[\$/day]} = \text{AVERAGE}(\textbf{[all Log\$/day] values]}) \quad \text{(E-7)}$$

$$\text{Standard Deviation Log[\$/day]} = \text{STDEVP}(\textbf{[all Log[\$/day] values]}) \quad \text{(E-8)}$$

Figure E-6 is a screen capture displaying the spreadsheet calculation using Equations E-5 and E-6 above.



(a) Mean Log[%E&I]



(b) Standard Deviation Log[%/E&I]

Figure E-6 Calculation of Mean and Standard Deviation Lognormal Values of Standardizing Variables.

***Task 3*:** Determine ±2 standard deviations from the '**Log[%E&I]**' and the '**Log[$/day]**' mean value using Equations E-9 through E-12, respectively. This allows for the upper and lower limits of the outlier analysis to be established.

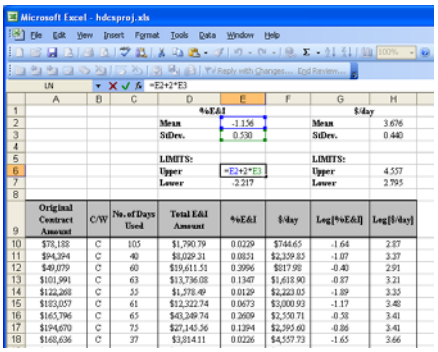
$$\text{Upper Limit} = [\textbf{Mean(Log[\%E\&I])}] + 2*[\textbf{StDev(Log[\%E\&I])}] \quad \text{(E-9)}$$

$$\text{Lower Limit} = [\textbf{Mean(Log[\%E\&I])}] - 2*[\textbf{StDev(Log[\%E\&I])}] \quad \text{(E-10)}$$

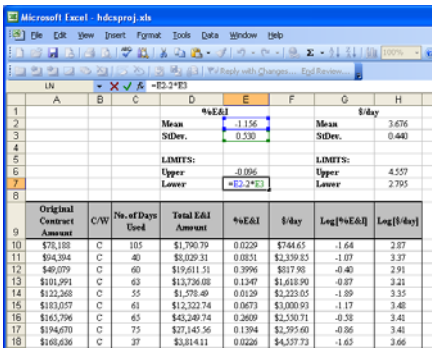
$$\text{Upper Limit} = [\textbf{Mean(Log[\$/day])}] + 2*[\textbf{StDev(Log[\$/day])}] \quad \text{(E-11)}$$

$$\text{Lower Limit} = [\textbf{Mean(Log[\$/day])}] - 2*[\textbf{StDev(Log[\$/day])}] \quad \text{(E-12)}$$

Figure E-7 is a screen capture displaying the spreadsheet calculation using Equations E-9 and E-10 above.



(a) Upper Limit [%E&I]



(b) Lower Limit [%/E&I]

Figure E-7 Calculation of Truncation Limits of Standardizing Variables.

STEP 4: Removal of Projects within the Data Set that Exceed ±2 Standard Deviations from Typical Values of Either Standardizing Variable.

***Purpose*:** The purpose of Step 4 is to truncate projects that exceed the upper and lower limits established in Step 3 of either (or both) of the standardizing variables. The projects with values exceeding these limits are considered abnormal values that may represent an atypical project or erroneous data entered incorrectly into the ALDOT mainframe database.

***Task 1*:** Develop an 'IF' statement to determine projects that are considered outliers based upon the two standardizing variables identified in Step 2. Insert two new column entitled 'Outlier Log[%E&I]' and 'Outlier Log[$/day] which are to utilize the following 'IF' statements show as Equation E-13 and Equation E-14, respectively:

$$= \text{IF}(\textbf{Log[\%E\&I]}<\textbf{[lower limit]},1,\text{IF}(\textbf{Log[\%E\&I]}>\textbf{[upper limit]},1,0)) \qquad \text{(E-13)}$$

$$=\text{IF}(\textbf{Log[\$/day]}<\textbf{[lower limit]},1,\text{IF}(\textbf{Log[\$/day]}>\textbf{[upper limit]},1,0)) \qquad \text{(E-14)}$$

Spreadsheet cells that need to be selected and included in the equations above are represented by the bold values shown in Equation E-13 and E-14. These IF statements compare the Log[%E&I] and Log[$/day] values for a project to both their particular upper and lower limits. If the value is outside of these limits a '1' is placed in the cell, otherwise a '0' is placed in the cell. [Tip: Use "$" in front of the letter and number of the cell reference for the upper and lower limits to "lock" the reference in while copying the formula as shown in the screen capture below].

Figure E-8(a) and E8(b) below shows a screen capture illustrating the spreadsheet representation of Equation E-13 and E-14, respectively.

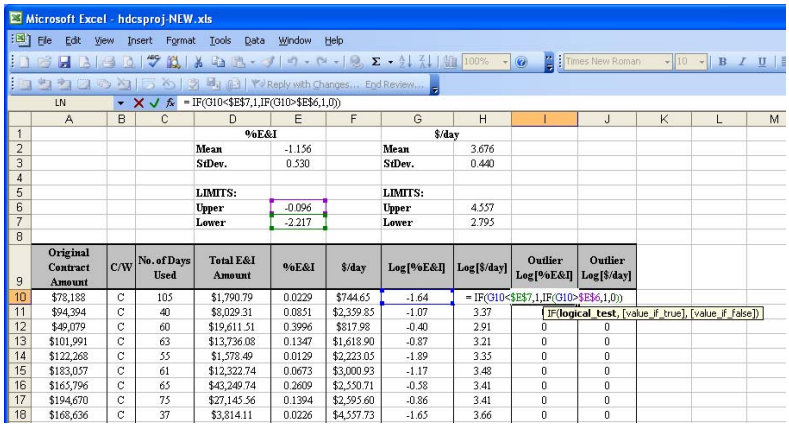
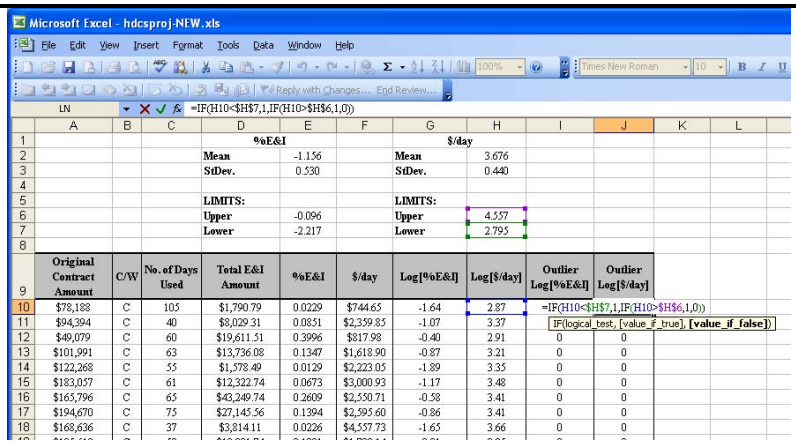


Figure E-8(a) Spreadsheet IF Statement Calculation used to Identify Outliers.

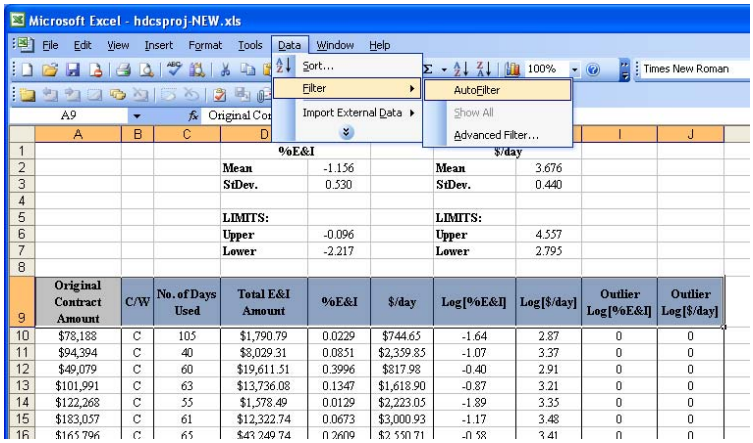


Original Contract Amount	C/W	No. of Days Used	Total E&I Amount	%E&I	$/day	Log[%E&I]	Log[$/day]	Outlier Log[%E&I]	Outlier Log[$/day]
$78,188	C	105	$1,790.79	0.0229	$744.65	-1.64	2.87	=IF(H10<H7,1,IF(H10>H6,1,0))	
$94,394	C	40	$8,029.31	0.0851	$2,359.85	-1.07	3.37	IF(logical_test, [value_if_true], [value_if_false])	
$49,079	C	60	$19,611.51	0.3996	$817.98	-0.40	2.91	0	0
$101,991	C	63	$13,736.08	0.1347	$1,618.90	-0.87	3.21	0	0
$122,268	C	55	$1,578.49	0.0129	$2,223.05	-1.89	3.35	0	0
$183,057	C	61	$12,322.74	0.0673	$3,000.93	-1.17	3.48	0	0
$165,796	C	65	$43,249.74	0.2609	$2,550.71	-0.58	3.41	0	0
$194,670	C	75	$27,145.56	0.1394	$2,595.60	-0.86	3.41	0	0
$168,636	C	37	$3,814.11	0.0226	$4,557.73	-1.65	3.66	0	0

Figure E-8(b) Spreadsheet IF Statement Calculation used to Identify Outliers.

***Task 2*:** Remove all projects which are identified as outliers according to both the 'Log[%E&I]' as well as 'Log[$/day]'. All projects identified as outliers should be filtered and the remaining projects that are not identified as outliers should be copied to a new spreadsheet for further analyses.

To do this, sort the projects in the outlier columns by selecting the row containing the column headings. Then, click **Data → Filter → Auto Filter**. For our example problem, the procedure is illustrated in Figure E-9 below.



Original Contract Amount	C/W	No. of Days Used	Total E&I Amount	%E&I	$/day	Log[%E&I]	Log[$/day]	Outlier Log[%E&I]	Outlier Log[$/day]
$78,188	C	105	$1,790.79	0.0229	$744.65	-1.64	2.87	0	0
$94,394	C	40	$8,029.31	0.0851	$2,359.85	-1.07	3.37	0	0
$49,079	C	60	$19,611.51	0.3996	$817.98	-0.40	2.91	0	0
$101,991	C	63	$13,736.08	0.1347	$1,618.90	-0.87	3.21	0	0
$122,268	C	55	$1,578.49	0.0129	$2,223.05	-1.89	3.35	0	0
$183,057	C	61	$12,322.74	0.0673	$3,000.93	-1.17	3.48	0	0
$165,796	C	65	$43,249.74	0.2609	$2,550.71	-0.58	3.41	0	0

Figure E-9 Screen Capture Illustrating AutoFilter Function.

Drop-down menus for each column will appear which can be used to sort the data. For the two outlier columns consecutively choose **Sort Descending** as shown in Figure E-10 below.

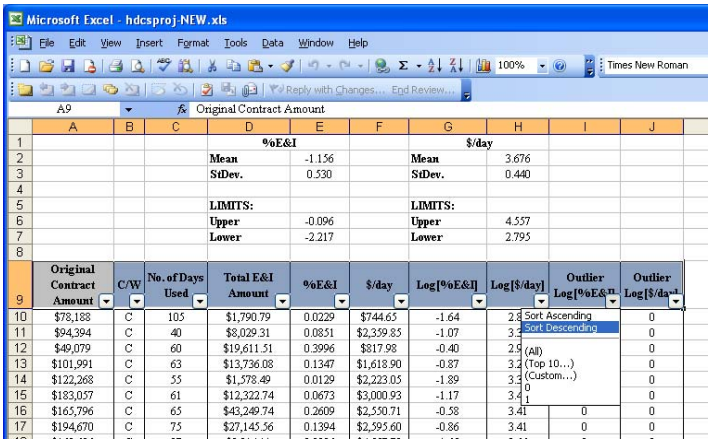


Figure E-10 Screen Capture Illustrating 'Sort Descending' Function.

Once the abovementioned task is complete, all the outlier projects (those with a 1 in either outlier column) will be moved to the top of the project list. Highlight the projects not identified as an outlier (e.g. all projects containing a '0' in either or both of the outlier columns), cut and paste them all at once into a separate worksheet. These are the remaining projects that will be used for the determination of liquidated damages rates for either calendar day or work day projects. All columns created in Part 2 can be ignored, since this information is no longer needed.

A total of 665 work day projects and 118 calendar day projects remained in the data set after outlier analysis was performed.

PART 3: CLASSIFICATION OF REMAINING PROJECTS IN THE SAMPLE SET

***Purpose*:** The overall purpose of Part 3 is to further classify and organize the remaining projects being used for analysis. The part is comprised of the following steps:

- *Step 1: Assign Contract Size Category*
- *Step 2: Count the Number of Projects Contained in All 16 Separate Groupings*
- *Step 3: Merge Groups with Fewer than Five (5) Projects into Adjoining Groups*
- *Step 4: Perform Alternative LD Rate Calculation for Projects Classified by Contract Time Provisions Containing Fewer than Four (4) Remaining Size Groups after Performing Step 3.*

The classification of remaining projects procedure outlined in Part 3 begins here:

STEP 1: Assign Contract Size Category

***Purpose*:** The purpose of step 1 is to classify projects into specific groups arranged by contract size. This step will be accomplished by assigning a contract size value to each of the projects based upon the original contract amount. The contract size categories designated by ALDOT are shown in Table E-1. Using these integer values between 1 and 8 will allow for all projects to be further classified into groups. There are two tasks required to accomplish this step.

Table E-1 Contract Value Ranges for Each Contract Size Group

Group	Contract Amount	
	From	To and Including
1	$0	$100,000
2	$100,000	$200,000
3	$200,000	$500,000
4	$500,000	$1,000,000
5	$1,000,000	$2,000,000
6	$2,000,000	$5,000,000
7	$5,000,000	$10,000,000
8	$10,000,000	-

***Task 1*:** Assign a contract size group to each individual project in the data set using the contract size categories shown in Table E-1 (i.e. an integer value between 1 and 8 representing a contract size group). The 'IF' statement shown in Equation 15 can be used to assign an integer value between 1 and 8 to each individual project in a spreadsheet program.

=IF(**[Original Contract Amount]** <100,000.01,1,IF(**[Original Contract Amount]**<200,000.01,2, IF(**[Original Contract Amount]**<500,000.01,3,IF(**[Original Contract Amount]**<1,000,000.01,4, IF(**[Original Contract Amount]**<2,000,000.01,5,IF(**[Original Contract Amount]**<5,000,000.01,6, IF(**[Original Contract Amount]** <10,000,000.01,7,IF(**[Original Contract Amount]** >10,000,000, 8)))))))) (E-15)

***Task 2*:** Sort projects according to their contract size groups. To do this, select the row containing all the column headings. Then, click **Data → Filter → Auto Filter**. Select the drop down menu for the '**Contract Size**' column and select '**Sort Ascending**' to organize the projects by contract sizes.

STEP 2*: *Count the Number of Projects Contained in All 16 Separate Groupings
In this step, the practitioner must evaluate each contract size group to ensure that there are at least 5 projects in each of the 16 separate groups. If a size grouping does not contain at least 5 projects, identify the group and proceed to Step 3. If all groupings contain 5 projects are more, proceed to Part 4.

STEP 3*: *Merge Groups with Fewer than Five (5) Projects into Adjoining Groups
***Purpose*:** The purpose of this step is to merge groups in a stepwise fashion with adjoining groups when one group does not contain 5 projects or more. The process of merging adjoining groups enables the practitioner to obtain the required sample sizes within groups in order to perform the Kruskal-Wallis test described in Part 4. There are two tasks associated with this step and are described below.

***Task 1*:** Starting with the highest 'Contract Size' group identified in step 2, begin by merging the identified groups with the next lowest adjoining 'Contract Size' grouping. Count the number of projects within the newly established group. If the newly established group does not contain at least 5 projects, merge the new group with the next lowest adjoining 'Contract Size' grouping. Once the newly established group contains 5 projects or more, proceed to the next identified group in Step 2 and follow the same procedure. Proceed until you reach Group 1.

***Task 2*:** In the case that Group 1 does not contain 5 projects or more, reverse the procedure and merge Group 1 with the next highest adjoining 'Contract Size' group. Evaluate the size of the newly established group. If the newly established group does not contain at least 5 projects, merge the new group with the next highest adjoining 'Contract Size' grouping. Once the newly established group contains 5 projects or more, proceed to the next identified group in Step 2 and follow the same procedure. Proceed until the highest established grouping is reached.

After performing Task 2, if the number of projects classified as either calendar day or work day projects contains fewer than four (4) contract size groupings, proceed to Part 6 and perform the described alternative rate calculation procedure.

In our example, the table below categorizes the number of projects (C/W) per contract size grouping.

Contract Size	No. of Work Day Projects	No. of Calendar Day Projects
1	14	3
2	50	14
3	176	32
4	221	32
5	128	10
6	41	14
7	26	9
8	9	4
Total	**665**	**118**

Contract size groups having fewer than 5 projects were merged following the procedure described in Step 3. As a result the contract size groups for work day projects remained the same since all the groups have more than 5 projects. However, for Calendar Day projects group 8 was merged with group 7, and group 1 was merged with group two to satisfy the Step 3 criteria, and contract size ranges were adjusted accordingly.

PART 4: ESTABLISHING CONTRACT MONETARY RANGES FOR LIQUIDATED DAMAGES (LDS) SCHEDULE

***Purpose*:** The purpose of Part 4 is to establish contract monetary ranges using statistical methods to determine whether adjacent 'Contract Size' groupings are statistically similar or different for one another. The procedure contained in this part will allow the practitioner to set the monetary ranges that will be used in the schedule of LDs to be included in ALDOTs standard specification. This part is comprised of the following steps:

- *Step 1: Calculate Individual Project Daily E&I amounts*
- *Step 2: Compare adjoining 'Contract Size' groups within the 'Contract Time Provision' class using the Kruskal-Wallis Test with 'Daily E&I' costs as the response and the 'Contract Size' variable as the factor.*
- *Step 3: Merge contract size groups that the Kruskal-Wallis testing reveals no statistical different in 'Daily E&I' costs between the groups.*
- *Step 4: Repeat Step 2 with merged groups until all remaining groups are statistically different in terms of 'Daily E&I' costs.*

- *Step 5: Perform Alternative LD Rate Calculation for Projects Classified by Contract Time Provisions Containing Fewer than Four (4) Remaining Size Groups after Performing Step 2.*

The procedure for establishing the contract monetary ranges to be used in the schedule of LDs begins here:

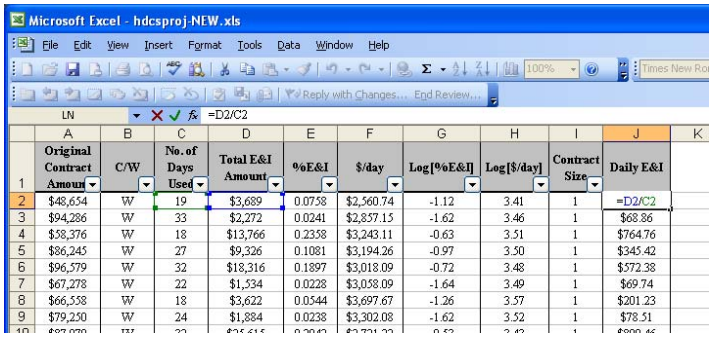
STEP 1: Calculate Individual Project Daily E&I Amounts by using Equation E-15 below:

$$Daily\ E\ \&\ I = \frac{Total\ E\ \&\ I\ Amount}{No.\ of\ \ Days\ Used} \qquad \text{(E-15)}$$

where,

Daily E&I	=	daily E&I costs of each individual project ($/day),
Total E&I Amount	=	total E&I costs for each project ($), and
No. of Days Used	=	total number of days used to complete each project (days).

Figure E-11 below shows a screen capture illustrating equation E-15 being applied in a spreadsheet program.



	A	B	C	D	E	F	G	H	I	J	K
1	Original Contract Amount	C/W	No. of Days Used	Total E&I Amount	%E&I	$/day	Log[%E&I]	Log[$/day]	Contract Size	Daily E&I	
2	$48,654	W	19	$3,689	0.0758	$2,560.74	-1.12	3.41	1	=D2/C2	
3	$94,286	W	33	$2,272	0.0241	$2,857.15	-1.62	3.46	1	$68.86	
4	$58,376	W	18	$13,766	0.2358	$3,243.11	-0.63	3.51	1	$764.76	
5	$86,245	W	27	$9,326	0.1081	$3,194.26	-0.97	3.50	1	$345.42	
6	$96,579	W	32	$18,316	0.1897	$3,018.09	-0.72	3.48	1	$572.38	
7	$67,278	W	22	$1,534	0.0228	$3,058.09	-1.64	3.49	1	$69.74	
8	$66,558	W	18	$3,622	0.0544	$3,697.67	-1.26	3.57	1	$201.23	
9	$79,250	W	24	$1,884	0.0238	$3,302.08	-1.62	3.52	1	$78.51	

Figure E-11 Spreadsheet Calculation of Daily E&I for Each Project.

STEP 2: Compare adjoining 'Contract Size' groups within the 'Contract Time Provision' class using the Kruskal-Wallis Test with 'Daily E&I' costs as the response and the 'Contract Size' variable as the factor.

Purpose: These contract size groups will be compared against each other to determine which are statistically the same or different from one another. Minitab will be used for this step which is described below. There are two tasks required to accomplish this step.

Task 1: Copy all the remaining data after outlier analysis and organization from the spreadsheet into a new Minitab worksheet.

Task 2: Perform the Kruskal-Wallis test to determine if any of the groups based on their 'Contract Size' category are statistically the same or different from each other.

To do this, first create a new worksheet by selecting '**File**' → '**New**' and selecting '**Worksheet**' in the window. Then copy and paste all the projects from the first two contract size groups (1 & 2) into the new worksheet. To run the test, select '**Stat**' → '**Nonparametrics**' → '**Kruskal-Wallis**'. Select the '**Daily E&I**' column as the '**Response**' and '**Contract Size**' as the '**Factor**'. Figure E-12 provides an illustration of the Kruskal-Wallis pop-up window contained in MiniTab.

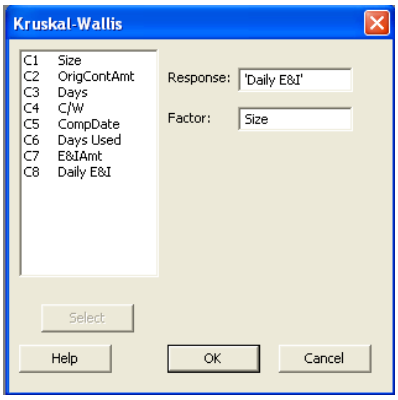


Figure E-12 Kruskal-Wallis Pop-up Window in MiniTab.

If the p-value resulting from the Kruskal-Wallis test is greater than or equal to 0.05, the groups are considered to be statistically the same.

For example, Figure E-2 shows the results of the Kruskal-Wallis test comparing groups 1 and 2 resulted in a p = 0.673, therefore groups 1 and 2 are considered statistically similar.

Kruskal-Wallis Test: Daily E&I versus Size

Kruskal-Wallis Test on Daily E&I

Size	N	Median	Ave Rank	Z
1	14	273.3	30.6	-0.42
2	50	343.0	33.0	0.42
Overall	64		32.5	

H = 0.18 DF = 1 P = 0.673

Figure E-13 Results of the Kruskal-Wallis Test Comparing Group 1 vs. 2.

STEP 3: Merge contract size groups that the Kruskal-Wallis testing reveals no statistical difference in 'Daily E&I' costs between the groups.

***Purpose*:** The purpose of this step is to combine 'Contract Size' groups that are deemed statistically the same into a new unique 'Contract Size' group. This step contains two tasks described below.

***Task 1*:** Identify groups that when compared resulted in a p value greater than 0.05 indicating that the groups are statistically similar.

In the example provided, the results of Step 2 above when comparing group 1 versus group 2 resulted in a p value equal to 0.673 which is greater than 0.05.

***Task 2*:** Combine statistically similar groups into one unique group and adjust the contract value range accordingly.

Since the p-value identified in task 1 is greater than 0.05, group 1 and group 2 are combined to create a new project group with contract value ranges from $0 to $200,000.

STEP 4: Repeat Step 2 with merged groups until all remaining groups are statistically different in terms of 'Daily E&I' costs.

Now that group 1 and group 2 are combined, the combined group should be compared against group 3 following the procedure outlined in step 2 above. If the p-value is less than 0.05 then the groups are considered to be statistically different and can not be combined.

For example, Figure E-3 shows the Kruskal-Wallis results after comparing the combined group 1&2 with group 3. The p-value = 0.007, therefore combined group 1&2 would remain its own unique group, and group 3 would then be compared against group 4 using the Kruskal-Wallis test as described above.

Kruskal-Wallis Test: Daily E&I versus Size

Kruskal-Wallis Test on Daily E&I

Size	N	Median	Ave Rank	Z
3	176	499.3	127.8	2.68
12	64	336.5	100.5	-2.68
Overall	240		120.5	

H = 7.21 DF = 1 P = 0.007

Figure E-14 Results of the Kruskal-Wallis Test Comparing Combined Group 1&2 vs. Group 3.

This process would continue sequential comparing groups against each other, combining when groups are considered statistically similar and maintaining unique groups when considered statistically different.

The results shown in Table E-2 provide a summary of p-values resulting from the Kruskal-Wallis test on the remaining projects within our example data set for work day projects. Table E-2 provides statistical justification for combining contract value groups together or not when developing the schedule of liquidated damages to be included in the standard specification. From the table, the results indicate groups 1 and 2 be merged into a single group, 3, 4, 5, and 6 remain as their own unique group, and groups 7 and 8 are merged into a single group.

Table E-2 Summary of Kruskal-Wallis Test on Remaining Work Day Project Data

	Kruskal-Wallis Test: p-values						
GROUP	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	0.673[1]	--	--	--	--	--	--
1&2	--	0.007	--	--	--	--	--
3	--	--	0.000	--	--	--	--
4	--	--	--	0.000	--	--	--
5	--	--	--	--	0.000	--	--
6	--	--	--	--	--	0.032	--
7	--	--	--	--	--	--	0.521[1]

Note:
1. P-values ≥ 0.05 therefore groups are considered statistically similar and are combined.

Table E-3 provides a summary of p-values resulting from the Kruskal-Wallis test on the remaining calendar day projects.

Table E-3 Summary of Kruskal-Wallis Test on Remaining Calendar Day Project Data

	Kruskal-Wallis Test: p-values				
GROUP	**3**	**4**	**5**	**6**	**7**
2	0.983[1]	--	--	--	--
2&3	--	0.025	--	--	--
4	--	--	0.014	--	--
5	--	--	--	0.412[1]	--
5&6	--	--	--	--	0.342[1]

Note:
1. P-values ≥ 0.05 therefore groups are considered statistically similar and are combined.

The results of the Kruskal-Wallis test on calendar day projects indicates that groups 2 (contains original groups 1 and 2) and 3 are merged into a single group, 4 remains its own unique group, while 5, 6, 7 (contains original groups 7 and 8) are merged into a single group.

STEP 5: Perform Alternative LD Rate Calculation for Projects Classified by Contract Time Provisions Containing Fewer than Four (4) Remaining Size Groups after Performing Step 2.

After performing Steps 1 through 4, if the number of projects classified as either calendar day or work day projects contains fewer than four contract size groupings, proceed to Part 6 and perform the described alternative rate calculation procedure.

In our example, since there are only 3 remaining contract size groupings for Calendar Day projects, proceed to part 6 and use the alternative method for calculating calendar day LD rates.

There are six remaining contract size groups for Work Day projects, therefore proceed to Part 5 to calculate work day LD rates.

PART 5: DETERMINING LD RATES

Purpose: The purpose of Part 5 is to provide a procedure to follow in determining the liquidated damage (LD) rates for each 'Contract Size' groups established at the conclusion of Part 4. This part consists of the following steps:

- *Step 1: Calculate the Average Daily E&I values for each remaining group within 'Contract Time Provision (C/W)' categories*
- *Step 2: Round the average daily E&I values to the nearest $100.*
- *Step 3: Prepare LD rate table with 'Contract Value' size ranges for remaining groups and rounded 'Average Daily E&I' values for those ranges.*

The procedure for Part 5 begins here:

STEP 1: Calculate the Average Daily E&I values for each remaining group within 'Contract Time Provision (C/W)' categories using Equation E-16.

$$AvgDailyE\&I_i = \frac{\sum_{j=1}^{n} DailyE\&I_{ij}}{n_i} \qquad \text{(E-16)}$$

where,

$Avg.\ Daily\ E\&I_i$ = average daily E&I costs for all projects in group i ($/day),
$Daily\ E\&I_{ij}$ = daily E&I costs for project j in group i ($/day), and
n_i = total number of projects in group i.

STEP 2: Round the average daily E&I values to the nearest $100. These rounded values represent the 'Contract Time Provision (C/W)' LD rates for their respective contract size groups. Place them in a table along with the 'Contract Size'groups monetary ranges.

Table E-4 is an example of the work day 'Average Daily E&I' rates arranged in a table by contract size groups along with the rounded value to use for the 'Work Day LD Rate'.

Table E-4 Example of Contract Value Ranges and Work Day LD Rates

Contract Value		Average Daily E&I	Work Day LD Rate
From	To & Including		
$0	$200,000	$518.23	$500
$200,000	$500,000	$728.94	$700
$500,000	$1,000,000	$1,283.73	$1,300
$1,000,000	$2,000,000	$2,027.23	$2,000
$2,000,000	$5,000,000	$3,055.27	$3,100
$5,000,000	---------	$3,704.43	$3,700

STEP 3: Prepare LD rate table with 'Contract Value' size ranges for remaining groups and rounded 'Average Daily E&I' values for those ranges.

Table E-5 illustrates the schedule of LD rates for work day projects established following the procedure outlined throughout these guidelines.

Table E-5 Schedule of LD Rates for Work Day Projects by Contract Value Ranges

Contract Value		LD rates
From	To & Including	Work Day
$0	$200,000	$500
$200,000	$500,000	$700
$500,000	$1,000,000	$1,300
$1,000,000	$2,000,000	$2,000
$2,000,000	$5,000,000	$3,100
$5,000,000	----------	$3,700

PART 6: ALTERNATIVE METHOD FOR LD RATE DETERMINATION DUE TO LIMITED SAMPLE GROUPINGS WITHIN CONTRACT TIME PROVISION PROJECT CLASSIFICATIONS

Purpose: The procedure to be followed in Part 6 is to determine LD rates in the situation when projects classified by a 'Contract Time Provision (C/W)' contained fewer than four (4) remaining size groupings after following the procedure in Part 4 of these guidelines. An alternative analysis was developed to calculate LD rates based upon the number of actual feasible work days available in a calendar year based upon historical rainfall data collected in Alabama. This procedure is comprised of two steps as detailed below:

- *Step 1: Convert contractually allocated time between calendar day and work day contract provisions based on lost time due to typical weather days experienced in the region. [Unless new analysis is performed to determine rates, use rounded value obtained from pervious rainfall data study of 50% of time lost due to weather].*

- *Step 2: Scale liquidated damage (LD) rates obtained in Part 5 for different 'Contract Time Provision' (C/W) project class based on converted time allocation. [Note: 'average daily E& I' rates would be twice as much for work day project types than for calendar day types due to have the contract time provided under this time provision.*

The alternative method for determining LD rates due to limited samples sizes within a contract time provision set begins here:

STEP 1: Convert contractually allocated time between calendar day and work day contract provisions based on lost time due to typical weather days experienced in the region. [Unless new analysis is performed to determine rates, use rounded value obtained from pervious rainfall data study of 50% of time lost due to weather].

In our example after the work day LD rates determined, the focus turned to calculating the calendar day rates. Since the number of size groupings was less than four, historical rainfall data was examined to determine the number of work days for each calendar month. In this procedure, experienced ALDOT engineers calculated the number of possible work days for each month based on historical project data. First, all Saturdays, Sundays, and Legal Holidays were excluded. Then, by examining the amount of rainfall each day, the engineers, using past on-site experience, determined if that day would be a feasible workday based on the amount of rainfall experienced. If so, it was counted. This process was carried out for each month and for four geographic regions in Alabama. The regions were: North Alabama (Divisions 1 & 2), Central Alabama (Divisions 3, 4, & 5), Southeast Alabama (Divisions 6 & 7), and Southwest Alabama (Divisions 8 & 9). In each region, multiple sites were used to determine the feasibility of working on any given day. Overall, a statewide average number of work days per calendar year were determined to be 189. This is equivalent to 52% of the year which was rounded to an even 2:1 ratio. The data used to determine this ratio is shown in Table E-6.

Table E-6 Table of the Average Available Workdays

Average Available Workdays					
Month	**Division**				**Statewide Average**
	1 & 2	**3, 4 & 5**	**6 & 7**	**8 & 9**	
January	11	12	15	16	13.5
February	10	12	15	15	13.0
March	15	16	16	16	15.8
April	16	17	17	18	17.0
May	16	17	18	19	17.5
June	15	15	15	15	15.0
July	16	16	15	16	15.8
August	18	17	18	17	17.5
September	16	16	16	17	16.3
October	18	19	19	19	18.8
November	16	16	16	16	16.0
December	10	13	15	14	13.0
Total:	177	186	195	198	189.0
% of 365	48%	51%	53%	54%	**52%**

Since calendar days occur twice as often as actual workable days, the calendar LD rates can be computed as 50% of the work day rates.

STEP 2: ***Scale liquidated damage (LD) rates obtained in Part 5 for different 'Contract Time Provision' (C/W) project class based on converted time allocation. [Note: 'average daily E& I' rates would be twice as much for work day project types than for calendar day types due to have the contract time provided under this time provision.***

The resulting schedule of LDs to be included in the standard specification, for both work days and calendar days as calculated by this methodology are presented in Table E-7.

Table E-7 Overall Daily E&I Values for Each Contract Size Group

Contract Value		LD rates	
From	To & Including	Work Day	Calendar Day
$0	$200,000	$500	$250
$200,000	$500,000	$700	$350
$500,000	$1,000,000	$1,300	$650
$1,000,000	$2,000,000	$2,000	$1,000
$2,000,000	$5,000,000	$3,100	$1,550
$5,000,000	----------	$3,700	$1,850

SUMMARY

The robust approach suggested will go a long way to addressing the three very practical problems faced by SHAs in dealing with LD review and updating which are: record data inaccuracy, time consuming process, and procedural soundness. First, the suggested approach automatically identifies data within the record that is most likely to be incorrect and trims them from the data prior to estimating rates. Second, the approach can be automated so that personnel charged with reviewing and updating rates will no longer need to relearning infrequently used techniques. Third, the procedure is sound with rates being estimated directly from underlying actual data of daily administrative costs incurred by SHAs. If this procedure is used honestly and intelligently, the LD rates developed and used by SHAs nationwide should be viewed as an objective and statistically justifiable pre-estimate of anticipated cost relating to untimely contractual performance.

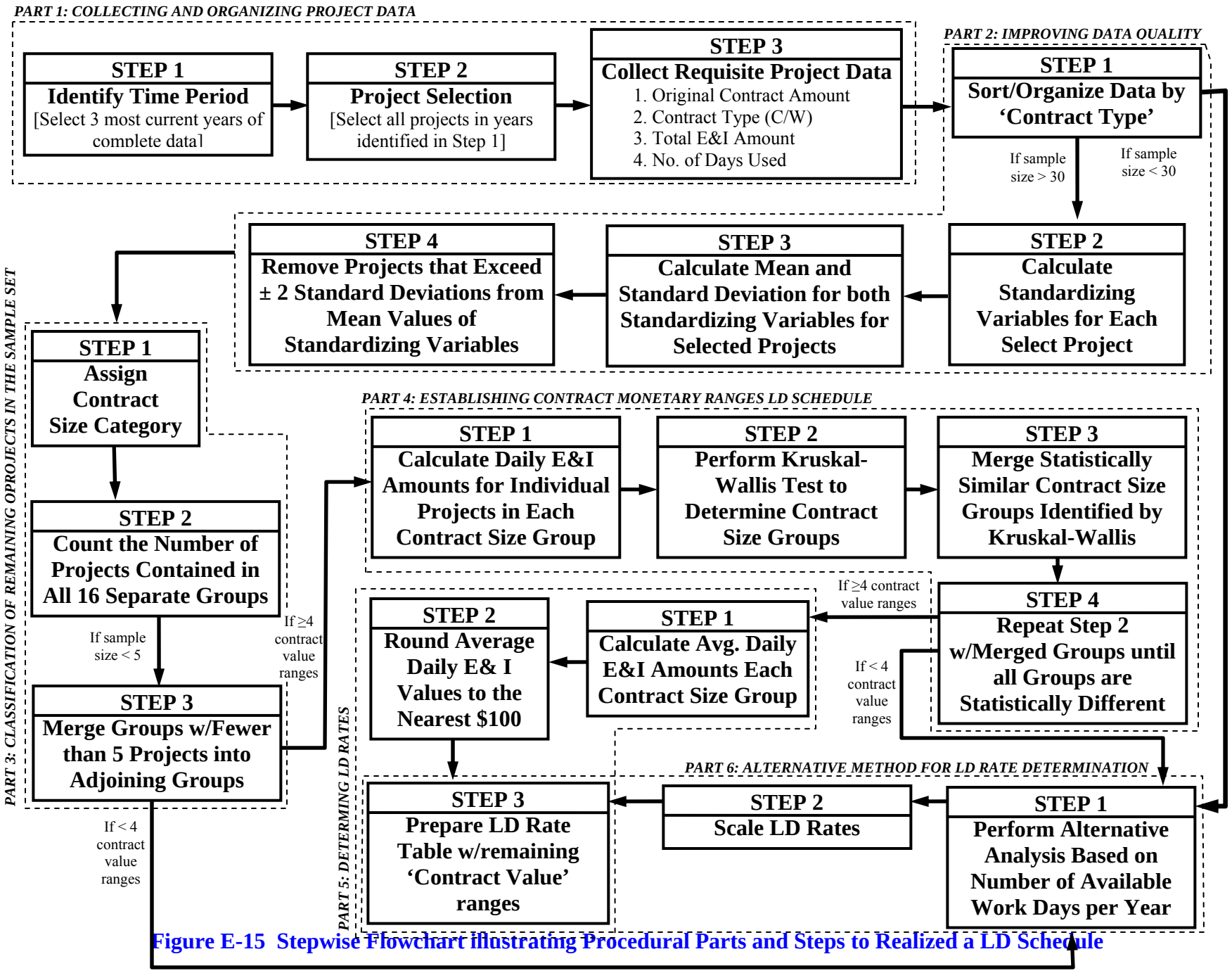


Figure E-15 Stepwise Flowchart illustrating Procedural Parts and Steps to Realized a LD Schedule

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APPENDIX F

ERS VALIDATION REPORT

Appendix F contains the validation report prepared by the Economic Research Services (ERS), Inc. ERS was hired by the Highway Research Center to review and validate the study performed for the Alabama Department of Transportation regarding the calculation of liquidated damages for construction contracts.

VALIDATION REPORT: REVIEW OF THE FINAL REPORT FOR PROJECT NUMBER 930-656

"DEVELOPMENT OF A BIENNIAL REVIEW PROCEDURE FOR UPDATING LIQUIDATED DAMAGE RATES USED IN ALDOT'S CONSTRUCTION CONTRACTS"

PREPARED BY
CHARLES J. MULLIN, PH.D.

June 12, 2008

Introduction

ERS Group (ERS)[1] was asked by the Alabama Department of Transportation (ALDOT) to review the report prepared by the Highway Research Center at Auburn University[2] (hereafter the HRC Report) regarding the calculation of liquidated damages for construction contracts. Specifically, we were asked to verify and validate the statistical aspects of the study. The HRC's study was designed to develop a statistically justifiable methodology for producing liquidated damage (LD) rates to be adopted by ALDOT for future construction projects. In addition, the HRC Report details a series of steps by which ALDOT personnel can update the LD rates every two years.

ERS was asked to review the HRC Report and the data on which it was based and determine if the statistical methods used were valid and the computations correct. We were also asked to determine if the procedure for updating the rates was computationally correct and if the directions developed for ALDOT personnel to update the LD rates could be followed based on the methodology outlined in the HRC Report. ERS did not investigate the engineering specifications or design assumptions of the study, nor did we take any steps to ensure the underlying historical contract data was correct. Our validation study was limited to the statistical and data decisions made in the HRC Report.

The remainder of our report consists of four sections. Section I consists of background information about the HRC study, details the specific items we reviewed, and

[1] ERS Group (ERS) is a part of Sourcecorp, Inc. and provides quantitative analysis of economic decisions to a variety of clients, including individuals, corporations, universities and government agencies. ERS also assists firms in developing Affirmative Action Programs and offers seminars in the use of statistics in economic analysis in litigation. ERS staff has worked for plaintiffs, defendants, and courts in discrimination litigation. Charles Mullin, Ph.D. prepared this validation study with input from Dr. Janet Thornton and Dr. Joan Haworth of ERS Group.

[2] Final Report, Project Number: 930-656 entitled "Development of a Biennial Review Procedure for Updating Liquidated Damage Rates used in ALDOT's Construction Contracts", Prepared by: Wesley C. Zech, Larry G. Crowley and Clark B. Bailey, October, 2007.

lists the specific statistical/data issues that we considered for this report. Section II provides our opinions about each of the specific issues we reviewed, along with any recommendations. Section III contains our comments on the step by step procedure developed for ALDOT to update the LD rates. Section IV contains a summary of our conclusions about the HRC Report.

I. Background

ERS was asked to review and comment on the validity of the HRC Report entitled "Development of a Biennial Review Procedure for Updating Liquidated Damage Rates used in ALDOT's Construction Contracts." The study was undertaken in an effort to produce a statistically valid methodology for constructing liquidated damage (LD) rates for ALDOT construction projects. Liquidated damages, typically set forth in construction contracts, are rates which specify the amount of money contractors will be charged for projects that are not completed in a timely fashion. These rates are used to recognize that the contracting agency has certain contract administration costs which are incurred on a daily basis as it oversees a project. The contracting agency sets forth LD rates which are meant to re-capture these costs should a project go beyond the contract time. By law, these rates should not penalize contractors, but rather are designed to simply recoup costs. Despite that, ALDOT's LD rates have been the recent focus of litigation. Accordingly, ALDOT commissioned the Highway Research Center at Auburn University for a study to develop a methodology for constructing its LD rates. ERS was asked to validate that study.

Materials Reviewed

In order to validate the Auburn study, we requested and received the following items:

- The HRC Report
- ALDOT's original historical Mainframe Construction Status file (with project type from the TRNSPORT system)
- The Final Report Data
- HRC's Calendar Day Project Rate Validation
- HRC's Kruskal-Wallis Test Results Summary
- Minitab programs and data files for work day projects
- Minitab programs and data files for calendar day projects

Statistical and Data Issues Considered

In order to properly evaluate the report, it was necessary to determine which issues/decisions that arose in the construction of the report were statistical in nature and which were engineering related, and therefore outside our area of expertise. Below is a list of the areas we examined:

1. The use of historical construction project data to estimate LD rates
2. Evaluation of outliers
3. Determination of contract size groups (and how groups should be redefined if necessary)
4. Calculation of final LD rates for Work Day Projects
5. Calculation of final LD rates for Calendar Day Projects

The details of our review and our opinions regarding these issues are set forth in the next section of this report.

II. Statistical Validation

The Use of Historical Construction Project Data to Estimate LD Rates

In order to estimate the current LD rates, which will be written into future contracts, the HRC chose to rely on historical construction contract data maintained by ALDOT. While there were other alternatives available (averages from other states, estimates from a survey of engineers), we agree with the HRC's decision to use historical data from ALDOT as the best source for estimating the LD rates. The ALDOT construction data are a rich set of data that contain information specifically related to the state of Alabama on the type of project, time to completion, contract size, and most importantly, *contract administration costs*. Typically, it is best to use existing data, rather than estimates based either on surveys or data from other states (whose LD rate setting methodologies may not be completely known or statistically valid). We concur that it is best to use data from projects that ended more recently because the experience of these projects are more relevant for making estimates about future projects.

Evaluation of Outliers

In order to construct LD rates, the HRC developed a methodology to exclude from the data those historical construction projects that it determined to be statistical outliers. Outliers often have the effect of skewing the mean (or average) away from the median so that the average is not representative of a randomly selected observation.[3] An outlier in statistics is defined as an observation which is numerically distant from the other observations, that is, it is an extreme measurement.[4] Numerically distant is

[3] Weiers, Ronald M., *Introduction to Business Statistics*. pp. 52-53.

[4] Studenmund, A. H., *Using Econometrics: A Practical Guide, second edition.* p. 79.

typically left up to the researcher, and while there is no rigid mathematical definition of what constitutes an outlier, it is not uncommon for an outlier to be defined as one which is more than 2 standard deviations (a 95 percent confidence interval) away from the mean in either direction (positive or negative).[5] This definition will define approximately 2.5 percent of the largest observations as outliers and approximately 2.5 percent of the smallest observations as outliers. This was the procedure followed by the HRC in its study and we agree it is an appropriate method for determining outliers. Using a statistical approach to identify outliers avoids ad hoc decision-making as to which observations to include (or exclude) in the calculation of LD rates.

The HRC procedure focuses on two separate measures that include the factors that are part of the LD rate calculation. Both of these measures were used to identify outliers. If an observation is identified as an outlier using either measure, then the observation is not included in the LD rate calculations. The two measures utilized by the HRC are total engineering and inspection costs (Total E&I) and project days. In both instances, the HRC scaled the measures based on the size of the contract to account for the fact that larger projects will have larger Total E&I and larger projects will require more days to complete. In addition, the HRC transformed the data using a logarithmic function, which has the effect of "normalizing" the data.[6] The HRC first tested the data to determine if it had a "log-normal" shape using a chi-squared test. This is an appropriate test to determine if the data are skewed and not "normally" distributed.[7] Transforming the data

[5] Studenmund, A. H., *Using Econometrics: A Practical Guide, fourth edition.* pp. 552-553.
[6] Normalizing the data facilitates the search for outliers, since the normal distribution is one in which the most frequent observations occur around the mean of the data and decrease in frequency as you move away from the mean in a well defined way (i.e., 95 percent of the values drawn from a normal distribution will lie within 2 standard deviations of the mean, over 99 percent will lie within 3 standard deviations and so on). Studenmund, A. H., *Using Econometrics: A Practical Guide, fourth edition.* pp. 539-542.
[7] Weiers, Ronald M., *Introduction to Business Statistics.* pp 596-605.

using a logarithmic function is a commonly used statistical technique to normalize such data.[8] The HRC then determined which historical construction projects had measures (either E&I as a percentage of contract value or dollars per day) that were outside of two standard deviations and, therefore, a statistical outlier.

Since the HRC defined an outlier as an observation (contract) in which either measure is more than two standard deviations from the mean, its method yields more historical observations as outliers than would be determined by looking at only one measure. The HRCs method of using two measures to identify outliers has two benefits:

1) projects with extremely low or high E&I costs will be identified (whether it be because of a large number of project days or some other reason unique to a project) ***and*** projects that had extremely low or high contract values given the number of days worked will be identified as outliers, and
2) the observations included in the LD calculations after removing the outliers may be more representative of a typical construction project.

Since the goal is to base the LD rates on typical projects, which will yield more robust results, the HRC approach of using two separate measures to identify outliers is beneficial and avoids an ad hoc determination of which historical projects to include in the calculation of LD rates.

It is also important to determine whether or not the various contract size groupings had projects that were similar enough that the outliers could be determined for all contract size groups jointly. While the HRC did not conduct that analysis ERS did by

[8] Moore, David S. and George P. McCabe, *Introduction to the Practice of Statistics*. pp. 521-522.

performing Klotz tests[9] to determine if the E&I as a percent of contract value (Log[(E&I)/(Contract size)]) and/or the dollars per day (Log[(contract size)/(number of days)]) in the various contract size groups had similar variance. Based on the initial tests we conducted on consecutive groups (group 1 v. group 2, group 2 v group 3, etc.), we found that in most instances, the Klotz tests on consecutive groups indicated that either one or both measures had variances that were different between groups. We performed subsequent tests on numerous contract size groups and determined that every contract size group had a variance that was different from at least one other contract size group for at least one of the measures used to identify outliers. Accordingly, the data support identifying outliers within each contract size group rather than identifying outliers without regard to contract size.

When we identified outliers within each contract group separately, using the same measures and method as the HRC, we found that the *number* of outliers was similar to that determined by the HRC method. The HRC method identified 61 outliers and the alternative method identified 64 outliers. However, the outliers themselves differed as only 40 outliers were the same between the two approaches. The alternative outlier analysis by contract group size identified 24 observations as outliers that were not part of the 61 HRC outliers, and the HRC approach identified 21 observations that were not part of the 64 alternative approach outliers.

Regardless of whether the outliers are derived from each contract group separately (as they should be, given the differences in the variance among the contract

[9] See Bonnett, Raymond and Edward Manoukian, *Mathematical Nonparametric Statistics,* pp. 246-254 for a discussion of the Klotz test. See also Klotz, Jerome, *The Annals of Mathematical Statistics*, Vol. 33, No. 2, pp 498-512.

groups) or from the entire population, both approaches derive similar LD rates and most of the estimated LD rates are identical, as shown in the table below.

Contract Size	HRC Outlier Approach LD Rates	Alternative Outlier Approach LD Rates
$0 -$200,000	$500	$600
$200,000 - $500,000	$700	$700
$500,000 - $1,000,000	$1,300	$1,300
$1,000,000 - $2,000,000	$2,000	$2,000
$2,000,000 - $5,000,000	$3,100	$3,100
$5,000,000 and higher	$3,700	$3,900

The LD rate on the smallest contract size group changed from $500 to $600 and the LD rate on the largest group changed from $3,700 to $3,900, otherwise the LD rates are identical between the two approaches. However, while the HRC methodology for identifying outliers is simpler and more straightforward, the data do not support pooling the entire population across contract sizes when identifying outliers.

Determination of Contract Size Groups (and which groups should be redefined if necessary)

Once the outliers were removed from the data, the HRC conducted an analysis to determine which, if any, of the contract size groupings should be redefined because they were statistically similar, meaning their daily E&I costs were similar enough that separating them into groups was not statistically justified. In many instances, an analysis of variance (ANOVA) or a simple t-test can be conducted to determine if two sets of data are statistically different, but these tests require that the data be normally distributed. As both we and the HRC determined, the data upon which this study was based was not

normally distributed.[10] Even if it were normally distributed, we agree with the HRC that future datasets may not be, and so an alternative statistical test that does not require the normality assumption is preferable. HRC used a non-parametric test known as the Kruskal-Wallis test to determine which if any groups should be combined. ERS Group confirmed that this is the appropriate test to use in this context.[11]

The Kruskal-Wallis test ranks each of the observations in a dataset and compares the overall ranking across groups. Therefore the overall size of the Daily E&I values is irrelevant, only their relative ranking is considered. The HRC performed the Kruskal-Wallis test on the consecutive groups (group 1 compared to group 2, group 2 compared to group 3, etc.) and determined that for purposes of computing LD rates, the two smallest contract size groups ($0 - $100,000 and $100,000 - $200,000) should be redefined to include all projects within the specified range. The HRC also determined the two largest groups ($5,000,000 - $10,000,000 and $10,000,000 and above) should be redefined. ERS Group reviewed the results of the statistical test performed and confirmed that these particular groups (and no others) should be redefined.[12]

Calculation of Final LD Rates for Work Day Projects

In order to verify that the final LD rates determined by the HRC were accurate, we replicated its procedures, including checking for mathematical errors, running the outlier analysis, performing the Kruskal-Wallis test, and computing the final LD rates.

[10] See above discussion of normal distributions.
[11] Berenson, Mark L. and David M. Levine, *Basic Business Statistics, 7th edition*. pp. 597-601.
[12] ERS also validated the use of Minitab to perform the Kruskal-Wallis test. The test statistic and resulting p-value were computed with another software package and the results compared. Both packages computed identical results.

We arrived at the same LD rates for each contract group and arrived at the same conclusions with regard to which contract size groups to redefine.[13]

Calculation of Final LD Rates for Calendar Day Projects

The construction projects undertaken by ALDOT can be specified as either work day or calendar day projects. Work day projects are defined as those in which days are charged against the project only when more than six hours of work could be completed. This is typically at the discretion of the field representative working for the ALDOT. All of the analyses noted above were limited to the work day projects from the ALDOT historical construction data. The data also contained information on calendar day projects. Calendar day projects are those in which a day is charged against completion of the project for every calendar day, regardless of whether or not work is completed. For the purposes of the HRC study, the calendar day data was excluded due to the small number of observations. The sample size of the specific contract size groups was deemed too small to conduct a rigorous statistical analysis. ERS reviewed the calendar day data and determined that the number of observations ranged from 3 to 36 when the data was grouped by contract size. We agree that several of the resulting samples are too small to arrive at statistically reliable LD estimates.

In order to arrive at LD rates for calendar day projects, the HRC adopted the methodology used by ALDOT. In this procedure, ALDOT engineers calculated the number of possible work days based on historical rainfall data. This was done by month and region within the state. The estimates for each region were clustered around 50%, ranging from 48% to 54%. Accordingly, ALDOT assumed that workdays were

[13] These supporting materials were provided on CD to ALDOT.

approximately 1 for every 2 calendar days. The result is to multiply the workday project LD rates by ½ to arrive at the corresponding calendar day project LD rates. Due to a lack of historical calendar day project data on which to base a consistent estimate, the option used by ALDOT, and adopted into the HRC methodology, is a reliable alternative.

III. Step by Step Procedure to Update Liquidated Damage Rates

In addition to verifying the reliability of the statistical methodology developed by the HRC, ERS Group also reviewed the step by step procedure created to update the LD rates biennially.[14] ERS Group personnel (who had not participated in our review of the report as a whole) performed the step by step procedure outlined by the HRC on the raw data provided to us. We found no computational or programming errors in the report.[15] ERS personnel indicated the instructions were easy to follow and straightforward. Using the step by step procedure, we were able to exactly replicate the LD rates the HRC noted in its report. Consequently, ALDOT personnel should be able to easily update the LD rates if it has access to similar data files.

IV. Conclusions

Counsel for the Alabama Department of Transportation requested that ERS Group review and validate the Report produced by the Highway Research Center at Auburn University. The HRC report memorializes the results of its study to determine a

[14] The HRCs step by step procedure can be found in Appendix E of its Report.

[15] ERS Group did find one data error in the raw data by visual inspection. In the project type field, which should only contain C or W (calendar or workday), one observation had a "D." ERS placed this observation in the calendar day data, essentially excluding it from further calculation. It may be helpful to include a direction on how to handle observations which do not fit the proper field parameters. We also note a typo which could lead to confusion in excluding outliers. On page 204, the statement "(e.g. all projects containing a '0' in either or both of the outlier columns)" should read "(i.e. all projects containing a '0' in both of the outlier columns)".

methodology for calculating liquidated damage rates that is both statistically reliable and defensible.

ERS Group reviewed the report and the underlying data on which the report is based. We verified the accuracy of the calculations and formulas on which the report rely. We also validated the use of the statistical computer program, Minitab, to perform certain statistical tests. In each case, we found no material errors which would impact the analysis of the HRC.

In addition, ERS Group examined the underlying statistical foundation for each of the statistical tests the HRC performed. The use of the Kruskal-Wallis test to determine which groups should be redefined is the appropriate statistical test. The HRC tests of normality are also valid and its transformations of the data follow standard statistical techniques.

The HRC identified outlier observations using a statistical method, rather than using an ad hoc approach. This statistical approach is based on two measures that include factors that are part of the calculation of LD rates. These are reasonable measures to identify observations that should be removed from the calculation of LD rates because the observations reflect statistically atypical situations, and their inclusion could potentially lead to inconsistent LD rates. However, the data support using these measures within each contract group, rather than pooling all the workday project data as the HRC did, in order to identify outliers. Using a standard statistical test (the Klotz test) we found that projects of different contract size have different variances in either or both of the measures used in the LD calculations (the percent E&I costs or the number of dollars per day), i.e., contracts of different size have fundamental differences which lead to

statistically different variability in their E&I cost structures. This is true even after transforming the data appropriately. Accordingly, we recommend conducting the outlier analysis by contract size group rather than pooling the data without regard to contract size. This recommended approach does not result in substantive differences in the LD rates from those calculated by the HRC for this set of historical data.

Lastly, ERS Group reviewed the step by step procedure described in the report which ALDOT is to follow in order to update the LD rates every two years. ERS Group was able to easily follow the directions given and to duplicate the work performed by the HRC to arrive at the LD rates reported. Given access to a similar database of historical completed construction projects, ALDOT should not have difficulty in updating the LD rates as needed. All of the statistical tests and validation procedures that ERS Group performed in connection with this report are enclosed on a CD attached to this report.

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APPENDIX G

GUIDELINES FOR CALCULATING LDS

(REVISED METHODOLOGY INCORPORATING ERS's SUGGESTIONS FROM

THE REPORT FOUND IN APPENDIX F)

The procedure herein is revised from that contained in Appendix E by incorporating suggestions may by statistical consultants after their review. It is the procedure for developing the schedule of liquidated damages included in the ALDOT Standard Specifications for Highway Construction. The outlier analysis documented in this methodology is a more robust approach than that contained in the earlier version. The outlier analysis relies on the median and the median absolute deviation (MAD) to identify variability within the data in lieu of the less robust statistical measure of the mean and standard deviation.

DEVELOPING LIQUIDATED DAMAGE (LD) RATES BIENNIALLY

INTRODUCTION:
The procedure described below is a suggested State Highway Agency (SHA) methodology for developing contractual Liquidated Damage (LD) rates from historical project cost data.

The discussion that follows has two distinct purposes. One purpose serves the needs of the practitioner as they follow the detailed steps, using their own data, in order to develop a working schedule of LD rates. In addressing their needs within the discussion, the steps are enumerated, sequenced, and illustrated with a parallel example (*shown by black boxes and blue writing*) so that the process can be more easily replicated by them.

The other purpose serves the needs of SHA administrators as they use the prototype method as a detailed template on which to base policy. Their needs require that the rationale and underlying principles of each subsequent step be fully explained. This explanation provides administrators with information to assure themselves they are in compliance with agency obligations imposed through oversight by the federal government and the courts, as well as, demonstrate the informed, reasonable and prudent exercise of their discretion in evaluating, modifying and adopting administrative policies as detailed here.

The enumerated steps in the procedure are grouped into six major parts, each of these parts is further enumerated into sequential steps, and on occasion these steps are then further divided into multiple tasks. The six major parts of the procedure are as follows:

- *Part 1: Collecting and Organizing Project Data*
- *Part 2: Improving Data Quality (removing projects with atypical data values)*
- *Part 3: Classification of Remaining Projects in the Sample Set by Contract Monetary Value.*
- *Part 4: Establishing Contract Monetary Ranges for LD Schedule*
- *Part 5: Determining Liquidated Damage (LD) Rates*
- *Part 6: Utilizing Alternative Method due to Limited Sample Sizes*

Figure G-16, at the end of this procedure, provides a flow chart summarizing the requisite steps detailed herein.

SUGGESTED SOFTWARE: MICROSOFT EXCEL | MINITAB 14.1

PART 1: COLLECTING AND ORGANIZING PROJECT DATA

***Purpose*:** The purpose of this part is to identify the data set that will be used throughout the remainder of the procedure and to collect all the requisite project data required for analysis. This part contains the following three major steps:

- *Step 1: Identify Time Period*
- *Step 2: Project Selection*
- *Step 3: Collect Requisite Project Data.*

The collection and organization of the project data begins here:

STEP 1*: *Identify Time Period

As a minimum, identify the most current three previous years of *complete* project data. Additional years of historical data can be included in the analysis if deemed appropriate by the practitioner conducting the analysis.

The time period used for analysis in the example provided includes years 2003, 2004, and 2005.

STEP 2*: *Project Selection

Identify and select all projects with completion dates occurring in any of the years identified during Step 1.

A total of 856 projects were completed in the years 2003, 2004, and 2005 were identified and selected in the ALDOT mainframe database.

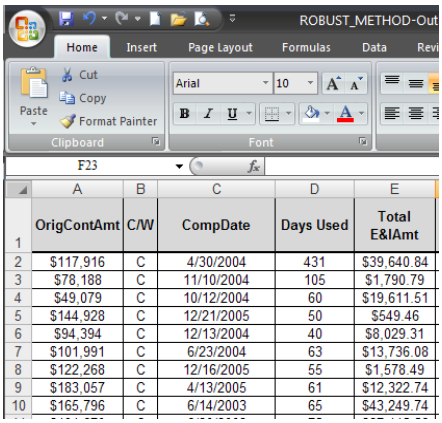
STEP 3*: *Collect Requisite Project Data

For each individual project, the following project characteristics should be collected:

(1) Original contract amount ($),
(2) Contract time provision (e.g. calendar day/date or work day (C/W)),
(3) Total engineering and inspection (E&I) costs ($), and
(4) Number of days used to complete project (days).

Once all the project data has been obtained from the ALDOT mainframe, import the data into a spreadsheet format.

Figure G-1 shows a screen capture of data used throughout the example provided in these guidelines.



	A	B	C	D	E
1	OrigContAmt	C/W	CompDate	Days Used	Total E&IAmt
2	$117,916	C	4/30/2004	431	$39,640.84
3	$78,188	C	11/10/2004	105	$1,790.79
4	$49,079	C	10/12/2004	60	$19,611.51
5	$144,928	C	12/21/2005	50	$549.46
6	$94,394	C	12/13/2004	40	$8,029.31
7	$101,991	C	6/23/2004	63	$13,736.08
8	$122,268	C	12/16/2005	55	$1,578.49
9	$183,057	C	4/13/2005	61	$12,322.74
10	$165,796	C	6/14/2003	65	$43,249.74

Figure G-1 Screen Capture Illustrating Example Required Data for Further Analysis.

PART 2: IMPROVING DATA QUALITY

***Purpose*:** Part 2 focuses on describing the procedure used to improve the quality of the data set by classifying and organizing project data collected while also removing projects with atypical data values using proper statistical techniques. Part 2 consists of the following six steps:

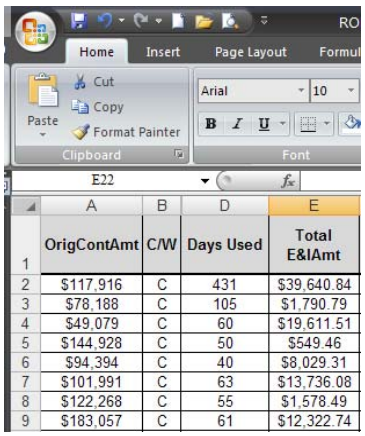
- *Step 1*: *Sort/Organize Data by 'Contract Type'*
- *Step 2*: *Assign Contract Size Category*
- *Step 3*: *Merge Groups with Fewer than Ten (10) Projects into Adjoining Groups*
- *Step 4*: *Calculate Standardizing Variables for Each Selected Project*

- *Step 5: Calculate the Lognormal Location (Median) and Scale (Median Absolute Deviation [MAD]) Parameters for both Standardizing Variables for Select Projects*
- *Step 6: Removal of Projects within the Data Set that Exceed ±2 Standard Deviations (using MAD) from Typical Values of Either Standardizing Variable.*

The improvement in quality of the project data set begins here:

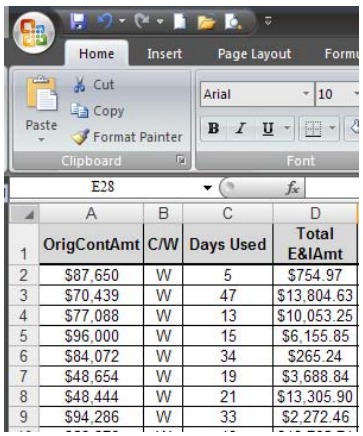
STEP 1: Sort/Organize Data by 'Contract Type'
All project data contained in the data set shall be sorted by 'contract type' (C/W day projects). The calendar day/date and work day projects should be separated and organized in two separate worksheets in a spreadsheet program.

Figure G-2(a) and G-2(b) illustrates the two separate spreadsheets for calendar and work day projects, respectively.



	A	B	D	E
1	OrigContAmt	C/W	Days Used	Total E&IAmt
2	$117,916	C	431	$39,640.84
3	$78,188	C	105	$1,790.79
4	$49,079	C	60	$19,611.51
5	$144,928	C	50	$549.46
6	$94,394	C	40	$8,029.31
7	$101,991	C	63	$13,736.08
8	$122,268	C	55	$1,578.49
9	$183,057	C	61	$12,322.74

(a) Calendar Day Projects



	A	B	C	D
1	OrigContAmt	C/W	Days Used	Total E&IAmt
2	$87,650	W	5	$754.97
3	$70,439	W	47	$13,804.63
4	$77,088	W	13	$10,053.25
5	$96,000	W	15	$6,155.85
6	$84,072	W	34	$265.24
7	$48,654	W	19	$3,688.84
8	$48,444	W	21	$13,305.90
9	$94,286	W	33	$2,272.46

(b) Work Day Projects

Figure G-2 Screen Capture Illustrating Separation of Project Data.

If either 'Contract Time Provision' data set contains less than 30 projects, proceed to Part 6 and perform the described alternative rate calculation procedure.

STEP 2: Assign Contract Size Category
***Purpose*:** The purpose of Step 2 is to classify projects into specific groups arranged by contract size. This step will be accomplished by assigning a contract size value to each of the projects based upon the original contract amount. The contract size categories designated by ALDOT are shown in Table G-1. Using these integer values between 1 and 8 will allow for all projects to be further classified into groups. There are two tasks required to accomplish this step.

Table G-1 Contract Value Ranges for Each Contract Size Group

Group	Contract Amount	
	From	To and Including
1	$0	$100,000
2	$100,000	$200,000
3	$200,000	$500,000
4	$500,000	$1,000,000
5	$1,000,000	$2,000,000
6	$2,000,000	$5,000,000
7	$5,000,000	$10,000,000
8	$10,000,000	------

***Task 1*:** Assign a contract size group to each individual project in the data set using the contract size categories shown in Table G-1 (i.e. an integer value between 1 and 8 representing a contract size group). The 'IF' statement shown in Equation G-1 can be used to assign an integer value between 1 and 8 to each individual project in a spreadsheet program.

=IF(**[Original Contract Amount]** <100,000.01,1,IF(**[Original Contract Amount]**<200,000.01,2, IF(**[Original Contract Amount]**<500,000.01,3,IF(**[Original Contract Amount]**<1,000,000.01,4, IF(**[Original Contract Amount]**<2,000,000.01,5,IF(**[Original Contract Amount]**<5,000,000.01,6, IF(**[Original Contract Amount]** <10,000,000.01,7,IF(**[Original Contract Amount]** >10,000,000, 8)))))))) (G-1)

***Task 2*:** Sort projects according to their contract size group. To do this, select the row containing all the column headings. Then, click **Data → Filter → Auto Filter**. Select the drop down menu for the '**Contract Size**' column and select '**Sort Ascending**' to organize the projects by contract sizes.

In our example, Table G-2 below categorizes the number of projects (C/W) per contract size grouping. There were a total of 726 Work Day projects and 129 Calendar Day/Date projects in the total data set.

Table G-2 Summary of C/W Projects by Contract Size

Contract Size	No. of Work Day Projects	No. of Calendar Day/Date Projects
1	22	3
2	60	16
3	187	36
4	232	34
5	139	11
6	45	14
7	27	9
8	14	6
Total	**726**	**129**

STEP 3*: *Merge Groups with Fewer than Ten (10) Projects into Adjoining Groups

***Purpose*:** The purpose of this step is to merge groups in a stepwise fashion with adjoining groups when one group does not contain 10 projects or more. The process of merging adjoining groups enables the practitioner to obtain the required sample sizes within groups in order to perform an adequate outlier analysis described in Steps 3 and 4 of this Part. There are two tasks associated with this step and are described below.

Task 1: Starting with the lowest 'Contract Size' group identified in Step 2, begin by merging the identified groups with the next lowest adjoining 'Contract Size' grouping if sample sizes are less than 10. Count the number of projects within the newly established group. If the newly established group does not contain at least 10 projects, merge the new group with the next highest adjoining 'Contract Size' grouping. Once the newly established group contains 10 projects or more, proceed to the next identified group in Step 2 and follow the same procedure. Proceed until you reach Group 8.

Task 2: In the case that Group 8 does not contain 10 projects or more, reverse the procedure and merge Group 8 with the next lowest adjoining 'Contract Size' group. Evaluate the size of the newly established group. If the newly established group does not contain at least 10 projects, merge the new group with the next lowest adjoining 'Contract Size' grouping. Once the newly established group contains 10 projects or more, proceed to the next identified group in Step 2 and follow the same procedure. Proceed until the lowest established grouping is reached.

After performing Task 2, if the number of projects classified as either calendar day/date or work day projects contains fewer than four contract size groupings, proceed to Part 6 and perform the described alternative rate calculation procedure.

In our example, Table G-3(a) and G-3(b) below summarizes the resulting redefined contract size groups after following the criteria outlined in Task 2. As seen in Table G-3(a), all Work Day Project contract size groups remained the same since each contract size group contained more than 10 projects. However, Calendar Day/Date Project contract size groups needed to be redefined. As seen in Table G-3(b), contract size 1 was merged with contract size 2 since contract size group 1 only contained 3 projects. This redefines the contract size range to $0 to $200,000. Similarly, contract size group 8 was merged with contract size group 7 since contract size group 7 only contained 9 projects while contract size group 8 only contained 6. This action redefined the contract size range to $5,000,000 and greater.

Table G-3 Contract Size Groups Redefined After Performing Task 2

Contract Size	No. of Work Day Projects
1	22
2	60
3	187
4	232
5	139
6	45
7	27
8	14
Total	**726**

(a)

Contract Size	No. of Calendar Day/Date Projects
1&2	19
3	36
4	34
5	11
6	14
7&8	15
Total	**129**

(b)

The project date set still includes a total of 726 Work Day projects and 129 Calendar Day/Date projects.

STEP 4*: *Calculate Standardizing Variables for Each Selected Project

***Purpose*:** The purpose of Step 4 is to calculate the standardizing variables to be used during outlier analysis to identify atypical data within the data set. The two standardized values that were selected as performance measures were: (1) '*total E&I amount as a percent of the original contract amount (%E&I)*' and (2) '*contract dollars placed per day ($/day)*'. There are two tasks required to complete Step 3.

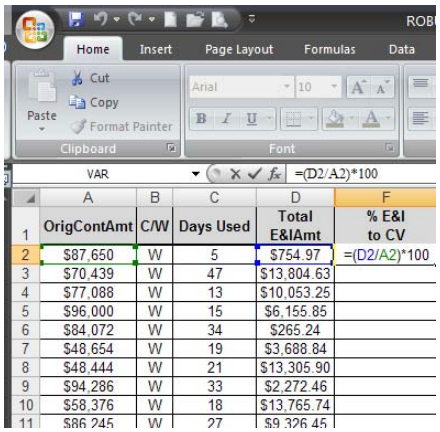
***Task 1*:** Calculate '*total E&I amount as a percent of the original contract amount (%E&I)*' for all C/W projects within their respective contract size group in a new column using equation G-2 below:

$$\%EI = \frac{E\&I}{CV} \qquad \text{(G-2)}$$

where,

$\%EI$ = total E&I as a percent of the original contract amount (%),
$E\&I$ = total E&I for the project ($), and
CV = original contract amount ($).

Figure G-3 is a screen capture displaying the spreadsheet representation of Equation G-1 shown in cell 'E2'.



	A	B	C	D	F
1	OrigContAmt	C/W	Days Used	Total E&IAmt	% E&I to CV
2	$87,650	W	5	$754.97	=(D2/A2)*100
3	$70,439	W	47	$13,804.63	
4	$77,088	W	13	$10,053.25	
5	$96,000	W	15	$6,155.85	
6	$84,072	W	34	$265.24	
7	$48,654	W	19	$3,688.84	
8	$48,444	W	21	$13,305.90	
9	$94,286	W	33	$2,272.46	
10	$58,376	W	18	$13,765.74	
11	$86,245	W	27	$9,326.45	

Figure G-3 Spreadsheet Calculation of %E&I.

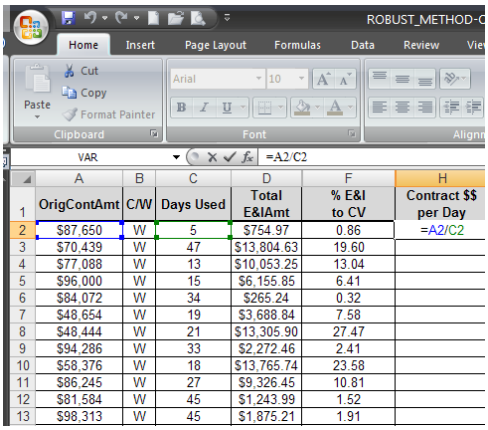
***Task 2*:** Calculate '*dollars placed per day ($/day)*' in a new column using Equation G-3 below:

$$\$/day = \frac{CV}{d} \qquad \text{(G-3)}$$

where,

$\$/day$ = dollars placed per day ($/day),
d = total number of days used for the project (days), and
CV = original contract amount ($).

Figure G-4 below shows the spreadsheet representation of Equation G-3, displayed in cell 'F2'.



	A	B	C	D	F	H
1	OrigContAmt	C/W	Days Used	Total E&IAmt	% E&I to CV	Contract $$ per Day
2	$87,650	W	5	$754.97	0.86	=A2/C2
3	$70,439	W	47	$13,804.63	19.60	
4	$77,088	W	13	$10,053.25	13.04	
5	$96,000	W	15	$6,155.85	6.41	
6	$84,072	W	34	$265.24	0.32	
7	$48,654	W	19	$3,688.84	7.58	
8	$48,444	W	21	$13,305.90	27.47	
9	$94,286	W	33	$2,272.46	2.41	
10	$58,376	W	18	$13,765.74	23.58	
11	$86,245	W	27	$9,326.45	10.81	
12	$81,584	W	45	$1,243.99	1.52	
13	$98,313	W	45	$1,875.21	1.91	

Figure G-4 Spreadsheet Calculation of $/day.

STEP 5: Calculate the Lognormal Location (Median) and Scale (Median Absolute Deviation [MAD]) Parameters for both Standardizing Variables for Select Projects

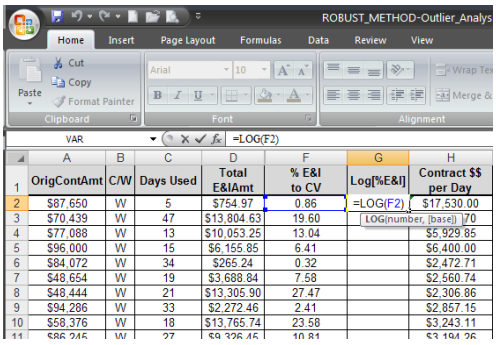
***Purpose*:** The purpose of Step 5 is to transform the data in order to realize a symmetrical distribution about the mean and set truncation limits for the purpose of removing unusual values (i.e. atypical projects or erroneous data) from the project data sets. There are four tasks to perform within this step.

***Task 1*:** Calculate the log of '**%E&I**' and '**$/day'** values for each project in new columns using equation G-4 and G-5 respectively:

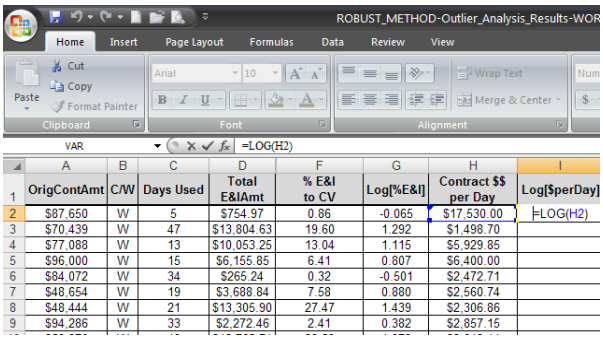
$$\text{Log[\%E\&I]} = \log(\textbf{[\%E\&I]}, 10) \qquad \text{(G-4)}$$

$$\text{Log[\$/day]} = \log(\textbf{[\$/day]}, 10) \qquad \text{(G-5)}$$

The screen capture displayed in Figure G-5 below shows the newly created columns entitled 'Log[%E&I]' and 'Log[$/day]' along with the spreadsheet formulas shown in cell 'G2'and 'H2', respectively. The spreadsheet equation is represented as '**=log(value, base)**' where the '**value**' is the cell containing the '**%E&I**' or '**$/day**' value and the '**base**' equals '**10**'.



(a) Log[%E&I]



(b) Log[$/day]

Figure G-5 Calculation of Lognormal Values of Standardizing Variables.

***Task 2*:** Calculate the median and the absolute value of the deviation (AD) from the median of the '**Log[%E&I]**' and '**Log[$/day]**' values for each contract size group using Equations G-6 through G-9, respectively.

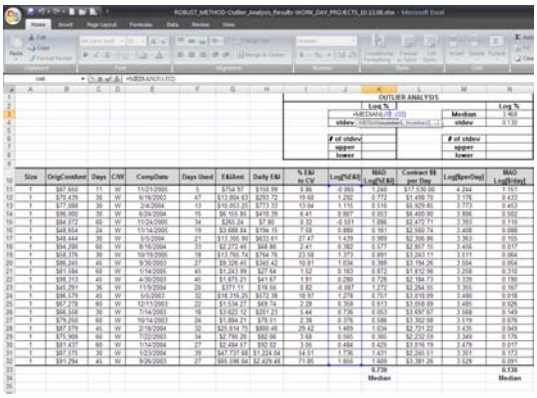
$$\text{Median(Log[\%E\&I])} = \text{MEDIAN}(\textbf{[all Log[\%E\&I] values]}) \qquad \text{(G-6)}$$

$$\text{AD} = [\text{ABS}[\text{Log}(\%\text{E\&I}) - \text{MEDIAN}(\textbf{[all Log[\%E\&I] values]})] \qquad \text{(G-7)}$$

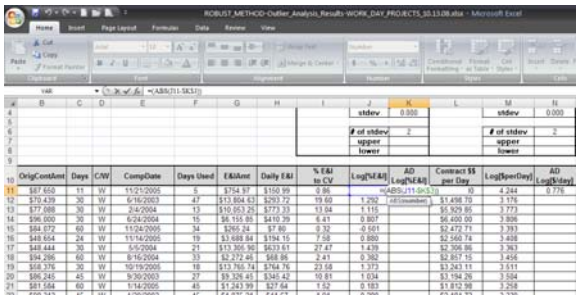
$$\text{Median(Log[\$/day])} = \text{MEDIAN}(\textbf{[all Log[\$/day] values]}) \qquad \text{(G-8)}$$

$$\text{AD} = [\text{ABS}[\text{Log}(\%\text{E\&I}) - \text{MEDIAN}(\textbf{[all Log[\$/day] values]})] \qquad \text{(G-9)}$$

Figure G-6 is a screen capture displaying the spreadsheet calculation using Equations G-6 and G-7 above.



(a) Median Log[%E&I]



(b) AD Log[%/E&I]

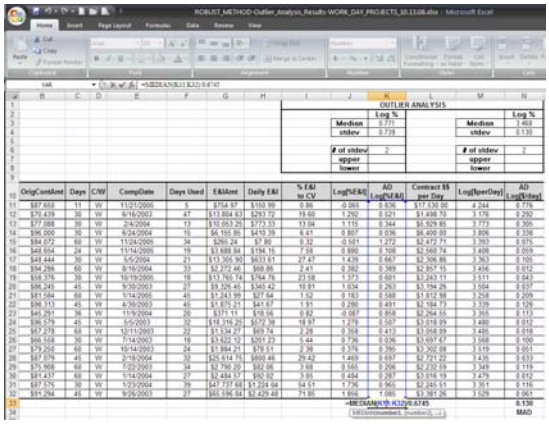
Figure G-6 Calculation of Mean and Standard Deviation Lognormal Values of Standardizing Variables.

***Task 3*:** Calculate the median absolute deviation (MAD) and convert by dividing by 0.6745 to an equivalent scale approximation computed in Task 2 using Equations G-10 and G-11.

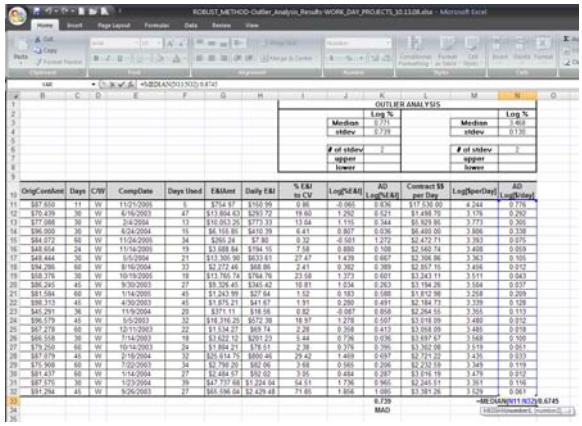
$$\text{MAD}(\textbf{Log[\%E\&I]}) = \text{MEDIAN}(\textbf{all AD's(Log[\%E\&I])})/0.6745 \qquad \text{(G-10)}$$

$$\text{MAD}(\textbf{Log[\$/day]}) = \text{MEDIAN}(\textbf{all AD's(Log[\$/day])})/0.6745 \qquad \text{(G-11)}$$

Figure G-7 is a screen capture displaying the spreadsheet calculation using Equations G-10 and G-11 above.



(a) MAD (Log[%E&I])



(b) MAD (Log[$$ per Day])

Figure G-7 Calculation of Truncation Limits of Standardizing Variables.

***Task 4*:** Determine ±2 standard deviations (using the MAD as a robust measure of the value) from the '**Log[%E&I]**' and the '**Log[$/day]**' median value using Equations G-12 through G-15, respectively. This allows for the upper and lower limits of the outlier analysis to be established.

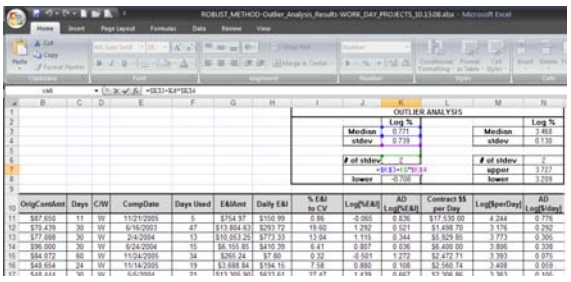
$$\text{Upper Limit} = [\textbf{MEDIAN(Log[\%E\&I])}] + 2*[\textbf{MAD(Log[\%E\&I])}] \quad \text{(G-12)}$$

$$\text{Lower Limit} = [\textbf{MEDIAN(Log[\%E\&I])}] - 2*[\textbf{MAD(Log[\%E\&I])}] \quad \text{(G-13)}$$

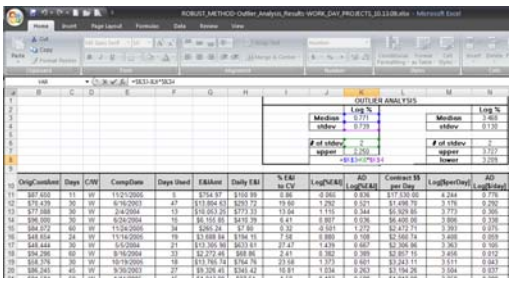
$$\text{Upper Limit} = [\textbf{MEDIAN(Log[\$/day])}] + 2*[\textbf{MAD(Log[\$/day])}] \quad \text{(G-14)}$$

$$\text{Lower Limit} = [\textbf{MEDIAN(Log[\$/day])}] - 2*[\textbf{MAD(Log[\$/day])}] \quad \text{(G-15)}$$

Figure G-8 is a screen capture displaying the spreadsheet calculation using Equations G-12 and G-13 above.



(a) Upper Limit [%E&I]



(b) Lower Limit [%/E&I]

Figure G-8 Calculation of Truncation Limits of Standardizing Variables.

STEP 6: Removal of Projects within the Data Set that Exceed ±2 Standard Deviations (using MAD) from Typical Values of Either Standardizing Variable.

***Purpose*:** The purpose of Step 6 is to truncate projects within each contract size group that exceed the upper and lower limits established in Step 5 of either (or both) of the standardizing variables in each of the established contract size groups. The projects with values exceeding these limits are considered abnormal values that may represent an atypical project or erroneous data entered incorrectly into the ALDOT mainframe database.

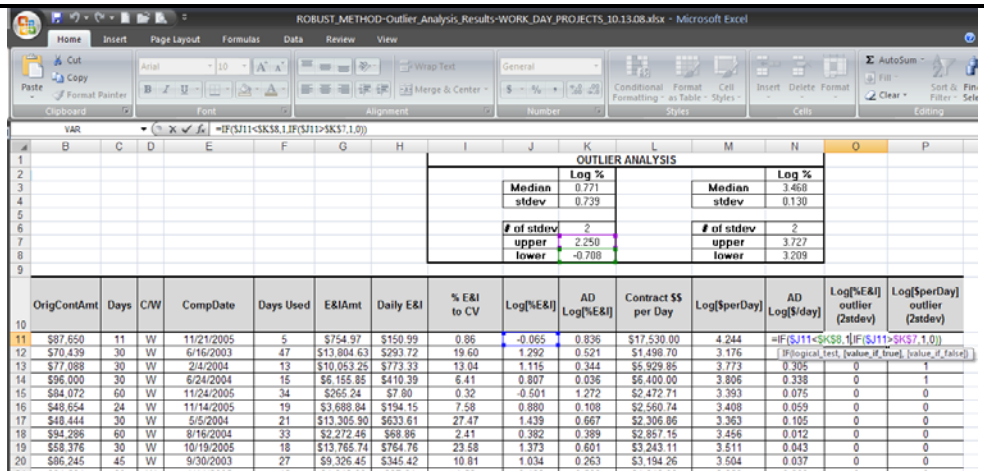
***Task 1*:** Develop an 'IF' statement to determine projects that are considered outliers based on the two standardizing variables identified in Step 4. Insert two new columns entitled 'Outlier Log[%E&I]' and 'Outlier Log[$/day] which are to utilize the following 'IF' statements shown as Equation G-15 and Equation G-16, respectively:

$$= \text{IF}(\textbf{Log[\%E\&I]}<\textbf{[lower limit]},1,\text{IF}(\textbf{Log[\%E\&I]}>\textbf{[upper limit]},1,0)) \quad \text{(G-15)}$$

$$=\text{IF}(\textbf{Log[\$/day]}<\textbf{[lower limit]},1,\text{IF}(\textbf{Log[\$/day]}>\textbf{[upper limit]},1,0)) \quad \text{(G-16)}$$

Spreadsheet cells that need to be selected and included in the equations above are represented by the bold values shown in Equation G-15 and G-16. These IF statements compare the Log[%E&I] and Log[$/day] values for a project to both their particular upper and lower limits. If the value is outside of these limits a '1' is placed in the cell, otherwise a '0' is placed in the cell. [Tip: Use "$" in front of the letter and number of the cell reference for the upper and lower limits to "lock" the reference in while copying the formula as shown in the screen capture below].

Figure G-9(a) and G-9(b) below shows a screen capture illustrating the spreadsheet representation of Equation G-15 and G-16, respectively.



ROBUST_METHOD-Outlier_Analysis_Results-WORK_DAY_PROJECTS_10.13.08.xlsx - Microsoft Excel

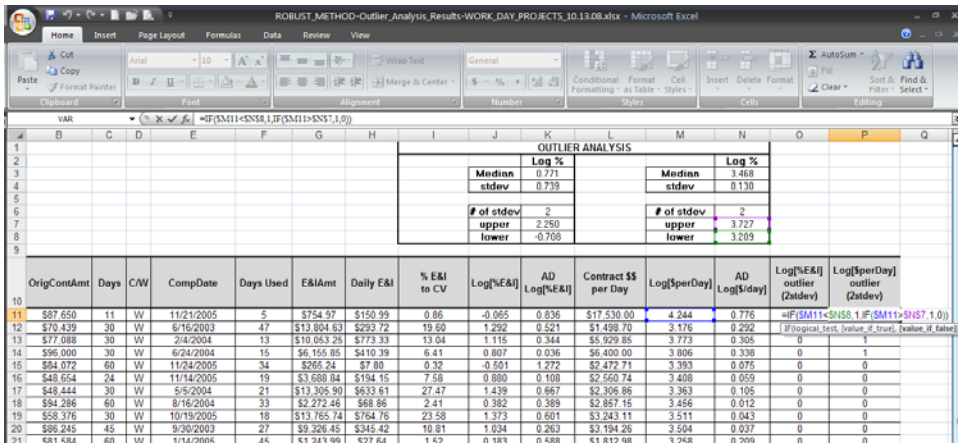
=IF($J11<$K$8,1,IF($J11>K7,1,0))

OUTLIER ANALYSIS

	Log %		Log %
Median	0.771	Median	3.468
stdev	0.739	stdev	0.130
# of stdev	2	# of stdev	2
upper	2.250	upper	3.727
lower	-0.708	lower	3.209

OrigContAmt	Days	C/W	CompDate	Days Used	E&IAmt	Daily E&I	% E&I to CV	Log[%E&I]	AD Log[%E&I]	Contract $$ per Day	Log[$perDay]	AD Log[$/day]	Log[%E&I] outlier (2stdev)	Log[$perDay] outlier (2stdev)
$87,650	11	W	11/21/2005	5	$754.97	$150.99	0.86	-0.065	0.836	$17,530.00	4.244	=IF($J11<$K$8,1,IF($J11>K7,1,0))		
$70,439	30	W	6/16/2003	47	$13,804.63	$293.72	19.60	1.292	0.521	$1,498.70	3.176	IF(logical_test, [value_if_true], [value_if_false])		
$77,088	30	W	2/4/2004	13	$10,053.25	$773.33	13.04	1.115	0.344	$5,929.85	3.773	0.305	0	1
$96,000	30	W	6/24/2004	15	$6,155.85	$410.39	6.41	0.807	0.036	$6,400.00	3.806	0.338	0	1
$84,072	60	W	11/24/2005	34	$265.24	$7.80	0.32	-0.501	1.272	$2,472.71	3.393	0.075	0	0
$48,654	24	W	11/14/2005	19	$3,688.84	$194.15	7.58	0.880	0.108	$2,560.74	3.408	0.059	0	0
$48,444	30	W	5/5/2004	21	$13,305.90	$633.61	27.47	1.439	0.667	$2,306.86	3.363	0.105	0	0
$94,286	60	W	8/16/2004	33	$2,272.46	$68.86	2.41	0.382	0.389	$2,857.15	3.456	0.012	0	0
$58,376	30	W	10/19/2005	18	$13,765.74	$764.76	23.58	1.373	0.601	$3,243.11	3.511	0.043	0	0
$86,245	45	W	9/30/2003	27	$9,326.45	$345.42	10.81	1.034	0.263	$3,194.26	3.504	0.037	0	0

Figure G-9(a) Spreadsheet IF Statement Calculation used to Identify Log[%E&I] Outliers.



ROBUST_METHOD-Outlier_Analysis_Results-WORK_DAY_PROJECTS_10.13.08.xlsx - Microsoft Excel

=IF($M11<$N$8,1,IF($M11>N7,1,0))

OUTLIER ANALYSIS

	Log %		Log %
Median	0.771	Median	3.468
stdev	0.739	stdev	0.130
# of stdev	2	# of stdev	2
upper	2.250	upper	3.727
lower	-0.708	lower	3.209

OrigContAmt	Days	C/W	CompDate	Days Used	E&IAmt	Daily E&I	% E&I to CV	Log[%E&I]	AD Log[%E&I]	Contract $$ per Day	Log[$perDay]	AD Log[$/day]	Log[%E&I] outlier (2stdev)	Log[$perDay] outlier (2stdev)
$87,650	11	W	11/21/2005	5	$754.97	$150.99	0.86	-0.065	0.836	$17,530.00	4.244	0.776	=IF($M11<$N$8,1,IF($M11>N7,1,0))	
$70,439	30	W	6/16/2003	47	$13,804.63	$293.72	19.60	1.292	0.521	$1,498.70	3.176	0.292	IF(logical_test, [value_if_true], [value_if_false])	
$77,088	30	W	2/4/2004	13	$10,053.25	$773.33	13.04	1.115	0.344	$5,929.85	3.773	0.305	0	1
$96,000	30	W	6/24/2004	15	$6,155.85	$410.39	6.41	0.807	0.036	$6,400.00	3.806	0.338	0	1
$84,072	60	W	11/24/2005	34	$265.24	$7.80	0.32	-0.501	1.272	$2,472.71	3.393	0.075	0	0
$48,654	24	W	11/14/2005	19	$3,688.84	$194.15	7.58	0.880	0.108	$2,560.74	3.408	0.059	0	0
$48,444	30	W	5/5/2004	21	$13,305.90	$633.61	27.47	1.439	0.667	$2,306.86	3.363	0.105	0	0
$94,286	60	W	8/16/2004	33	$2,272.46	$68.86	2.41	0.382	0.389	$2,857.15	3.456	0.012	0	0
$58,376	30	W	10/19/2005	18	$13,765.74	$764.76	23.58	1.373	0.601	$3,243.11	3.511	0.043	0	0
$86,245	45	W	9/30/2003	27	$9,326.45	$345.42	10.81	1.034	0.263	$3,194.26	3.504	0.037	0	0

Figure G-9(b) Spreadsheet IF Statement Calculation used to Identify Log [$perDay] Outliers.

***Task 2*:** Remove all projects which are identified as outliers according to both the 'Log[%E&I]' as well as 'Log[$/day]' in each individual contract value group. All projects identified as outliers should be filtered and the remaining projects not identified as outliers copied to a new spreadsheet for further analyses.

To do this, sort the projects in the outlier columns by selecting the row containing the column headings. Then, click **Data → Filter → Down Arrow on the Column to be Filtered**. The task is illustrated in Figure G-10 below for the example problem. Drop-down menus for each column will appear which can be used to sort the data. Choose consecutively **Sort Descending** as shown in Figure G-10 below for the two outlier columns.

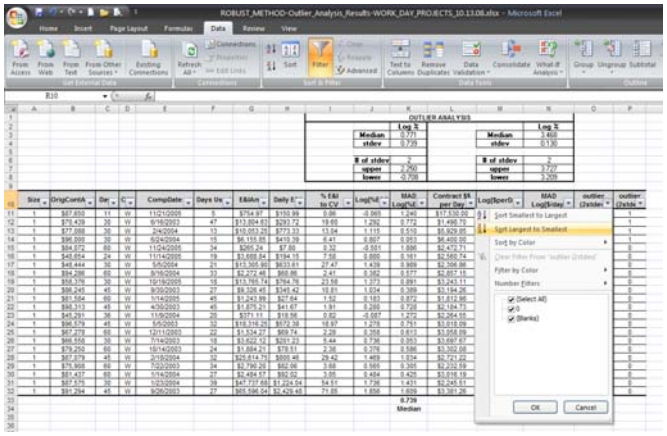


Figure G-10 Screen Capture Illustrating AutoFilter Function.

Once the abovementioned task is complete, all the outlier projects (those with a '1' in either outlier column) will be moved to the top of the project list. Highlight the projects not identified as outliers (e.g. all projects containing a '0' in either or both of the outlier columns), copy and paste these remaining project collectively into a separate worksheet for use in determining liquidated damage rates for either C/W projects. All columns created in Part 2 can be ignored, since this information is no longer needed.

In the example problem, a total of 608 work day projects and 97 calendar day projects remained in the data set after outlier analysis was performed.

PART 3: CLASSIFICATION OF REMAINING PROJECTS IN THE SAMPLE SET

***Purpose*:** The overall purpose of Part 3 is to further organize the remaining projects being used for analysis. The part is comprised of the following steps:

- *Step 1: Count the Number of Projects Contained in each of the Separate Groupings*
- *Step 2: Merge Groups with Fewer than Five (5) Projects into Adjoining Groups*
- *Step 3: Perform Alternative LD Rate Calculation for Projects Classified by Contract Time Provisions Containing Fewer than Four (4) Remaining Size Groups after Performing Step 3.*

The classification of remaining projects procedure outlined in Part 3 begins here:

***STEP 1*: Count the Number of Projects Contained in each of the Separate Groupings**

In this step, the practitioner must evaluate each contract size group to ensure that there are at least 5 projects in each of the separate groups. If a size grouping does not contain at least 5 projects, identify the group and proceed to Step 2. If all groupings contain 5 projects are more, proceed to Part 4.

STEP 2*: *Merge Groups with Fewer than Five (5) Projects into Adjoining Groups

***Purpose*:** The purpose of this step is to merge groups in a stepwise fashion with adjoining groups when one group does not contain 5 projects or more. The process of merging adjoining groups enables the practitioner to obtain the required sample sizes within groups in order to perform the Kruskal-Wallis test described in Part 4. There are two tasks associated with this step and are described below.

***Task 1*:** Starting with the highest 'Contract Size' group identified in Step 1, begin by merging the identified groups with the next lowest adjoining 'Contract Size' grouping. Count the number of projects within the newly established group. If the newly established group does not contain at least 5 projects, merge the new group with the next lowest adjoining 'Contract Size' grouping. Once the newly established group contains 5 projects or more, proceed to the next identified group in Step 1 and follow the same procedure. Proceed until you reach Group 1.

***Task 2*:** In the case that Group 1 does not contain 5 projects or more, reverse the procedure and merge Group 1 with the next highest adjoining 'Contract Size' group. Evaluate the size of the newly established group. If the newly established group does not contain at least 5 projects, merge the new group with the next highest adjoining 'Contract Size' grouping. Once the newly established group contains 5 projects or more, proceed to the next identified group in Step 1 and follow the same procedure. Continue in like manner until all groups have at least 5 projects.

After performing Task 2, if the number of projects classified as either calendar day/date or work day projects contain fewer than four contract size groupings, proceed to Part 6 and perform the described alternative rate calculation procedure.

In our example, Table G-4 below categorizes the number of projects (C/W) remaining per contract size after outlier analysis and merging/redefining of the contract size groups.

Table G-4 Contract Size Groups Redefined After Performing Task 2

Contract Size	No. of Work Day Projects
1	18
2	47
3	167
4	207
5	103
6	34
7	21
8	11
Total	**608**

(a)

Contract Size	No. of Calendar Day/Date Projects
1&2	15
3	29
4	20
5	9
6	11
7&8	13
Total	**97**

(b)

PART 4: ESTABLISHING CONTRACT MONETARY RANGES FOR LIQUIDATED DAMAGES (LDS) SCHEDULE

***Purpose*:** The purpose of Part 4 is to investigate contract monetary ranges using statistical methods to determine whether adjacent 'Contract Size' groupings are statistically similar or different from one another in terms of 'Daily E&I' costs. By combining similar groupings and retaining those that differ, the practitioner can establish monetary ranges that will be used in the

schedule of LDs to be included in ALDOTs standard specification. This part is comprised of the following steps:

- *Step 1: Calculate Individual Project Daily E&I amounts*
- *Step 2: Compare adjoining 'Contract Size' groups within the 'Contract Time Provision' class(i.e. C/W projects) using the Kruskal-Wallis Test with 'Daily E&I' costs as the response and the 'Contract Size' variable as the factor.*
- *Step 3: Merge contract size groups that the Kruskal-Wallis testing reveals no statistical difference in 'Daily E&I' costs between the groups.*
- *Step 4: Repeat Step 2 with merged groups until all remaining groups are statistically different in terms of 'Daily E&I' costs.*
- *Step 5: Perform Alternative LD Rate Calculation for Projects Classified by Contract Time Provisions Containing Fewer than Four (4) Remaining Size Groups after Performing Step 2.*

The procedure for establishing the contract monetary ranges to be used in the schedule of LDs begins here:

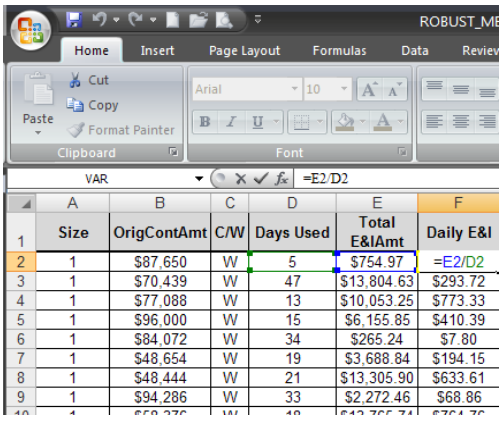
STEP 1: Calculate Individual Project Daily E&I Amounts by using Equation G-17 below:

$$Daily\ E\ \&\ I = \frac{Total\ E\ \&\ I\ Amount}{No.\ of\ \ Days\ Used} \qquad \text{(G-17)}$$

where,

Daily E&I = daily E&I costs of each individual project ($/day),
Total E&I Amount = total E&I costs for each project ($), and
No. of Days Used = total number of days used to complete each project (days).

Figure G-11 below shows a screen capture illustrating equation G-16 being applied in a spreadsheet program.



	A	B	C	D	E	F
1	Size	OrigContAmt	C/W	Days Used	Total E&IAmt	Daily E&I
2	1	$87,650	W	5	$754.97	=E2/D2
3	1	$70,439	W	47	$13,804.63	$293.72
4	1	$77,088	W	13	$10,053.25	$773.33
5	1	$96,000	W	15	$6,155.85	$410.39
6	1	$84,072	W	34	$265.24	$7.80
7	1	$48,654	W	19	$3,688.84	$194.15
8	1	$48,444	W	21	$13,305.90	$633.61
9	1	$94,286	W	33	$2,272.46	$68.86

Figure G-11 Spreadsheet Calculation of Daily E&I for Each Project.

STEP 2: Compare adjoining 'Contract Size' groups within the 'Contract Time Provision' class (i.e. C/W projects) using the Kruskal-Wallis Test with 'Daily E&I' costs as the response and the 'Contract Size' variable as the factor.

Purpose: These contract size groups will be compared against each other to determine which are statistically the same or different from one another. Minitab™ will be used for this step which is described below. There are two tasks required to accomplish this step.

Task 1: Copy all the remaining data after outlier analysis and organization from the spreadsheet into a new Minitab worksheet.

Task 2: Perform the Kruskal-Wallis test to determine if any of the groups based on their 'Contract Size' category are statistically the same or different from each other.

To do this, first create a new worksheet by selecting '**File**' → '**New**' and selecting '**Worksheet**' in the window. Then copy and paste all the projects from the first two contract size groups (1 & 2) into the new worksheet. To run the test, select '**Stat**' → '**Nonparametrics**' → '**Kruskal-Wallis**'. Select the '**Daily E&I**' column as the '**Response**' and '**Size**' (i.e. contract size group) as the '**Factor**'. Figure G-12 provides an illustration of the Kruskal-Wallis pop-up window contained in MiniTab.

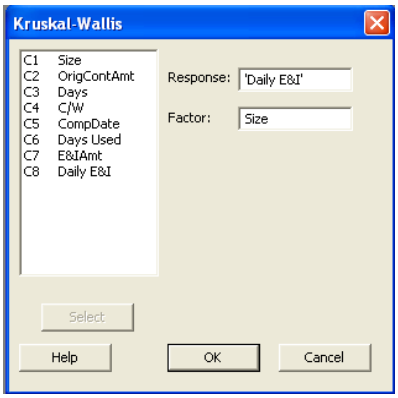


Figure G-12 Kruskal-Wallis Pop-up Window in MiniTab™.

If the p-value resulting from the Kruskal-Wallis test is greater than or equal to 0.05, the groups are considered to be statistically the same.

For example, Figure G-13 shows the results of the Kruskal-Wallis test comparing groups 1 and 2 resulted in a p = 0.263, therefore groups 1 and 2 are considered statistically similar and are merged together and the contract value range is redefined as: $0 – $200,000.

Kruskal-Wallis Test: Daily E&I versus Contract Size [*Work Day Projects*]

```
Kruskal-Wallis Test on Daily E&I

Size      N  Median  Ave Rank      Z
1        18   143.1      26.9  -1.60
2        47   266.7      35.3   1.60
Overall  65              33.0

H = 2.55  DF = 1  P = 0.110
```

Figure G-13 Results of the Kruskal-Wallis Test Comparing Group 1 vs. 2 [*Work Day Projects*].

STEP 3: Merge contract size groups that the Kruskal-Wallis testing reveals no statistical difference in 'Daily E&I' costs between the groups.

***Purpose*:** The purpose of this step is to combine 'Contract Size' groups that are deemed statistically the same into a new unique 'Contract Size' group. This step contains two tasks described below.

***Task 1*:** Identify groups that when compared resulted in a p-value greater than 0.05 indicating that the groups are statistically similar.

In the example provided, the results of Step 2 above when comparing group 1 versus group 2 resulted in a p-value equal to 0.110 which is greater than 0.05.

***Task 2*:** Merge statistically similar groups into one unique group and redefine contract value ranges accordingly.

Since the p-value identified in task 1 is greater than 0.05, group 1 and group 2 are merged to create a new project group with the contract value range from $0 to $200,000.

STEP 4: Repeat Step 2 with merged groups until all remaining groups are statistically different in terms of 'Daily E&I' costs.

Now that group 1 and group 2 are merged, the redefined contract size group should be compared against group 3 following the procedure outlined in step 2 above. If the p-value is less than 0.05 then the groups are considered to be statistically different and cannot be merged.

For example, Figure G-14 shows the Kruskal-Wallis results after comparing the redefined contract size group 1&2 with group 3. The p-value = 0.000, therefore redefined group 1&2 would remain its own unique group, and group 3 would then be compared against group 4 using the Kruskal-Wallis test as described above.

Kruskal-Wallis Test: Daily E&I versus Contract Size [*Work Day Projects*]

```
Kruskal-Wallis Test on Daily E&I

Size       N  Median  Ave Rank      Z
 3       167   492.8     126.6   3.66
12        65   256.5      90.6  -3.66
Overall  232              116.5

H = 13.41  DF = 1  P = 0.000
```

Figure G-14 Results of the Kruskal-Wallis Test Comparing Combined Group 1&2 vs. Group 3 [*Work Day Projects*].

This process would continue sequential comparing groups against each other, redefining contract size ranges when groups are considered statistically similar and maintaining unique groups when considered statistically different.

The results shown in Table G-5 provide a summary of p-values resulting from the Kruskal-Wallis test on the remaining projects within our example data set for work day projects. Table G-5 provides statistical justification for merging groups together and redefining contract value ranges when developing the schedule of liquidated damages to be included in the standard specification. From the table, the results indicate groups 1 and 2 be merged into a single, redefined contract value group, 3, 4, 5, and 6 remain as their own unique group, and groups 7 and 8 are merged into a single, redefined contract value group.

Table G-5 Summary of Kruskal-Wallis Test on Remaining Work Day Project Data

	Kruskal-Wallis Test: p-values						
GROUP	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	0.110[1]	--	--	--	--	--	--
1&2	--	0.000	--	--	--	--	--
3	--	--	0.000	--	--	--	--
4	--	--	--	0.000	--	--	--
5	--	--	--	--	0.000	--	--
6	--	--	--	--	--	0.022	--
7	--	--	--	--	--	--	0.258[1]

Note:
1. p-values ≥ 0.05 therefore groups are considered statistically similar, merged, and contract value ranges are redefined.

Table G-6 provides a summary of p-values resulting from the Kruskal-Wallis test on the remaining calendar day/date projects.

Table G-6 Summary of Kruskal-Wallis Test on Remaining Calendar Day/Date Project Data

	Kruskal-Wallis Test: p-values				
GROUP	**3**	**4**	**5**	**6**	**7&8**
1&2	0.757[1]	--	--	--	--
1,2,&3	--	0.075[1]	--	--	--
1,2,3,&4	--	--	0.000	--	--
5	--	--	--	0.342[1]	--
5&6	--	--	--	--	0.224[1]

Note:
1. p-values ≥ 0.05 therefore groups are considered statistically similar, merged, and contract value ranges are redefined.

The results of the Kruskal-Wallis test on calendar day/date projects indicates that groups 1,2,3 and 4 are merged into a single, redefined contract value group, while 5, 6, 7, and 8 are merged into a single, redefined contract value group.

STEP 5: Perform Alternative LD Rate Calculation for Projects Classified by Contract Time Provisions Containing Fewer than Four (4) Remaining Size Groups after Performing Step 2.

After performing Steps 1 through 4, if the number of projects classified as either C/W projects contains fewer than four contract size groupings, proceed to Part 6 and perform the described alternative rate calculation procedure.

In our example, since there are only 2 remaining contract size groupings for calendar day/date projects, proceed to part 6 and use the alternative method for calculating calendar day LD rates.

There are six remaining contract size groups for Work Day projects, therefore proceed to Part 5 to calculate work day LD rates.

PART 5: DETERMINING LD RATES

Purpose: The purpose of Part 5 is to provide a procedure to follow in determining the liquidated damage (LD) rates for each 'Contract Size' groups established at the conclusion of Part 4. This part consists of the following steps:

- *Step 1: Calculate the Average Daily E&I values for each remaining group within 'Contract Time Provision (C/W)' categories*
- *Step 2: Round the average daily E&I values to the nearest $100.*
- *Step 3: Prepare a LD rate table with 'Contract Value' size ranges for remaining groups and rounded 'Average Daily E&I' values for those ranges.*

The procedure for Part 5 begins here:

STEP 1: Calculate the Average Daily E&I values for each remaining group within 'Contract Time Provision (C/W)' categories using Equation G-18.

$$AvgDailyE\&I_i = \frac{\sum_{j=1}^{n} DailyE\&I_{ij}}{n_i} \qquad \text{(G-18)}$$

where,

$Avg.\ Daily\ E\&I_i$ = average daily E&I costs for all projects in group i ($/day),
$Daily\ E\&I_{ij}$ = daily E&I costs for project j in group i ($/day), and
n_i = total number of projects in group i.

STEP 2: Round the average daily E&I values to the nearest $100. These rounded values represent the 'Contract Time Provision (C/W)' LD rates for their respective contract size groups. Place them in a table along with the 'Contract Size'groups monetary ranges.

Table G-7 is an example of the work day 'Average Daily E&I' rates arranged in a table by contract size groups along with the rounded value to use for the 'Work Day LD Rate'.

Table G-7 Example of Contract Value Ranges and Work Day LD Rates

Contract Value		Average Daily E&I	Work Day LD Rate
From	To & Including		
$0	$200,000	$455	$500
$200,000	$500,000	$673	$700
$500,000	$1,000,000	$1,341	$1,300
$1,000,000	$2,000,000	$2,187	$2,200
$2,000,000	$5,000,000	$3,172	$3,200
$5,000,000	---------	$4,055	$4,100

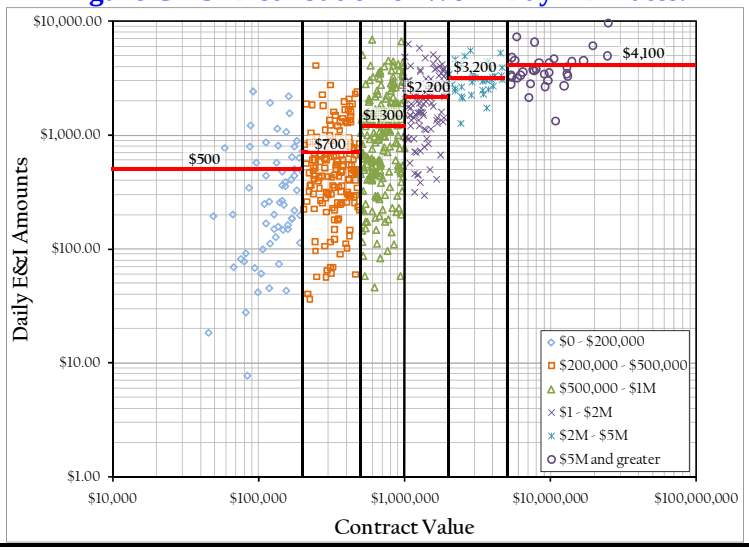
STEP 3: ***Prepare a LD rate table with 'Contract Value' size ranges for remaining groups and rounded 'Average Daily E&I' values for those ranges.***

Table G-8 illustrates the schedule of LD rates for work day projects established following the procedure outlined throughout these guidelines. Figure G-15 shows the distribution of data used to compute the LD rates specified in Table G-8.

Table G-8 Schedule of LD Rates for Work Day Projects by Contract Value Ranges

Contract Value		LD rates
From	To & Including	Work Day
$0	$200,000	$500
$200,000	$500,000	$700
$500,000	$1,000,000	$1,300
$1,000,000	$2,000,000	$2,200
$2,000,000	$5,000,000	$3,200
$5,000,000	----------	$4,100

Figure G-15 Distribution of Work Day LD Rates.



PART 6: ALTERNATIVE METHOD FOR LD RATE DETERMINATION DUE TO LIMITED SAMPLE GROUPINGS WITHIN CONTRACT TIME PROVISION PROJECT CLASSIFICATIONS

Purpose: The procedure to be followed in Part 6 is to determine LD rates in the situation when projects classified by a 'Contract Time Provision (C/W)' contained fewer than four remaining size groupings after following the procedure in Part 4 of these guidelines. An alternative analysis was developed to calculate LD rates based upon the number of actual feasible work days available in a calendar year based upon historical rainfall data collected in Alabama. This procedure is comprised of two steps as detailed below:

- *Step 1: Convert contractually allocated time between calendar day and work day contract provisions based on lost time due to typical weather days experienced in the region. [Unless new analysis is performed to determine rates, use rounded value obtained from pervious rainfall data study of 50% of time lost due to weather].*

- *Step 2: Scale LD rates obtained in Part 5 for different 'Contract Time Provision' (C/W) project class based on converted time allocation. [Note: 'average daily E&I' rates would be twice as much for work day project types than for calendar day types due to half the contract time provided under this time provision.*

The alternative method for determining LD rates due to limited samples sizes within a contract time provision set begins here:

STEP 1: Convert contractually allocated time between calendar day and work day contract provisions based on lost time due to typical weather days experienced in the region. [Unless new analysis is performed to determine rates, use rounded value obtained from pervious rainfall data study of 50% of time lost due to weather].

In our example after the work day LD rates are determined, the focus turned to calculating the calendar day rates. Since the number of size groupings was less than four, historical rainfall data was examined to determine the number of work days for each calendar month. In this procedure, experienced ALDOT engineers calculated the number of possible work days for each month based on historical project data. First, all Saturdays, Sundays, and Legal Holidays were excluded. Then, by examining the amount of rainfall each day, the engineers, using past on-site experience, determined if that day would be a feasible workday based on the amount of rainfall experienced. If so, it was counted. This process was carried out for each month and for four geographic regions in Alabama. The regions were: North Alabama (Divisions 1 & 2), Central Alabama (Divisions 3, 4, & 5), Southeast Alabama (Divisions 6 & 7), and Southwest Alabama (Divisions 8 & 9). In each region, multiple sites were used to determine the feasibility of working on any given day. Overall, a statewide average number of work days per calendar year were determined to be 189. This is equivalent to 52% of the year which was rounded to an even 2:1 ratio. The data used to determine this ratio is shown in Table G-9.

Table G-9 Table of the Average Available Workdays

Average Available Workdays					
Month	Division				Statewide Average
	1 & 2	3, 4 & 5	6 & 7	8 & 9	
January	11	12	15	16	13.5
February	10	12	15	15	13.0
March	15	16	16	16	15.8
April	16	17	17	18	17.0
May	16	17	18	19	17.5
June	15	15	15	15	15.0
July	16	16	15	16	15.8
August	18	17	18	17	17.5
September	16	16	16	17	16.3
October	18	19	19	19	18.8
November	16	16	16	16	16.0
December	10	13	15	14	13.0
Total:	177	186	195	198	189.0
% of 365	48%	51%	53%	54%	**52%**

Since calendar days occur twice as often as actual workable days, the calendar LD rates can be computed as 50% of the work day rates.

STEP 2: ***Scale LD rates obtained in Part 5 for different 'Contract Time Provision' (C/W) project class based on converted time allocation. [Note: 'average daily E&I' rates would be twice as much for work day project types than for calendar day types due to half the contract time provided under this time provision.***

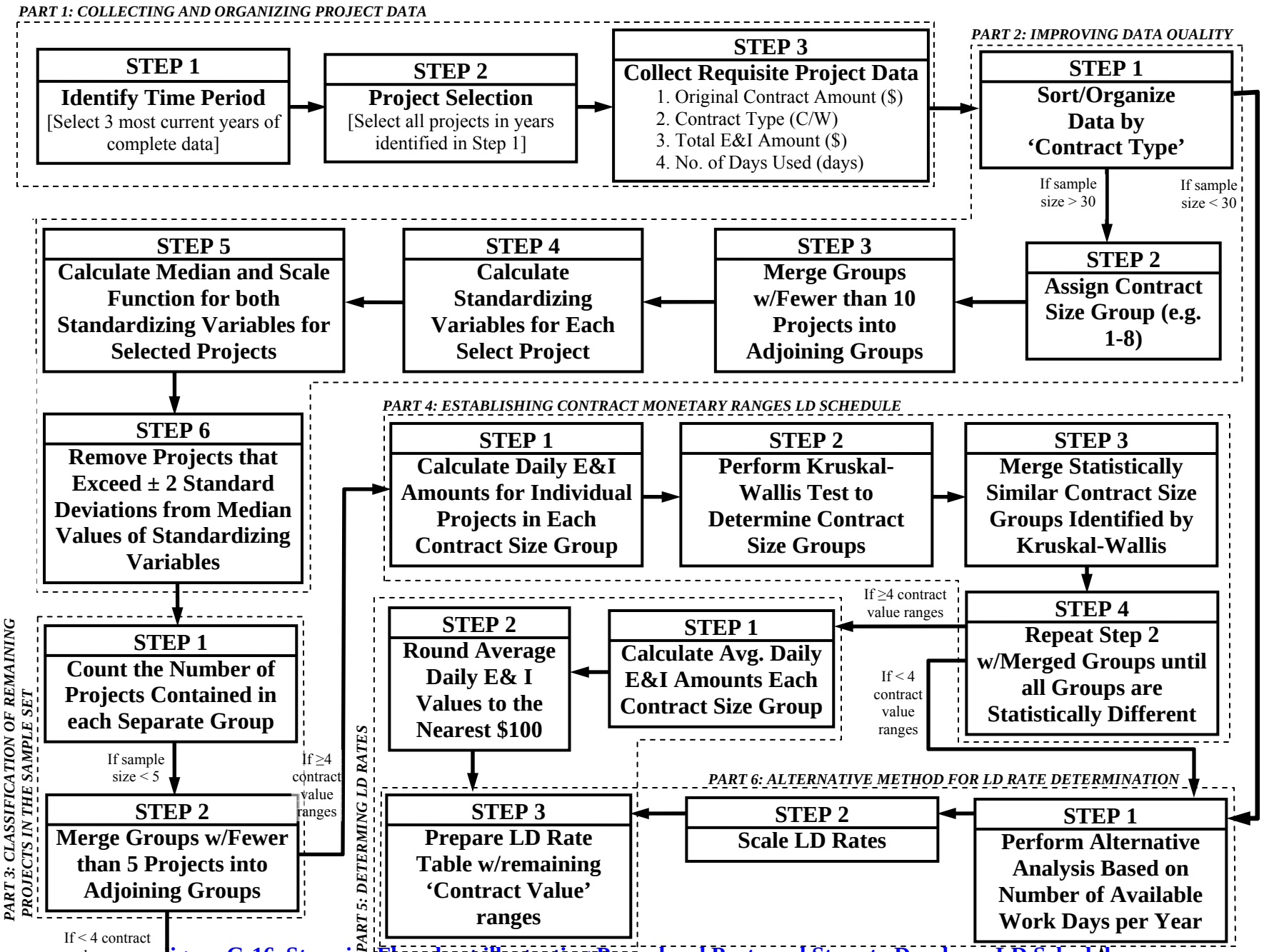
The resulting schedule of LDs to be included in the standard specification, for both work day and calendar day/date projects as calculated by this methodology are presented in Table G-10.

Table G-10 Overall Daily E&I Values for Each Contract Size Group

Contract Value		LD rates	
From	**To & Including**	**Work Day**	**Calendar Day**
$0	$200,000	$500	$250
$200,000	$500,000	$700	$350
$500,000	$1,000,000	$1,300	$650
$1,000,000	$2,000,000	$2,200	$1,100
$2,000,000	$5,000,000	$3,200	$1,600
$5,000,000	----------	$4,100	$2,050

SUMMARY

The robust approach suggested will go a long way to addressing the three very practical problems faced by SHAs in dealing with LD review and updating which are: record data inaccuracy, time consuming process, and procedural soundness. First, the suggested approach automatically identifies data within the record that is most likely to be incorrect and trims them from the data prior to estimating rates. Second, the approach can be automated so that personnel charged with reviewing and updating rates will no longer need to relearn infrequently used techniques. Third, the procedure is sound with rates being estimated directly from underlying actual data of daily administrative costs incurred by SHAs. If this procedure is used honestly and intelligently, the LD rates developed and used by SHAs nationwide should be viewed as an objective and statistically justifiable pre-estimate of anticipated cost relating to untimely contractual performance.



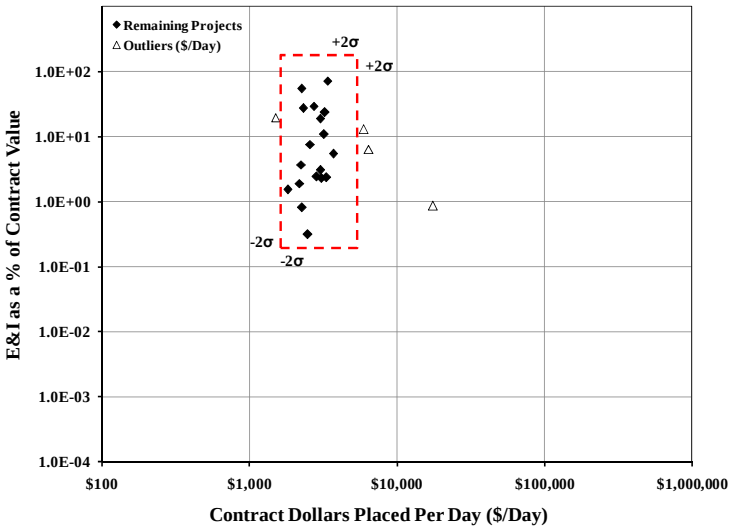
igure G-16 Stepwise Flowchart illustrating Procedural Parts and Steps to Develop a LD Schedule.

APPENDIX H

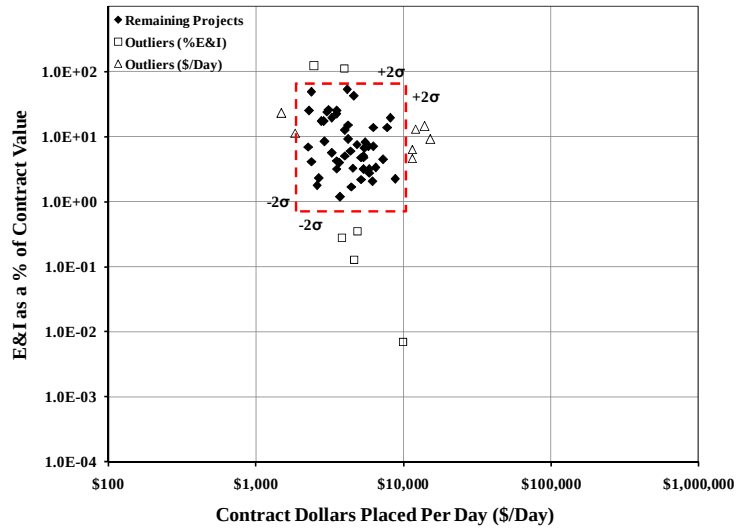
RESULTS OF OUTLIER ANALYSIS

Appendix H includes the graphical results of the outlier analysis performed in Part 2 of the revised methodology detailed in Appendix G on both C/W projects. Figures H-1(a) through H-1(h) show the limiting criteria (i.e. 'E&I as a percentage of contract value' and 'dollars placed per day') represented by dotted lines. From these graphs, all outliers are represented by triangles and squares and can be easily seen since the axes represent both of the evaluated parameters.

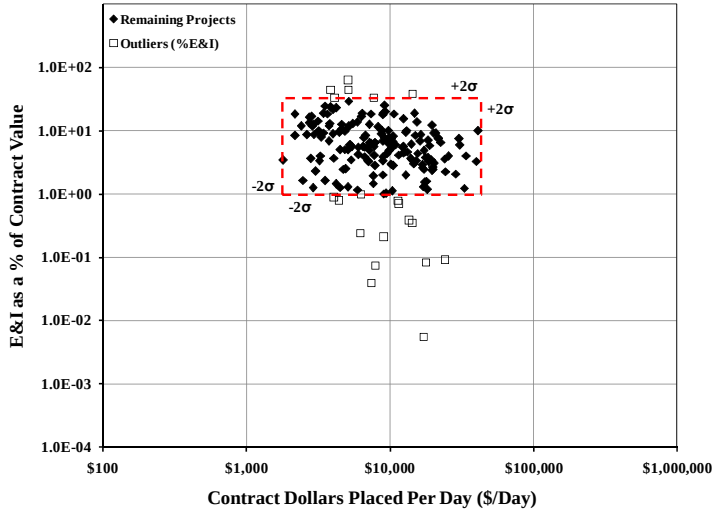
Figures H-2(a) through H-2(f) illustrate the results for calendar day/date projects after performing the outlier analysis.



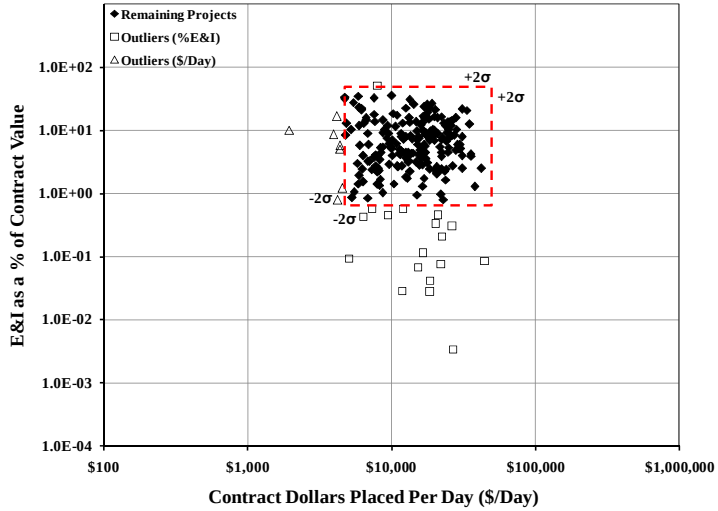
(a) CV Range 1: $0 to $100,000



(b) CV Range 2: $100,000 to $200,000

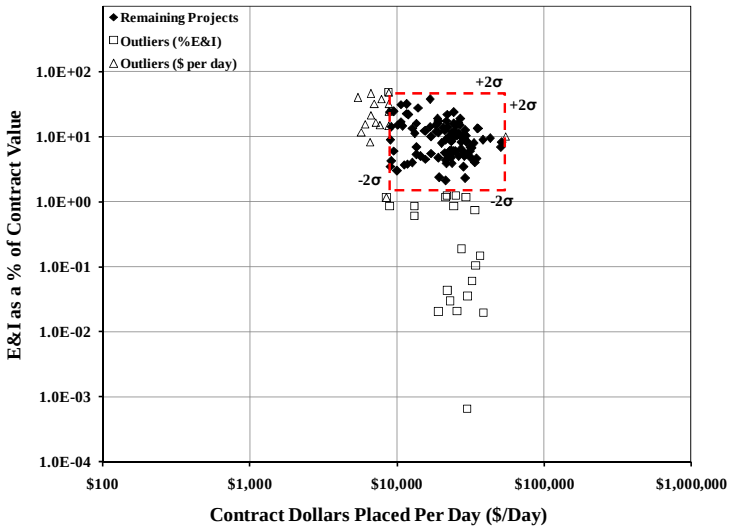


(c) CV Range 3: $200,000 to $500,000

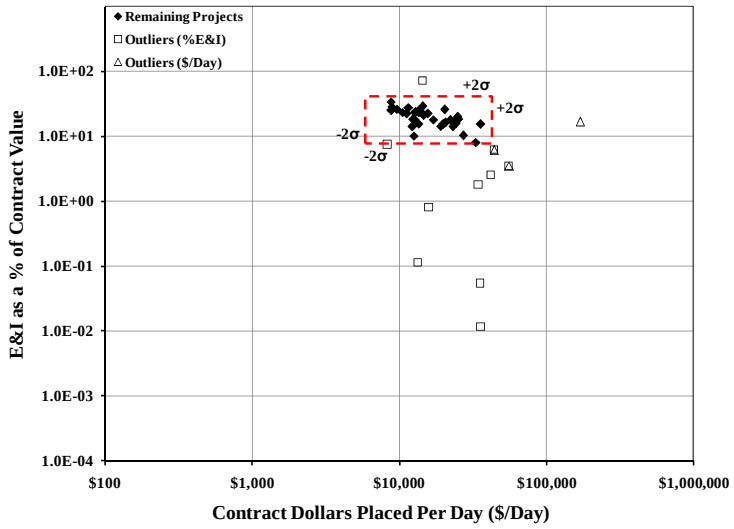


(d) CV Range 4: $500,000 to $1,000,000

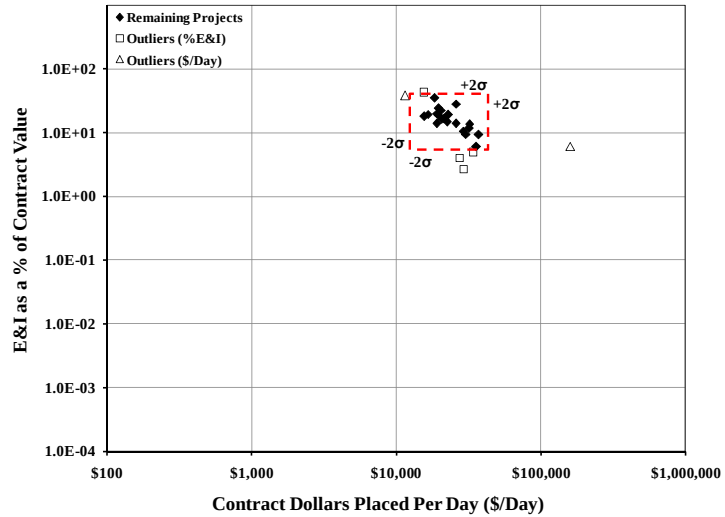
Figure H-1 Result of Outlier Analysis Performed by Individual Contract Value Ranges [*Work Day Projects*]



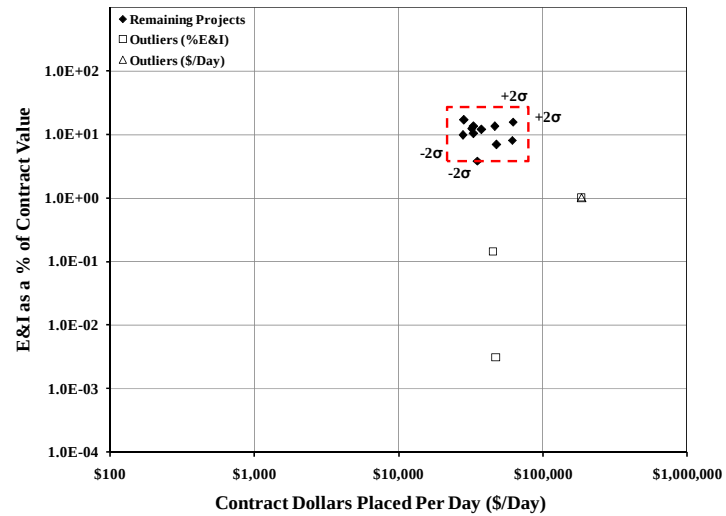
(e) CV Range 5: $1,000,000 to $2,000,000



(f) CV Range 6: $2,000,000 to $5,000,000

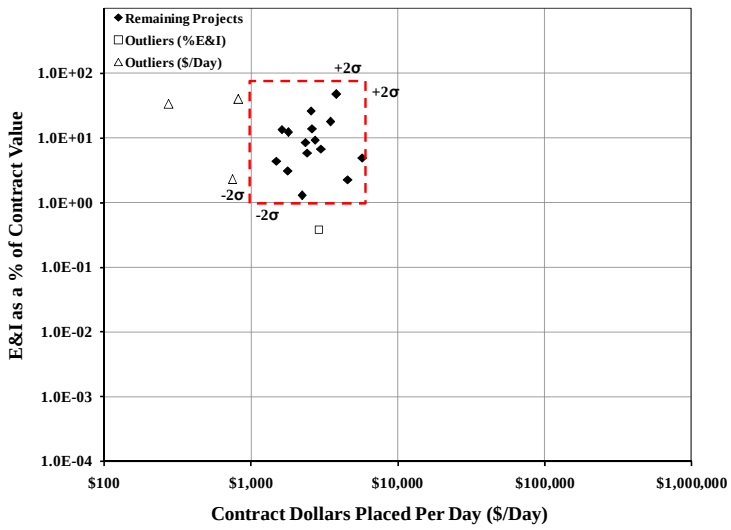


(g) CV Range 7: $5,000,000 to $10,000,000

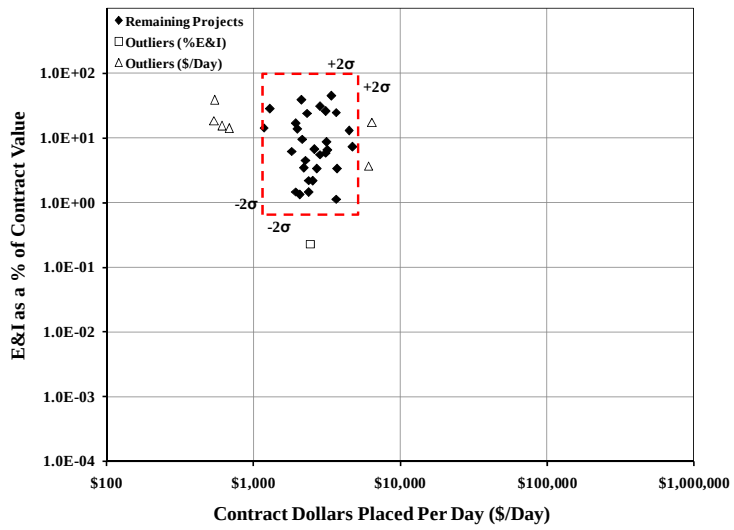


(h) CV Range 8: $10,000,000 and Greater

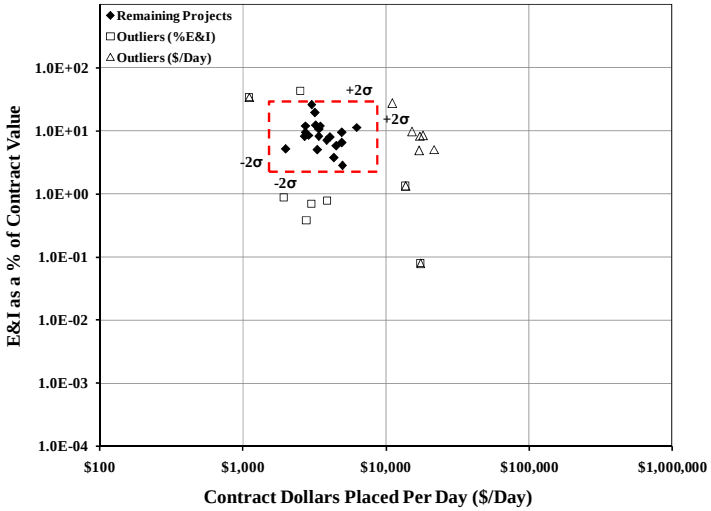
Figure H-1 Result of Outlier Analysis Performed by Individual Contract Value Ranges [*Work Day Projects*] (cont'd)



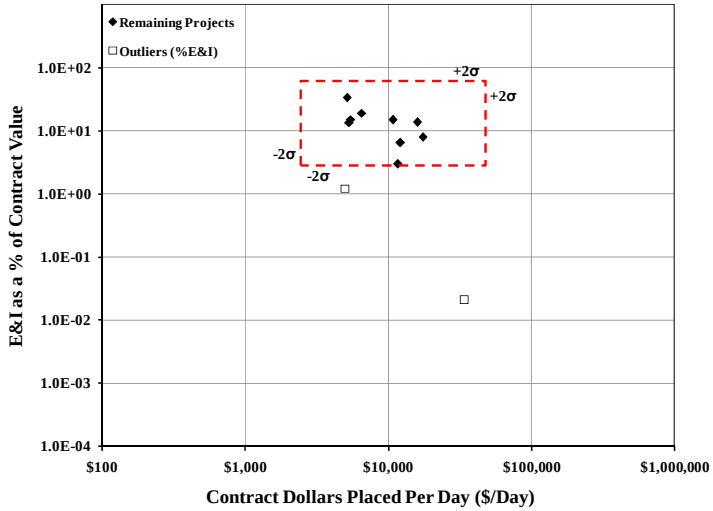
(a) CV Range 1/2: $0 to $200,000



(b) CV Range 3: $200,000 to $500,000

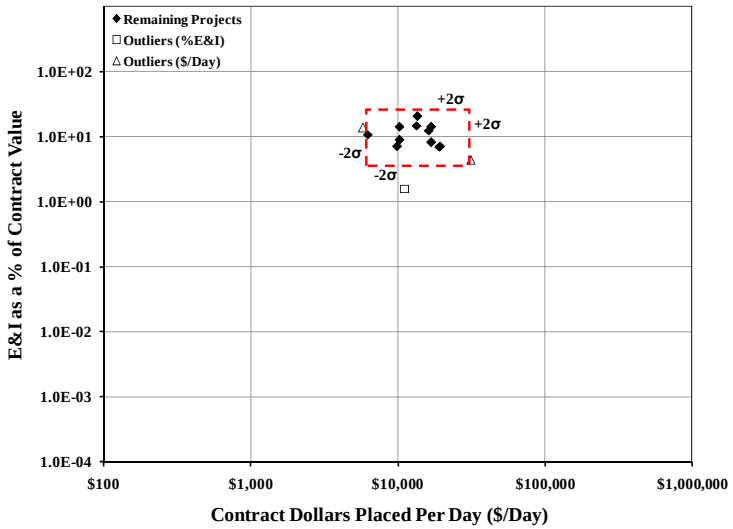


(c) CV Range 4: $500,000 to $1,000,000

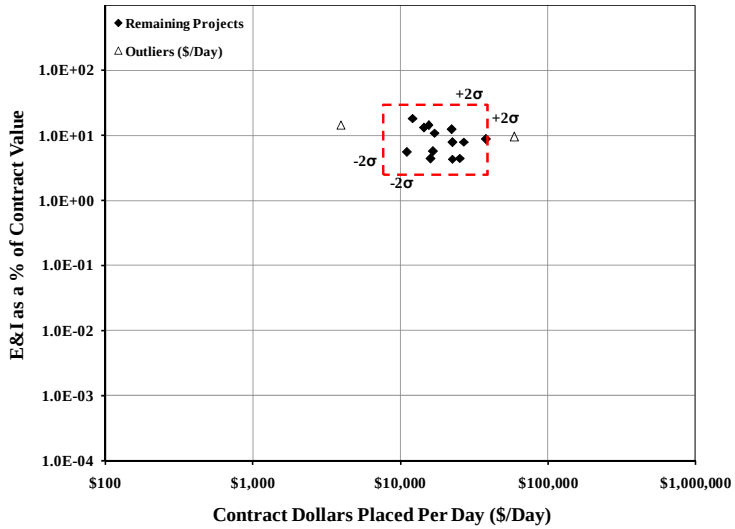


(d) CV Range 5: $1,000,000 to $2,000,000

Figure H-2 Result of Outlier Analysis Performed by Individual Contract Value Ranges [*Calendar Day/Date Projects*]



(e) CV Range 6: $2,000,000 to $5,000,000



(f) CV Range 7/8: $5,000,000 and Greater

Figure H-2 Result of Outlier Analysis Performed by Individual Contract Value Ranges [*Calendar Day/Date Projects*] (cont'd)

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APPENDIX I

RESULTS OF THE KRUSKAL WALLIS TEST

PERFORMED IN MINITAB™

Appendix I provides a summary of results obtained from the MiniTab™ report regarding the Kruskal-Wallis test performed on the data in Part 4 of the revised methodology outlined in Appendx G. The statistical results are summarized by Work Day projects and then by Calendar Day/Date projects.

Kruskal-Wallis Test: Daily E&I versus Contract Size [*Work Day Projects*]

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Kruskal-Wallis Test on Daily E&I

Size      N  Median  Ave Rank      Z
1        18   143.1      26.9  -1.60
2        47   266.7      35.3   1.60
Overall  65              33.0

H = 2.55  DF = 1  P = 0.110
-------------------------------------
Kruskal-Wallis Test on Daily E&I

Size       N  Median  Ave Rank      Z
 3       167   492.8     126.6   3.66
12        65   256.5      90.6  -3.66
Overall  232             116.5

H = 13.41  DF = 1  P = 0.000
-------------------------------------
Kruskal-Wallis Test on Daily E&I

Size       N  Median  Ave Rank      Z
3        167   492.8     151.4  -5.80
4        207   974.7     216.6   5.80
Overall  374             187.5

H = 33.69  DF = 1  P = 0.000
-------------------------------------
Kruskal-Wallis Test on Daily E&I

Size       N  Median  Ave Rank      Z
4        207   974.7     133.2  -6.20
5        103  1980.2     200.3   6.20
Overall  310             155.5

H = 38.47  DF = 1  P = 0.000
-------------------------------------
Kruskal-Wallis Test on Daily E&I

Size       N  Median  Ave Rank      Z
5        103    1980      60.6  -4.30
6         34    3071      94.4   4.30
Overall  137              69.0

H = 18.45  DF = 1  P = 0.000
-------------------------------------
Kruskal-Wallis Test on Daily E&I

Size      N  Median  Ave Rank      Z
6        34    3071      24.1  -2.29
7        21    3570      34.3   2.29
Overall  55              28.0

H = 5.23  DF = 1  P = 0.022
-------------------------------------
Kruskal-Wallis Test on Daily E&I

Size      N  Median  Ave Rank      Z
7        21    3570      15.1  -1.13
8        11    4398      19.1   1.13
Overall  32              16.5

H = 1.28  DF = 1  P = 0.258
-------------------------------------
```

Kruskal-Wallis Test: Daily E&I versus Contract Size [*Calendar Day/Date Projects***]**

```
-------------------------------------
Kruskal-Wallis Test on Daily E&I

Size      N  Median  Ave Rank      Z
 3       29   182.7      22.1  -0.31
12       15   218.0      23.3   0.31
Overall  44              22.5

H = 0.10  DF = 1  P = 0.757
-------------------------------------
Kruskal-Wallis Test on Daily E&I

Size      N  Median  Ave Rank      Z
  4      20   295.6      38.6   1.78
123      44   203.3      29.7  -1.78
Overall  64              32.5

H = 3.17  DF = 1  P = 0.075
-------------------------------------
Kruskal-Wallis Test on Daily E&I

Size      N  Median  Ave Rank      Z
   5      9  1247.8      64.2   4.11
1234     64   249.1      33.2  -4.11
Overall  73              37.0

H = 16.90  DF = 1  P = 0.000
-------------------------------------
Kruskal-Wallis Test on Daily E&I

Size      N  Median  Ave Rank      Z
5         9    1248       9.1  -0.95
6        11    1394      11.6   0.95
Overall  20              10.5

H = 0.90  DF = 1  P = 0.342
-------------------------------------
Kruskal-Wallis Test on Daily E&I

Size      N  Median  Ave Rank      Z
56       20    1375      15.4  -1.22
78       13    1867      19.5   1.22
Overall  33              17.0

H = 1.48  DF = 1  P = 0.224
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```