Examining Engineering Costs for Development of Highway Projects

Technical Report 0-6730-1

Cooperative Research Program

TEXAS STATE UNIVERSITY SAN MARCOS
DEPARTMENT OF ACCOUNTING
SAN MARCOS, TEXAS

in cooperation with the
Federal Highway Administration and the
Texas Department of Transportation
http://tti.tamu.edu/documents/0-6730-1.pdf

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/TX-13/0-6730-1		

4. Title and Subtitle
EXAMINING ENGINEERING COSTS FOR DEVELOPMENT OF HIGHWAY PROJECTS

5. Report Date
Published: December 2012

6. Performing Organization Code

7. Author(s)
Roselyn E. Morris, Lucille Montondon, and Kathleen Moffitt

8. Performing Organization Report No.
Report 0-6730-1

9. Performing Organization Name and Address
Texas State University-San Marcos
601 University Drive
San Marcos, TX 78666

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
Project 0-6730

12. Sponsoring Agency Name and Address
Texas Department of Transportation
Research and Technology Implementation Office
P.O. Box 5080
Austin, Texas 78763-5080

13. Type of Report and Period Covered
Technical Report:
December 2010–August 2012

14. Sponsoring Agency Code

15. Supplementary Notes
Project performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration.
Project Title: Examining Engineering Costs for Development of Highway Projects
URL: http://tti.tamu.edu/documents/0-6730-1.pdf

16. Abstract
The Texas Department of Transportation (TxDOT) commissioned a research team at Texas State University-San Marcos Department of Accounting to analyze the cost of projects by determining the cost of a preliminary engineering hour necessary to develop highways projects. The current study determined the cost of engineering design on an hourly basis using comparable direct and indirect cost definitions and allocations as used by external consulting engineering firms. The analysis consisted of three tasks:

- Task 1: Determine average TxDOT cost per engineering hour.
- Task 2: Determine the typical cost of design engineering team members.
- Task 3: Determine the challenges of comparing costs to the private sector, which included analysis and comparison of the various overhead rates.

17. Key Words
Costs, Cost Allocation, Direct, Indirect

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	58	

EXAMINING ENGINEERING COSTS FOR DEVELOPMENT OF HIGHWAY PROJECTS

by

Roselyn E. Morris, PhD, CPA
Lucille Montondon, PhD
Kathleen Moffitt, MAcy, CPA

Department of Accounting
McCoy College of Business

Report 0-6730-1
Project 0-6730
Project Title: Examining Engineering Costs for Development of Highway Projects

Performed in cooperation with the
Texas Department of Transportation
and the
Federal Highway Administration

Published: December 2012

Texas State University-San Marcos
601 University Drive
San Marcos, TX 78666

TEXAS STATE UNIVERSITY
SAN MARCOS
The rising STAR of Texas

DISCLAIMER

ACKNOWLEDGMENTS

This project was conducted in cooperation with TxDOT and FHWA. The authors thank the project director and members of the Project Monitoring Committee.

TABLE OF CONTENTS

Executive Summary **1**
Background 1
Scope of Review 1
Study Team Approach 2
Results 3
Limitations and Challenges 5

Background **7**
Previous Studies 8
Texas A&M Transportation Institute 8
Office of the State Auditor 8
PricewaterhouseCoopers 9
Reznick Group 9
Out of State Studies 9

Scope of Review **11**
Task 1: Determine Total TxDOT Cost per Engineering Employee 11
Task 2: Determine the Typical Cost of the Relevant Employees Identified 12
Task 3: Analyze and Compare the Various Overhead Rates 12

Study Team Approach **13**
Phase I – Discovery Phase and Identification of Variables and Assumptions 14
Direct Labor Costs 14
Indirect Costs 14
Design Project Team Members 16
Phase 2 – Calculating a Preliminary Engineering Cost (PE) per Hour Using Two Different Approaches and Annual Costs of a Design Team Member 17
Indirect Cost Allocations, Assumptions and Calculations 17
Annual Costs of Design Team Members - Assumptions and Calculations 18
Overhead Rates 18

Results and Limitations **21**
Task 1: Determine Total TxDOT Cost to the Taxpayer per Engineering Employee 21
Results 21
Task 2: Determine the Typical Cost of Engineering Team Members 21
Results 21
Task 3: Analyze and Compare the Various Overhead Rates 22
Results 22
Limitations 23

Challenges **27**

Appendix A – Cost Accounting Glossary **29**

Appendix B – Tables **31**

Appendix C – Detailed Calculation Methods **45**

EXECUTIVE SUMMARY

BACKGROUND

The Texas Department of Transportation (TxDOT) is committed to act in the best interest of the citizens of Texas in every endeavor. TxDOT's administration is actively engaged in determining the appropriate engineering staff levels to conduct the business of the department efficiently while adhering to applicable laws and regulations. TxDOT's administration realizes the value of both in-house staff and consultant staff in conducting the business of the state. Both internal and external engineering staffs are critical to provide efficient and effective engineering services.

TxDOT keeps all cost accounting information in Financial Information Management System (FIMS), its accounting system of record. TxDOT each year develops its fully loaded cost of engineering services through a payroll additive. This method allows TxDOT to maximize federal highway fund reimbursements and be consistent in billing other government agencies or private citizens. The method consists of determining a payroll additive for all personnel related indirect costs (vacation, training, pension, sick leave, holidays, etc.) to be added to each labor hour cost with all other indirect costs allocated based upon engineering project costs. External engineering firms collect all indirect costs, including personnel related indirect costs (vacation, pension, insurance, etc.), and allocate based upon direct engineering hours.

TxDOT projects include preliminary design and other engineering work that is performed by either the public sector (TxDOT employees) or the private sectors (consultant engineers). There have been many studies, in Texas and in other states, to review the total cost of public sector work and in some studies, compare these to the cost of private sector work. This research documents several of those studies, including the report commissioned by the Texas Comptroller of Public Accounts, as directed by Rider 57 during the 2009 Legislative session.

The previous studies faced many challenges in comparing the public sector to the private sector costs. First, the cost accounting methods of the two sectors are not comparable and not easily converted from one method to another. Second, information needed to convert from one accounting method to another required data that was not retained, acquired, provided, or stored so that comparison could be made concurrently or in the future. The main challenge was due to differences in definitions and allocations of indirect costs between in-house (TxDOT or public sector) and externally contracted engineering services. This study utilized a joint working group comprised of the American Council Engineering Companies (formerly Consultant Engineering Council), TxDOT representatives, and Texas State University-San Marcos Department of Accounting. The joint working team agreed upon common definitions and allocations of costs so that TxDOT preliminary engineering cost per hour could be compared to an external consultant's cost per hour.

SCOPE OF REVIEW

TxDOT commissioned a research team at Texas State University-San Marcos Department of Accounting to analyze the cost of projects by determining the cost of a preliminary engineering hour necessary to develop highways projects. The objective of the current study was to determine the cost of engineering design on an hourly basis using comparable direct and indirect cost definitions and allocations as used by external consulting engineering firms. This was a follow up study to the Rider 57 study undertaken by the Comptroller of Public Accounts and the Reznick Group in January 2010 and was performed in consultation with the Texas Department of Transportation, the American Council of Engineering Companies (ACEC, formerly Consultant Engineer Council (CEC)), and the Texas State research team.

The team used preliminary design engineering direct and indirect costs for the 2010 fiscal year to determine common definitions and allocations of costs to align TxDOT and external consultants' methods. Cost data from the 2011 fiscal year and details of the Waco district office were added to refine the methodology of converting the TxDOT method to a method comparable with external consultants represented by the ACEC.

The analysis consisted of three tasks:

- Task 1: Determine average TxDOT cost per engineering hour;
- Task 2: Determine the typical cost of design engineering team members; and
- Task 3: Determine the challenges of comparing costs to the private sector, which included analysis and comparison of the various overhead rates.

STUDY TEAM APPROACH

The research team of external consultants, ACEC representatives, TxDOT representatives, and Texas State representatives met to gain an understanding of the TxDOT accounting system and to agree on definitions and treatment of indirect costs. A glossary of agreed upon accounting terminology is provided in Appendix A.

This study examined all of the direct and indirect costs associated with maintaining an engineering employee who does preliminary design engineering at TxDOT. These costs included salary, retirement contributions, insurance, computers, software, equipment, office space, training, support (human resources, finance, supervision, public relations, etc.), leaves, (vacation, sick, military, etc.) and other costs.

TxDOT currently accounts for costs and makes allocations to maximize Federal Highway dollars. This method considers direct labor costs to include both direct labor salary costs and benefits. The indirect costs are allocated on total engineering costs. External consultants allocate indirect costs on direct engineering hours.

Two different approaches were used to calculate a preliminary engineering cost (PE).

Approach 1 mimicked the approach of consultants by using total engineering costs from the previous fiscal years and allocating indirect costs based on total direct engineering (labor) hours.

Approach 2 used detailed costs from three district offices in 2010 and four district offices in 2011 to capture the relevant costs and determine the cost per hour of preliminary engineering. Three districts were selected for extensive examination because of the diversity among districts across the state. One represented a large metropolitan area (Dallas), a mid-sized metropolitan area (Beaumont), and the last a rural area (Odessa). The Waco office was analyzed in 2011 in addition to the previous three offices since Waco had numerous projects (both in-house and external) during the time period examined. The data from these district offices were used to calculate average costs per direct engineering hour that could then be used in subsequent calculations and serve as a check of TxDOT as a whole.

Engineering project teams are used in both in-house and out-sourced engineering and design services for transportation projects. A project team may be as few as two individuals or may be comprised of many individuals with the same and/or different titles working on complex transportation projects. The implied overhead and utilization rates from the above calculation were applied to per hour costs for each role; these rates include numerous assumptions which inflated the overhead rates while the utilization rate understated the overhead rates.

RESULTS

Approach 1 used direct labor costs and hours charged to specific projects. The direct labor costs were combined with the indirect costs of benefits, office space costs, division and district general and administrative allocation, resident engineer overhead, and other preliminary engineering costs. A table detailing Approach 1 is found in Appendix B as Table 3 for 2010 and Table 4 for 2011. Approach 2 combined the cost per productive hour plus training costs, human resource costs, benefit costs, technology costs and cost of office space (the cost to the state of Texas to employ a Professional Engineer in each of the three districts examined). A table detailing Approach 2 is found in Appendix B in Table 5 for 2010 and Table 6 for 2011. Table 7 details the assumptions made for Approach 2.

A comparison of preliminary engineering per hour costs in Approach 1 and 2 for 2010 and 2011 is shown in Table 13.

Table 13
Texas State University-San Marcos
Comparison of Approach 1 and Approach 2
PE Cost per Hour

		2010		2011
Approach 1	$	114.44	$	120.19
Approach 2				
Dallas	$	108.95	$	107.47
Beaumont	$	124.81	$	118.54
Odessa	$	118.29	$	120.33
Waco		-	$	102.60

The research team then examined the salaries of those with different job titles fulfilling various roles on engineering project teams. The overhead and utilization rates, determined in Task 1, were applied to per hour costs for each role. TxDOT provided the research team with monthly salary information and approximate design team roles by job classification for all 25 district offices. Table 8 and 9 in Appendix B summarize the per hour costs and range of per hour costs across the offices of Dallas, Beaumont, and Odessa of each design team role for FY 2010 and offices of Dallas, Beaumont, Odessa, and Waco for FY 2011, using several assumptions discussed later in the report. Tables 10 and 11 in Appendix B detail the team descriptions for 2010 and 2011. The table below summarizes the per hour costs and range of per hour costs across the offices of Dallas, Beaumont, and Odessa of each design team role using the assumptions discussed above. The table compares Tables 8 for 2010 and 9 for 2011 from Appendix B.

Table 14
Costs of Engineering Project Team Roles

	2010		2011	
Project Team Role	**Average of all TxDOT Offices Per Hour Costs**	**Range of Averages Across 3 Offices**	**Average of all TxDOT Offices Per Hour Costs**	**Range of Averages Across 3 Offices**
Design Team Leader (PE) *(Professional or Engineer VI, VII)*	$ 137.69	$128.49 - $155.34	$143.41	$135.87- $158.87
Design Team Member (PE) *(Professional or Engineer III, IV, V, VI)*	$ 112.08	$107.92 - $116.03	$116.44	$112.85- $121.99
Engineering Assistant (Grad. Engr. Non-PE) *(Professional or Engineer I,II, III)*	$ 92.67	$ 84.63 - $97.07	$98.12	$86.55- $101.37
Lead Design Technician or Specialist (Non Engr.)	$ 99.44	$83.02 - $98.61	$103.07	$87.80- $114.65
Mid-grade Design Technician (Non Engr.)	$ 81.74	$79.80 - $89.15	$84.79	$80.29- $87.96
Entry Level Design Technician (Non Engr.)	$ 63.89	$60.12 - $71. 35	$66.60	$63.25- $73.15

TxDOT utilizes the payroll additive or the federal composite rate as its overhead rate. This captures the fringe benefits and personal time leaves of employees. Task 1 and 2 calculated an implied overhead based on project costs or direct labor hours. A comparison of the payroll additive with the calculated overhead rates from Approach 1 and 2 are presented in the table below.

Table 15 Comparison of Overhead Rates	2010	2011
Federal Composite Rate or Payroll Additive	171.61%	175.77%
Approach 1	285.76%	286.91%
Approach 2		
Dallas	245.78%	242.40%
Beaumont	287.89%	286.50%
Odessa	293.68%	292.42%
Waco	-	245.75%

LIMITATIONS AND CHALLENGES

The study calculated the per hour cost for a preliminary engineering design hour under two different approaches and the in-house per hour costs of engineering project team titles. These calculations may be used to make decisions on whether to out-source or utilize in-house design engineering. However, these costs should not be confused with avoidable costs per hour. That is, TxDOT could not out-source all preliminary engineering design work and not incur in-house engineering design costs (most notably TxDOT would still have to oversee the out-sourced work, provide legal and public safety oversight). Strategic considerations regarding out-sourcing versus in-house costs include the quality of work, expertise needed, TxDOT workload, relationships with contractors, and project completion timeline.

The study employed different overhead rates in the calculations. TxDOT uses the payroll additive as its basic overhead rate. The payroll additive is limited to benefits, PTO and other personnel costs. This additive is just one component of the overhead rates calculated in Approach 1 and 2. Approaches 1 and 2 included a non-cash rent proxy which inflates the overhead rates. Approach 1 allocated overhead in three methods and Approach 2 allocated overhead based upon direct labor hours and employed a utilization rate of 75 percent. If the utilization is assumed to be too high or low, the overhead rates will be understated or overstated, respectively. Thus, these three rates are not comparable.

The team faced many challenges in the process of completing this study, including the accessibility of meaningful data in the TxDOT accounting data and the accessibility of detailed information on costs incurred by out-sourced projects. The FIMS system automatically adds the payroll additive to each labor hour costs that is incurred on projects. Thus, the total additive must be removed from the calculations and then some components added back to get base salary per hour.

This study and previous studies have tried to compare the cost of a project using in TxDOT labor versus external consultant labor. This has proved to be difficult. Once a project has been contracted with external consultants, the information provided in the billing has been inconsistent in the past. Valuable information, such as direct labor hours by design team classification, was previously not included in all billings. This made comparisons between TxDOT and external consultants difficult. TxDOT and consultants have been working together over the past few years to standardize forms and procedures to make the process simpler and easier to understand for all stakeholders. Continued improvements to the process are planned for the future.

BACKGROUND

The Texas Department of Transportation (TxDOT) is committed to act in the best interest of the citizens of Texas in every endeavor. TxDOT's administration is actively engaged in determining the appropriate engineering staff levels to conduct the business of the department efficiently while adhering to applicable laws and regulations. TxDOT's administration realizes the value of both in-house staff and consultant staff in conducting the business of the state. Both internal and external engineering staffs are critical to provide efficient and effective engineering services.

Numerous studies, including one conducted by the Comptroller of Public Accounts in response to Rider 57 from the 2009 Legislative session, have compared the engineering costs for projects internally developed by staff with those externally developed by consultants. Despite these numerous studies, questions remained.

Several issues contribute to this uncertainty; these include a lack of readily available data, the fact that many projects are developed partially internally and partially externally, different accounting methods between the public and private sector, and a lack of definition as to which costs should be included for a complete analysis. TxDOT accounting systems are based on maximizing Federal Fund reimbursements.

Since September 1, 1997, state law requires that 35 percent of appropriated funds in specific strategies are to be expended by private sector providers for engineering-related services. Specifically section 223.041 of the Texas Transportation Code states that:

> Sec. 233.041 ENGINEERING AND DESIGN CONTRACTS. (a) The department shall use private section engineering-related services to assist in accomplishing its activities in providing transportation projects. For the purpose of this section, engineering-related services means engineering, land surveying, environmental, transportation feasibility and financial, architectural, real estate appraisal, and material laboratory services. These engineering-related services are for highway improvements, right-of-way acquisition, and aviation improvements.
>
> (b) The department, in setting a minimum level of expenditures in these engineering-related activities that will be paid to the private section providers, shall provide that the expenditures level for a state fiscal year in all strategies paid to private sector providers for all department engineering-related services for transportation projects is not less that 35 percent of the total funds appropriates in Strategy A.1.1. Plan/Design/Manage and Strategy A.1.2. of the General Appropriations Act for that state fiscal biennium. The department shall attempt to make expenditures for engineering-related services with private section providers under this subsection with historically underutilized businesses, as defined by Section 2161.001, Government Code, in an amount consistent with the applicable provision of the Government Code, any applicable state disparity study, and in accordance with the good-faith-effort procedures outlines in the rules adopted by the comptroller.
> (Http://www.statutes.legis.state.tx.us/Docs/TN/htm/TN.223.htm#223.041)

In procuring professional engineering services, Sections 2254.003 and 2254.004 of the Texas government Code require a state agency first to select the most highly qualified provider of those services on the basis of demonstrated competence and qualifications, and then attempt to negotiate with the provider a contract at a fair and reasonable price.

This study utilized a joint working group comprised of consultants representing the American Council of Engineering Companies (formerly Consultant Engineering Council), TxDOT representatives, and the Texas State University-San Marcos Department of Accounting. The joint working team determined common definitions of costs so that a TxDOT preliminary engineering cost per hour could be compared to a consultant's cost per hour. The Research Project Team consisted of Susie Albright, Ken Barnett, David Casteel, Bob Cuellar, Glen Knipstein, Sandra Kaderka, Teresa Lemons, Raymond Martinez, Kef Mason, Roselyn Morris, Matthew Sansone, Steve Stagner, Robert Stuard, Duane Sullivan, Paul Summerbell, and Camille Thomason. Team composition changed over time. Additional review was provided by Colin Parish, John Barton, Mark Marek, Mike Lehmann, Phil Wilson, and other engineers.

This study includes a discussion of previous studies, the current study approach, as well as results and limitations of the study.

PREVIOUS STUDIES

Over the past 25 years, TxDOT has sponsored studies to examine the fully loaded cost of engineering services. Four studies, with findings and limitations are summarized below. Additionally, two out-of-state studies are summarized for application to TxDOT.

Texas A&M Transportation Institute

Texas A&M Transportation Institute analyzed the cost, quality, and policy of using consulting services in a report released in May 1987. The study examined the use of external consultants for complex projects requiring particular expertise or specialized equipment, or when TxDOT did not have the capacity to perform the project in a timely manner. The study analyzed projects in pairs, comparing in-house projects with out-sourced projects. The study included training, operating supplies, safety, supervision, indirect labor, overtime premiums, fringe benefits and travel as components of overhead costs. The limitations of the study include lack of quality assessments, personnel, and size of the projects. Project characteristics were not consistent across all projects and likely not generalizable. The study concluded that the cost of using state engineers was lower than the cost of external consultants.

Office of the State Auditor

The Office of the State Auditor reported on the engineering costs at TxDOT in August 1997. At the time, statute did not require a minimum of 35 percent of certain strategy appropriations to be contracted engineering services. The department often out-sourced the work based on workload, staff availability, expertise, and time constraints. Under the law, the department was required to achieve a balance in the use of TxDOT employees and private contractors, if the cost for preliminary, construction, and design engineering services were equivalent. The objectives of the study were to evaluate the methodologies for ensuring compliance with achieving a balance of out-sourced work and to identify costs which should be used in determining whether the cost of in-house and consultant services were equivalent. Overhead costs included utilities, phone and communications, distributed service center costs and indirect administration costs such as accounting, human resources, executive office and direct administration. The limitations of the study included incorrect allocation of costs between the segments of a project and inaccurate calculations of indirect cost rates. The study recommended that the department improve its cost allocation process to provide decision-makers inside and outside the department with more relevant, reliable information about the costs of its products and services. The conclusion of the study was that the methodology of determining preliminary engineering costs data may be acceptable for some purposes, but was not appropriate for cost-based decisions which require a more equitable distribution of indirect costs. The department's response to this study was that the procedures in use were consistent with standard procedures in out-sourcing analyses.

PricewaterhouseCoopers

TxDOT requested that PricewaterhouseCoopers (PwC) conduct a comparative study of in-house and contract preliminary engineering and design work in February 1999. Cost comparisons were made from the perspective of the Texas taxpayer. Costs were analyzed and associated with processes, not broken down into direct and indirect costs for 13 different design categories. The study employed a reallocation of certain overhead costs based on cause and effect relationships, which may change over time. It concluded that out-sourced costs are higher than in-house costs for a majority of the design categories. If out-sourced or in-house costs were greater was indeterminate in the remaining design categories.

Reznick Group

The 2009 Texas Legislature directed the Comptroller of Public Accounts to examine engineering staffing patterns at TxDOT in highway, bridge, and maintenance operations. Reznick Group conducted the study to determine the incremental benefits of using outside consultants rather than TxDOT personnel. Indirect costs were defined as equipment operations, maintenance, depreciation costs, fringe benefits, and salary costs for management and support personnel. The data collected by TxDOT was not easily comparable to consultants' data because of differing accounting methods and allocations of components in determining costs. This incomparability prevented any conclusions from being drawn.

Out of State Studies

A study by New York University (NYU) examined the New York State Department of Transportation. This study compared the cost of public-sector design work performed in-house versus out-sourcing. Both functional and administrative overheads were analyzed. There were considerable differences in the allocation methods between the public-sector in-house and out-sourced work. These allocation differences resulted in variability of the estimates used to determine the in-house design cost of an average employee. The study concluded that the cost of an in-house design engineer exceeds that of a private design engineer.

The University of California, Berkeley examined the pay and benefits of public sector workers in the State of California compared to those in the private sector, and investigated whether California public employees are overpaid at the expense of California taxpayers. Note that this study was of all public employees, not just transportation or design engineers. Regression adjusted analysis was used to compare the compensation package of public versus private sector employees. Overhead was not separately addressed in the study.

The study made many assumptions on the human capital and fundamental personal characteristics of full-time public and private sector employees. Most California public employees are unionized which allows for those with a high school education or less to earn considerably more than their private sector counterparts, while college educated public sector employees earn considerably less than their private sector counterparts.

The conclusion of the study was that public employees in California are neither overpaid nor overcompensated. Wages received by California public employees are about 7% lower, on average, than wages received by comparable private sector employees; however, public employees receive more generous benefits.

A summary of these studies can be found in Tables 1 and 2 in Appendix B.

SCOPE OF REVIEW

Texas Department of Transportation (TxDOT) commissioned a research team from Texas State University-San Marcos Department of Accounting to analyze the cost of a preliminary engineering hour in developing highways projects. This was a follow up study to the Rider 57 study undertaken by the Comptroller of Public Accounts and the Reznick Group in January 2010. The objective of the current study was to determine the cost of an engineering design on an hourly basis using the direct and indirect cost definitions and allocations as used by external consulting engineering firms. The work performed in this study was performed in consultation with the Texas Department of Transportation, the American Council of Engineering Companies (ACEC, formerly Consultant Engineering Council (CEC)), and the Texas State research team.

TxDOT employs a fully loaded cost of engineering services. This method allows TxDOT to maximize federal highway fund reimbursements and be consistent in billing other government agencies or private citizens. The method consists of determining a payroll additive for all personnel related indirect costs (vacation, training, pension, sick leave, holidays, etc.) to be added to each labor hour cost with all other indirect costs allocated based upon engineering project costs. External engineering firms collect all indirect costs, including personnel related indirect costs, and allocate based upon direct engineering hours.

The direct and indirect costs of preliminary design engineering for the 2010 fiscal year were used by the team to determine common definitions and allocations of costs to align TxDOT and external consultants accounting methods. The study was expanded to include the 2011 fiscal year and to refine the methodology to convert from the TxDOT method of automatically adding a payroll additive to a method comparable with external consultants represented by the CEC.

The analysis was to be conducted in several parts:

TASK 1: DETERMINE TOTAL TXDOT COST PER ENGINEERING EMPLOYEE

The team agreed that the average cost of an engineering hour was the desired outcome. Total cost was calculated as the sum of all direct and indirect costs for maintaining an engineering employee at TxDOT. These costs included, but not limited to:

- Salary
- Retirement contributions
- Insurance
- Hardware (computers, survey equipment, pickup trucks including fuel and servicing, etc.)
- Software (computer programs, computer updating and services)
- Accommodations (Building, HVAC, security, etc.)
- Training
- Support (Human resources, Finance, Supervision, Public Relations, etc.)
  Leave
- Retiree Insurance Contributions
- Others to be determined and assigned using cost allocation methodologies generally accepted as standards in determining private sector costs

TASK 2: DETERMINE THE TYPICAL COST OF THE RELEVANT EMPLOYEES IDENTIFIED

- Design Team Leader (Professional Engineer)
- Design Team members that are Professional Engineers
- Engineering Assistant (Graduate Engineers that are not registered as Professional Engineers)
- Lead Design Technician or Specialist (non Engineers)
- Mid grade Design Technician (non Engineers)
- Entry Level Design Technician (non Engineers)

TASK 3: ANALYZE AND COMPARE THE VARIOUS OVERHEAD RATES

- Payroll Additive
- Indirect Costs Allocated Based upon Total Engineering Costs
- Indirect Costs Allocated Based upon Direct Engineering Hours

STUDY TEAM APPROACH

The research team organized the work into three phases.

Phase 1 consisted of meetings to obtain agreement on common cost accounting variables and assumptions. The resulting Cost Accounting Glossary can be found in Appendix A.

Phase 2 consisted of gaining an understanding of the TxDOT cost accounting practices as compared to the cost accounting practice of external consulting engineering firms. The external consulting engineering firms use the American Association of State Highway and Transportation Officials *Uniform Audit and Accounting Guide* as the industry practice guide. This phase included the collection of TxDOT cost accounting information and allocations, detailed costs of specific offices and direct engineering hours for the fiscal years. The data was used to calculate the average cost of an engineering hour and the annual costs of design team members. In addition, an analysis and comparison of the various overhead rates implied or developed in phase 2 was conducted. Findings, observations, methodology, challenges and future considerations are presented in the sections below.

TxDOT currently accounts for costs and makes allocations to maximize Federal Highway dollars and to be consistent in billing of services to other state agencies or citizens. This method considers direct labor costs to include both direct labor salary costs and benefits with the allocation of other indirect costs based on total engineering costs. External engineers, however, allocate based upon engineering direct labor hours. TxDOT benefit costs are applied to labor hours as a payroll additive. The payroll additive or federal composite rate includes longevity, leave times or PTO, retirement matching, benefit replacement, state portion of FICA, worker's compensation, compensatory time, health insurance, unemployment insurance, and overtime pay. A challenge for this and other studies is the Financial Information Management System (FIMS) automatically applies the payroll additive to labor hours and costs before storing the raw data. The direct labor hours and costs without the payroll additive is not available without performing calculations to back out the payroll additive.

Using the costs described above, two different approaches were used to calculate a preliminary engineering (PE) cost per hour. The study examined all of the direct and indirect costs associated with maintaining an engineering employee who does preliminary design engineering at TxDOT.

Approach 1 mimicked the approach of consultants by using total engineering costs from the previous fiscal years and allocating indirect costs based on total direct engineering (labor) hours.

Approach 2 used detailed costs from three to four district offices to capture the relevant costs and determine the cost per hour of preliminary engineering for that office. Because of the diversity among districts across the state, four districts were selected for extensive examination, one representing a large metropolitan area (Dallas), two mid-sized metropolitan areas (Beaumont and Waco (2011 only)), and a rural area (Odessa.). The detailed costs of these different offices were used to develop office averages to compare with the overall TxDOT average from Approach 1 above.

PHASE I – DISCOVERY PHASE AND IDENTIFICATION OF VARIABLES AND ASSUMPTIONS

The research team of external consultants, TxDOT representatives, and Texas State representatives met to gain an understanding of the TxDOT accounting system and to agree on definitions and allocation treatment of indirect costs. A glossary of cost accounting terms can be found in Appendix A. A detail of the calculations and how the adjustments were made to TxDOT data may be found in Appendix F. Below are the variables and assumptions used for the study:

Direct Labor Costs

The base salaries per person for each title were treated as direct labor costs and a base salary cost per productive hour calculated. Base salaries included longevity, benefit replacement and direct overtime pay. A productive hour was time spent on engineering tasks (directly related to engineering design or projects) and not spent on training or personal time off (PTO), or other functions of TxDOT. For Approach 2, the analysis assumed a utilization rate of 75% for each productive hour or the time spent on engineering projects that go to lettings and not work on projects (such as phone calls, meetings, emails, etc., unrelated to engineering projects) that does not go to lettings.

Indirect Costs

Fringe Benefits

Fringe benefits were calculated as the payroll additive of 0.7161 times base pay for 2010, the baseline of the study, and the payroll additive of .7577 times base pay for 2011. The payroll additive was updated each year and included state longevity, leaves (vacation, sick, military, etc.), retirement matching, benefit replacement, state paid portion of FICA, worker's compensation, compensatory time, health insurance premiums, unemployment insurance, retirement dues, longevity and overtime pay. The treatment of this variable was the same whether using Approach 1 or 2.

Division and District G&A

Division and district general and administrative costs, such as the salaries and payroll additive of accounting, human resources, and research personnel, were collected and allocated between preliminary engineering and construction engineering based on direct labor engineering costs for Approach 1. This is the allocation method under FIMS. For Approach 2, the allocation of division general and administrative costs is based on direct labor hours and the allocation of district indirect costs is described below.

Detail of District Indirect Costs

In addition to salaries and payroll additives, the cost of a PE to the state of Texas included various other indirect cost components: human resources, office space, technology support, and training. For Approach 1 these costs were combined to calculate general and administrative/overhead per direct labor costs. For Approach 2, these costs were combined to calculate general and administrative overhead per each position and job title for that district office. Discussions of the components of the district indirect costs are detailed below.

Human Resources

Human resource costs included the sum of HR salaries, office space, technology and computers. For Approach 1, these costs were captured within the division and district general and administrative overhead; for Approach 2, these costs were allocated as a fixed cost per employee basis within each district office.

Office Space

Annual cost proxy of office space included an average office size and cost per square foot which was specific for each district. (The cost proxy of office space may be a non-cash cost to TxDOT.) Actual building costs reported by TxDOT were based on historic cost, date of purchase, expected life, etc. because TxDOT owns the offices it occupies. To standardize this cost, a proxy cost of office space per district was based on average rental costs in that district. In this way, there is a cost/benefit relationship that exists between the occupancy of office space and the cost of that office space. Office space used for engineering activities associated with the completion of individual projects was considered an overhead cost for that project. For Approach 1, the district annual rentals were averaged and allocated at a rate of $1.58 per direct labor hour for 2010 and $1.25 per direct labor hour for 2011, which is a state average rental rate allocated on direct labor hours. For Approach 2, the rental rates for the district offices were calculated for the estimated PE office space per employee multiplied by the average rental rates for that specific district.

Technology Support

For Approach 1 and 2, annual technology costs included cost of a computer, software, and technology support. Technology support included the salaries of the techs, the portion of the human resources costs associated with them plus the technicians' office space costs. This assumed a five year life for the computers and one computer per full time equivalent PE. In Approach 1, these costs were included in general and administrative/overhead per direct labor cost. For Approach 2, these costs were combined to calculate general and administrative overhead per each position and job title for each district office.

Training

For both approaches, training costs were strictly the cost of providing training. In Approach 1, training costs were included in general and administrative/overhead per direct labor cost. For Approach 2, training costs per job title data was provided by TxDOT for each of the districts. The number of hours of training for each job title and the related cost per hour was determined. The hours spent in training for PEs as well as their PTO was subtracted from the yearly hours worked (2080) to determine productive hours for each job title in the district office.

Design Project Team Members

Engineering project teams were used in both in-house and out-sourced engineering and design services for transportation projects. Transportation projects included engineering, land surveys, environmental, transportation feasibility, financial, architectural, real estate appraisal, and materials laboratory services for highway improvements, right-of-way acquisition, and aviation improvements. A project team may be as few as two individuals or may be comprised of many individuals with the same and/or different titles working on complex transportation projects. The relevant roles included in a typical TxDOT project team include design team leader (professional engineer, PE), design team member(s) (PE), engineering assistant (graduate engineer that is not registered as a PE), lead design technician or specialist (non-engineer), mid-grade design technician (non-engineer), entry level design technician (non-engineer), principle in charge, and administrative support.

The project team roles have been used by TxDOT district offices for a few years. Each employee of TxDOT also has a staffing classification, such as Design Technician I-VI, Transportation Specialist I – V, Engineering Assistant I – V, Transportation Engineer I – VI, Area Engineer, District Engineer, etc. The staffing classifications are comparable to external engineering firms' classifications (descriptions) of employees. Tables 10 and 11 located in Appendix B aid in the conversion of external consultant titles or grades to project roles. Table 10 details the different professional grade descriptions. This table was developed from the Texas Council of Engineering Companies (TCEC) annual salary survey. Table 11 details the different engineering grade descriptions with associated equivalent Federal General Schedule grade (GS ranking as used by the Federal Highway Administration). This table was developed from the National Society of Professional Engineers (NSPE) annual salary survey. These tables, used for annual salary surveys, summarize the accepted definitions within the engineering industry, based on progressive increase in experience and professional responsibility.

The engineering project PE team role equivalents to TCEC and NSPE grade descriptions for this task are: design team leader is equivalent to professional or engineer VI or VII (and very rarely professional or engineer VIII or IX); design team member(s) is equivalent to professional or engineer III, IV, V, or VI; and engineering assistant is equivalent to professional or engineer I, II or III. (The correlation of project titles to grades is in the table below.) The results will be detailed by both project team roles and engineering or professional grade below.

Table 12.
Project Roles Correlated to Grade

TxDOT Project Roles	TCEC Professional Grades	NSPE Engineering Grades
Design Team Leader	Professional VI or VII	Engineer VI or VII
Design Team Member	Professional III, IV, V, or VI	Engineer III,IV, V, or VI
Engineering Assistant	Professional I, II, or III	Engineer I, II, or III

PHASE 2 – CALCULATING A PRELIMINARY ENGINEERING COST (PE) PER HOUR USING TWO DIFFERENT APPROACHES AND ANNUAL COSTS OF A DESIGN TEAM MEMBER

Direct labor hours and base salary were used to calculate the PE cost per hour in both approaches. To obtain the complete cost of a TxDOT employee involved in preliminary engineering activity, the costs of benefits and various support activities were determined and allocated based on direct labor hours as described below.

Indirect Cost Allocations, Assumptions and Calculations

Approach 1

Approach 1 used direct labor costs and hours charged to specific projects. The direct labor costs were combined with the indirect costs of benefits, space costs, division and district general and administrative allocation, resident engineer overhead and other preliminary engineering costs. The total engineering costs of direct labor and the indirect costs were then divided by the direct labor hours.

Approach 2

Approach 2 combines the cost per productive hour plus training costs, human resource costs, benefit costs, technology costs and cost of office space (the cost to the state of Texas to employ a Professional Engineer in each of the four districts examined). The calculation of indirect costs for total division and district costs are described below. These were used to determine indirect labor costs per productive hour for each job title.

1. Human resource costs: The total human resource specialists' salaries times payroll additive divided by number of employees was calculated for each district examined.
2. Office space costs: The average office space was assumed to be 120 square feet. This was multiplied by the average rental cost for each district.
3. Technology support costs: A one-time per computer cost of $2,409.28 with a life of 5 years plus annual software costs of $1,480.79 were provided by TxDOT. The number of computers per district was multiplied by $1,962.65 based on the yearly cost devised from these costs. To this total, the sum of technology salaries including payroll additive was added as well as the cost of office space and cost of human resources for each technician to obtain the total cost of technology support per district. This number was then divided by the number of computers per district to determine the total cost of technology per computer.
4. Training costs: For each job title, actual training costs per district was divided by actual hours of training per district to find training cost per hour.
5. Supervision costs were assumed to be $0.055 per productive hour. Productive hours are defined as 2080 hours less training hours less hours charged to 9000 level accounts, which are various accounts for leave or vacation, for employees with a given job title.
6. Utilization rate of 75 percent.

Annual Costs of Design Team Members - Assumptions and Calculations

Assumptions

The relationships of indirect costs to direct labor costs as determined in Task 1 were assumed to be applicable to the design team costs examined in Task 2. The roles of principle in charge and administrative support were assumed to be part of general and administrative costs included in the overhead rates of Task 1 and were not delineated for this task.

This study examined the salaries of those with different job titles fulfilling the various roles on engineering project teams. The overhead and utilization rates, determined in Task 1, were applied to per hour costs for each role. TxDOT provided the research team with monthly salary information and approximate design team roles by job classification for all 25 district offices. Comparing this with the details provided for the four district offices of Dallas, Beaumont, Waco and Odessa (those offices analyzed in Task 1), not all job titles could easily be assigned to a project role. This may be due to TxDOT's encouragement of engineering and maintenance staff to share high workload demands within and across districts with less workload demands.

Per Hour Costs

The per hour costs across all TxDOT offices were compared to the range of five per hour costs; those of the Dallas, Beaumont, Waco and Odessa offices, and the average per hour costs of those four offices. The TxDOT averages fall within that range except for the Lead Design Technician role. This could be due to longevity of the personnel in that role across TxDOT or due to the competition for that role in the four offices compared to the other locations. Using the utilization rate of 75 percent and overhead rate calculated in Task 1**,** the design team per hour costs to the taxpayer was calculated by the research team.

Annual Costs

Task 2 required that the annual cost to the taxpayer be calculated for an engineering project team. However, since each design team role rarely works on one design task for an entire year and each individual team member may utilize a different amount of leave and receive differing amounts of training, it was difficult to accurately determine the number of annual hours. The overhead rate of 285.76% for 2010 and 292.25% for 2011 from Task 1 included an amount for leave and training. If the standard of 2,080 annual hours (52 weeks at 40 hours a week) was used, leave taking would then be included twice in the annual costs. The research team determined per hour costs to be more meaningful and comparable with the approach of external engineering firms. Thus, the annual costs of each team member was not calculated nor presented.

Overhead Rates

Payroll Additive

The payroll additive is the federal composite rate for federal highway reimbursement. It is an overhead rate that incorporates indirect costs associated with personnel costs and consists of benefits, vacation, leave and PTO.

Implied Overhead from Approach 1

Overhead in Approach 1 included benefits and space allocated on direct labor hours; division and district general and administrative costs allocated on direct labor costs; other and resident engineer overhead allocated on projects.

Implied Overhead from Approach 2

Overhead in Approach 2 assumed a fixed amount of human resource for each employee; technology and office space was a fixed amount for each full time equivalent employee; and division and district general and administrative costs were allocated based upon direct labor hours. This overhead rate assumed a 75 percent utilization or time spent on projects that go to letting.

Comparisons of the Overhead Rates

The payroll additive was limited to benefits, PTO and other personnel expenses; it was the basic overhead allowed for federal highway reimbursement. It was just one component of the overhead rates for Approaches 1 and 2. Approach 1 had some overhead components allocated based upon direct labor costs; some based upon projects; and some based upon direct labor hours. Approach 2 allocated overhead components as either a fixed amount per employee or equivalent full time employee, or allocated based upon direct labor hours. Approach 2 also assumed a 75 percent utilization rate. (If the utilization rate is too high then overhead is understated; and if the utilization rate is too low then overhead is overstated.) Approach 1 did not assume a 75 percent utilization rate since the indirect costs other than the payroll additive are allocated based upon engineering projects costs.

RESULTS AND LIMITATIONS

TASK 1: DETERMINE TOTAL TXDOT COST TO THE TAXPAYER PER ENGINEERING EMPLOYEE

Results

Under Approach 1, the average cost per hour of PE for TxDOT was $114.44 for 2010 and $120.19 for 2011. The total indirect and overhead costs to direct labor costs was 285.76% for 2010 and 292.25% for 2011. Approach 1 results are found in Appendix B Table 3 for 2010 and Table 4 for 2011.

Under Approach 2, the average cost of employing a PE in the Odessa district was $118.29 in 2010 and $120.33 in 2011; in the Beaumont district, $124.81 in 2010 and $118.54 in 2011; in the Waco district, $102.60 in 2011; and in the Dallas district, $108.95 in 2010 and $107.47 in 2011. The overhead costs to direct labor costs percent for the Odessa district was 293.68% in 2010 and 292.42% in 2011; for the Beaumont district 287.89% in 2010 and 286.50% in 2011; for the Waco district 245.75% in 2011; and in the Dallas district is 245.78% in 2010 and 242.40% in 2011. Approach 2 results are found in Table 5 for 2010 and Table 6 for 2011. Table 7 details the assumptions made for Approach 2.

A comparison of preliminary engineering per hour costs in Approach 1 and 2 for 2010 and 2011 is shown in Table 13.

Table 13.
Texas State University-San Marcos
Comparison of Approach 1 and Approach 2

	PE Cost per Hour			
		2010		**2011**
Approach 1	$	114.44	$	120.19
Approach 2				
Dallas	$	108.95	$	107.47
Beaumont	$	124.81	$	118.54
Odessa	$	118.29	$	120.33
Waco		-	$	102.60

TASK 2: DETERMINE THE TYPICAL COST OF ENGINEERING TEAM MEMBERS

Results

This task calculated the in-house per hour costs of engineering project team titles. The range of the per hours cost of the Dallas, Beaumont, Odessa, and Waco offices, and the average of those were presented for comparison. The table below summarizes the per hour costs and range of per hour costs across the offices of Dallas, Beaumont, and Odessa of each design team role using the assumptions discussed above. The table compares Tables 8 and 9 from Appendix B.

The annual costs of project teams were not calculated. Additionally, the hour requirements for each job title vary by project and may require less time from the leadership roles versus the technician roles. The calculations below used implied overhead rates from task 1.

Table 14.
Costs of Engineering Project Team Roles

	2010		2011	
Project Team Role	**Average of all TxDOT Offices Per Hour Costs**	**Range of Averages Across 3 Offices**	**Average of all TxDOT Offices Per Hour Costs**	**Range of Averages Across 3 Offices**
Design Team Leader (PE) *(Professional or Engineer VI, VII)*	$ 137.69	$128.49 - $155.34	$143.41	$135.87- $158.87
Design Team Member (PE) *(Professional or Engineer III, IV, V, VI)*	$ 112.08	$107.92 - $116.03	$116.44	$112.85- $121.99
Engineering Assistant (Grad. Engr. Non-PE) *(Professional or Engineer I,II, III)*	$ 92.67	$ 84.63 - $97.07	$98.12	$86.55- $101.37
Lead Design Technician or Specialist (Non Engr.)	$ 99.44	$83.02 - $98.61	$103.07	$87.80- $114.65
Mid-grade Design Technician (Non Engr.)	$ 81.74	$79.80 - $89.15	$84.79	$80.29- $87.96
Entry Level Design Technician (Non Engr.)	$ 63.89	$60.12 - $71. 35	$66.60	$63.25- $73.15

TASK 3: ANALYZE AND COMPARE THE VARIOUS OVERHEAD RATES

Results

This task compared the payroll additive with the calculated overheads rates from Approach 1 and 2. The table below summarizes the payroll additives, and calculated overhead rates for 2010 and 2011. TxDOT utilizes the payroll additive or the federal composite rate as its overhead rate based. This captures the fringe benefits and personal time leaves of employees. Task 1 and 2 calculated an implied overhead based on direct labor costs or direct labor hours.

Table 15. Comparison of Overhead Rates	2010	2011
Federal Composite Rate or Payroll Additive	171.61%	175.77%
Approach 1	285.76%	286.91%
Approach 2		
Dallas	245.78%	242.40%
Beaumont	287.89%	286.50%
Odessa	293.68%	292.42%
Waco	-	245.75%

Limitations

This study calculated the per hour cost of a preliminary engineering design hour under two different approaches. These calculations may be used to make decisions to out-source or utilize in-house design engineering. However, it is not an avoidable cost per hour. That is, TxDOT could not out-source all preliminary engineering design work and avoid in-house engineering design costs. That is, TxDOT must still oversee the outsourced work and provide the public service component for all projects. Strategic considerations regarding out-sourcing versus in-house costs include the quality of work, expertise needed, TxDOT workload, relationships with contractors, and project completion timeline.

This study included a non-cash proxy for office rental and assumes that all accrued leaves were used in the fiscal year in which they were earned. Thus, the cost of an engineering hour is not representative of the cash per hour cost to TxDOT. The cost per hour under Approach 1 was averaging all TxDOT offices while Approach 2 was the weighted average of specific offices. Each specific office had a different rental rate, different number, seniority, and level of employees, different training and leave hours (a variable that is related to the seniority and level of employees), and the different offices had different competitive pressures or influences on the salaries. Approach 2 also assumed a utilization rate of 75 percent. If the utilization rate is set too high, then the overhead rate is understated; if the utilization rate is set too low, then the overhead rate is overstated.

Limitations to using to this cost study to compare with outsourced costs including the following:

- In-house engineering overhead data lacks details. A component of this is indirect labor that normally is reported in the general overhead section of a private firm. It is assumed that other costs in this component would be included in various other accounts such as materials or supplies. This account could possibly include utilities, which also would be better reported in a manner consistent with private firms. Details of this account need to be provided for any valid comparison.
- Materials, Supplies, and Other costs are not consistent with a private firm. Examples from 2010 of materials that would not be used in the preliminary engineering stages of a private firm are “Reclaimed Asphalt” or “Signs and Markers.” These costs give the impression that other cost accounts charged to PE are not entirely consistent with the costs a private firm would assign.

- "Other" expenses charged to PE include "Hazardous Waste Disposal," "Legal and Court Costs," "Research," "Railroads," and "Financial and Accounting Services." Determining what component of "Hazardous Waste Disposal" should be considered consistent with activities of a private firm is relatively easy, since it would be either small or non-existent. The issue of reporting "Legal and Court Costs" and "Financial Accounting Services" in a manner consistent with private firms cannot be determined from current TxDOT information. These costs are likely costs that would be retained even when engineering services are out-sourced and should be considered as non-avoidable costs.
- Division and district general and administrative costs are comprised of various indirect costs that do not reflect the same nature as that of a private firm. These costs also capture portions of indirect labor and overhead that are not consistent with an external firm, and would be irrelevant for the cost analysis. An example of irrelevant overhead that is the overseeing of the actual determination to begin a design project, or the disbursements of funds to cover the expenses associated with the project.
- Consultant billing detail on invoices has not been consistent in the past. Classifications differ between the consultant firms and details provided on billings are insufficient for easy comparisons to TxDOT costs.
- Bundled TxDOT accounting data in the FIMS is not easy disaggregated. Some components of the payroll additive must be removed to determine base direct labor costs and hours.

The study was to compare the average cost of an engineering hour to TxDOT and to determine the typical cost of engineering design team members. As a result of calculating these costs, overhead rates were also calculated. To the extent that non-cash proxies were used in the calculations, the overhead rates may be inflated. Below is a discussion of the calculated overhead rates and limitations.

Payroll Additive

The payroll additive is the federal composite rate for federal highway reimbursement. It is an overhead rate that incorporates indirect costs associated with personnel costs and consists of benefits, vacation, leave and PTO.

Implied Overhead from Approach 1

Overhead in Approach 1 included benefits and space allocated on direct labor hours; division and district general and administrative costs allocated on direct labor costs; other and resident engineer overhead allocated on projects.

Implied Overhead from Approach 2

Overhead in Approach 2 assumed a fixed amount of human resource for each employee; technology and office space was a fixed amount for each full time equivalent employee; and division and district general and administrative costs were allocated based upon direct labor. Approach 2 assumed a utilization rate of 75 percent. If the utilization rate is in fact lower than 75 percent, then the calculated overhead is understated. Likewise, since the assumed utilization rate has an inverse effect on the overhead rate, if the utilization rate is in fact higher than 75 percent, then the calculated overhead is overstated.

CHALLENGES

This study has faced two major challenges. First, TxDOT keeps all cost accounting information in Financial Information Management System (FIMS), its accounting system of record. This is fully loaded cost system, which is used to be reimbursed from federal highway funds, other government agencies or citizens. The payroll additive is automatically added as each labor hour is added to projects. Thus, the additive has to be subtracted and then some components of the additive added back in to get base salary per hour.

Second, this study and previous studies have tried to compare the cost of projects using TxDOT labor versus external consultant labor. However, when a project has been contracted with external consultants, the billing format has not been consistent. Valuable information, such as direct labor hours by design team classification, was previously not included in all billings. This made comparisons between TxDOT and external consultants difficult. TxDOT and consultants have been working together over the past few years to standardize forms and procedures to make the process simpler and easier to understand for all stakeholders. Continued improvements to the process are planned for the future.

The challenges have caused complicated and costly solutions when TxDOT costs need to be compared to consultants on the cost of engineering hours. Contracts with external consultants are being standardized as to information and format of billings, which will provide better information for strategic planning and decision making. A system of collecting TxDOT relevant data and asking for detailed bills for out-sourced projects will provide better information for strategic planning and decision making.

APPENDIX A – COST ACCOUNTING GLOSSARY

Definitions obtained from the Houghton Mifflin Brief Accounting Dictionary (Copyright 2000)

- Cost Allocation—The process of assigning a specific cost to a specific objective. Also called cost assignment.
- Cost Center—Any part of an organization or area of activity, such as a specific division or department, for which there is a reason to record, calculate, and allocate cots. Another term for expense center.
- Direct Cost—A cost that can be easily and economically traced to a specific product that was completed during an accounting period.
- Direct Expense—An operating (or overhead) expense that can be assigned to a specific department and is under the control of the department head. *The usual way to identify a direct expense is: If the department did not exist, the expense would not exist.*
- Direct Labor Costs—The labor cost is for specific work that can be easily and economically traced to an end product.
- Direct Material—A material that will become part of a finished product and can be easily and economically traced to specific product units.
- Indirect Cost—Any cost that cannot be conveniently and economically traced to a specific department; a manufacturing cost that is not easily traced to a specific product and must be assigned using an allocation method. For example, a property tax is an indirect expense because it is incurred by the entire company, not a single department. Another term for indirect expense.
- Indirect Expense—Another term for indirect cost.
- Indirect Labor Costs—Labor costs for production-related activities than cannot be connected with or conveniently and economically traced to a specific end product.
- Indirect Materials—Minor materials and other production supplies that cannot be conveniently and economically traced to specific products.
- Overhead—The operating expenses of a business, such as rent, insurance premiums, taxes, and electricity

APPENDIX B – TABLES

Table 1.
Summary of Past TxDOT Studies

	Texas A&M *Texas Transportation Institute*	*Office of the State Auditor*	*PWC*	*Reznick Group*
Date Study Completed	May 1987	August 1997	February 1999	January 2010
Study Sponsor	Texas State Department of Highways and Public Transportation	The State of Texas	Texas Department of Transportation (TxDOT)	Texas Comptroller of Public Accounts
Study Purpose and Reason	Analyze the cost, quality, and policy of using consulting services. Response to increased work load “peak loads” or to obtain experts or specialized equipment.	Report on the engineering costs at TxDOT. State law at the time provided that cost was not the determinate factor in decisions to contract for engineering services; the Department decided to outsource the work based on factors such as workload, staff availability, expertise, and time constraints.	Comparative study of in-house and contract preliminary engineering and design work. Determinates to outsource: Costs, available resources, quality of work, timelines.	Analyze the benefits of using transportation consultants. 2009 Texas Legislature directed the Comptroller of Public Accounts to examine engineering staffing patterns at TxDOT. When demand exceeds TxDOT’s in-house resources or engineering capabilities, TxDOT considered outsourcing the opportunity to the consulting community.
Ways in which Study was Analyzed	Projects were analyzed in pairs of in-house projects compared to external consultants.	Analyzed the state statute requirement balance in the use of Department employees and private contractors for preliminary and construction engineering and design engineering services when costs were equivalent.	Cost comparisons were made from the perspective of the Texas taxpayer. Costs were analyzed and associated with processes.	Incremental benefit of using transportation consultants to perform highway construction and maintenance engineering services compared to using TxDOT personnel
Overhead/Indirect Components	Training, operating supplies, safety, supervision, indirect labor, overtime premiums, fringe benefits, and travel	Overhead Costs: Utilities, phone and communications, and distributed service center costs. Indirect Admin Costs: accounting, human resources, executive office, and district administration	Costs were assigned to specific processes, not broken down into components.	Indirect costs: equipment operations, maintenance, depreciation costs, fringe benefits, and salary costs for management and support personnel. Indirect costs, which are not identifiable to a specific project, are collected in the accounting system as indirect costs and allocated to projects based upon total direct costs incurred for a particular project.

Study Limitations	Quality Assessment of organization structure, personnel and size of the operations, use of consulting engineers, quality of work appraisal completed by both SDHPT personnel and consultants, and project characteristics.	Incorrect allocation of costs between the segments of a project, improper inclusion of projects paid for by third parties, and inaccurate calculations of indirect cost rates	Different project databases (5 year process map and 10 year statistical analysis), different thresholds to define what constitutes an in-house project (10% direct costs outsourced versus 25%) and cost adjustments to data in the statistical analysis so study was comparable	TxDOT would need to have historical cost data from projects that were performed solely by TxDOT and from projects performed solely by consultant engineers of similar scope and nature to produce a meaningful analysis and comparison.
Conclusions	Cost of using state engineers was lower than the use of consultants.	PE cost data had limited usefulness, contained inaccuracies, and included allocations of indirect costs that were not appropriate for comparing the cost of in-house and consultant services.	Out-source design was more expensive than in-house design for 8 out of 13 types of processes.	Reznick could not accurately determine the true cost impact of a "one percent increase in production by consultants offset by a reduction to production by Department of Transportation personnel."

Table 2.
Summary of Out-of-State Studies

	New York University	*University of California, Berkeley*
Date Study Completed	October 2008	October 2010
Study Sponsor	New York State Department of Transportation	State of California
Study Purpose and Reason	Compare cost of public-sector design work performed in-house versus outsourcing. To accomplish their programs and in-house training goals, many agencies set design work-load targets of 25% in-house and 75% outsourced.	To determine how the pay and benefits of public sector workers compare to those in the private sector and investigate whether California public employees are overpaid at the expense of California taxpayers.
Ways in which Study was Analyzed	Analyze and compare the cost of having public-sector design work performed in-house with outsourcing that same work to private engineering consulting companies.	Regression adjusted analysis was used to compare the compensation package of public versus private sector employees. For the study, self-employed, part-time, agricultural and domestic workers were excluded from the study. The study all other state and local employees, including educational employees.
Study Limitations	There was considerable variability in the estimates used to determine the in-house design cost of an average employee. This variation method is known as the Monte Carlo Simulation.	The study made many assumptions on the human capital and fundamental personal characteristics of full-time public and private sector employees. Most California public employees are unionized and allows for those with a high school education or less to earn considerably more than their private sector counterparts. On the other hand, college educated private sector employees earn considerably more than similarly educated public sector workers.
Overhead/Indirect Components	Overhead: Functional and Administrative	Overhead not separately addressed in the study.
Conclusions	In-house design engineer's actual expected cost to the taxpayer exceeds that of a private design engineer by about 14%, based on conservative assumptions. Public employees in New York State are unionized.	Public employees in California are neither overpaid nor overcompensated. Wages received by California public employees are about 7% lower, on average, than wages received by comparable private sector workers; however, public employees do receive more generous benefits. Public employees in California are unionized.

Table 3.
Texas State University-San Marcos
Approach 1 FY 2010
TEXAS DEPARTMENT OF TRANSPORTATION
Analysis of Preliminary and Construction Engineering Expenditures

COST CATEGORY	PE	CE	Total PE and CE
Direct Labor Hours	1,636,817	2,529,627	4,166,444
Direct Labor (base rate)	$ 48,557,916	$ 59,234,721	$ 107,792,637
Indirect Costs			
Benefits	$ 25,836,843	$ 31,517,790	$ 57,354,633
Other	$ 11,082,615	$ 345,988	$ 11,428,603
Space	$ 2,586,171	$ 3,996,811	$ 6,582,982
Division & District G&A	$ 80,072,003	$ 97,678,055	$ 177,750,058
Res Eng Overhead	$ 19,183,293	$ 30,084,276	$ 49,267,569
Total Overhead	$138,760,925	$163,622,920	$ 302,383,845
Total Engineering Costs	$187,318,841	$222,857,640	$ 410,176,481
per Hour	$ 114.44	$ 88.10	$ 98.45
Overhead Rate	285.76%	276.23%	280.52%
Reimburseable Costs			
Rental Equipment	$ 844,744	$ 9,152,697	$ 9,997,441
Materials and Supplies	$ 18,660	$ 553,185	$ 571,845
Travel	$ 39,454	$ 71,037	$ 110,491
In House Survey	$ 450,767	$ 15,886	$ 466,653
	$ 1,353,625	$ 9,792,805	$ 11,146,430
Additional TxDOT Costs			
In House Lab & Core Tests	$ 339,600	$ 19,084,441	$ 19,424,041
In House Photogram Services	$ 481,972	$ -	$ 481,972
Advertisement	$ 978,686	$ 12,047	$ 990,733
Inter Agency Prof Fees	$ 409,729	$ -	$ 409,729
	$ 2,209,987	$ 19,096,488	$ 21,306,475

Table 4.
Texas State University-San Marcos
Approach 1 FY 2011
TEXAS DEPARTMENT OF TRANSPORTATION
Analysis of Preliminary and Construction Engineering Expenditures

COST CATEGORY	**PE**	**CE**	**Total PE and CE**
Direct Labor Hours	1,557,576	2,437,970	3,995,546
Direct Labor (base rate)	$ 47,726,122	$ 59,368,921	$107,095,043
Indirect Costs			
Benefits	$ 26,905,985	$ 33,469,706	$ 60,375,691
Other	$ 11,397,664	$ 5,761,053	$ 17,158,717
Space	$ 1,946,970	$ 3,047,463	$ 4,994,433
Division & District G&A	$ 78,700,375	$ 97,899,350	$ 176,599,726
Res Eng Overhead	$ 20,528,338	$ 27,609,442	$ 48,137,780
Total Overhead	$139,479,332	$167,787,014	$ 307,266,346
Total Engineering Costs	$187,205,454	$227,155,935	$ 414,361,389
per Hour	$ 120.19	$ 93.17	$ 103.71
Overhead Rate	292.25%	282.62%	286.91%
Reimburseable Costs			
Rental Equipment	$ 779,936	$ 8,992,578	$ 9,772,514
Materials and Supplies	$ (80,684)	$ 1,631,475	$ 1,550,791
Travel	$ 39,411	$ 67,299	$ 106,710
In House Survey	$ 327,757	$ -	$ 327,757
	$ 1,066,420	$ 10,691,352	$ 11,757,772
Additional TxDOT Costs			
In House Lab & Core Tests	$ 286,038	$ 18,271,161	$ 18,557,199
In House Photgram Services	$ 500,963	$ -	$ 500,963
Advertisement	$ 1,036,538	$ 15,631	$ 1,052,169
Inter Agency Prof Fees	$ 2,074,924	$ -	$ 2,074,924
	$ 3,898,463	$ 18,286,792	$ 22,185,255

Table 5.
Texas State University-San Marcos
Approach 2 – 2010

Texas State University - San Marcos

Approach 2 - 2010

Job Title	Average Total Cost Per Productive Hour			Average Base Hourly Base Pay			Average Fringe Benefits Paid			Average General and Administrative		
	Dallas	Beaumont	Odessa	Dallas	Beaumont	Odessa	Dallas	Beaumont	Odessa	Dallas	Beaumont	Odessa
Adv Project Devlpmt Dir I Total			$114.03			$40.55			$29.04			$44.44
Adv Project Devlpmt Dir II Total	$132.97			$48.14			$34.47			$50.36		
Area Engineer I Total		$123.92			$41.94			$30.04			$51.95	
Area Engineer II Total			$114.97			$42.87			$30.70			$41.40
Area Engineer III Total	$128.21	$125.43		$48.02	$46.01		$34.39	$32.95		$45.80	$46.46	
Area Engineer IV Total	$127.79			$48.50			$34.73			$44.56		
Assistant Area Engineer I Total	$114.47		$93.47	$36.38		$32.37	$26.05		$23.18	$52.03		$37.92
Assistant Area Engineer II Total	$101.58			$37.47			$26.83			$37.29		
Assistant Area Engineer III Total	$120.60			$41.99			$30.07			$48.55		
Deputy District Engineer Total	$140.41			$62.64			$44.85			$32.92		
Dir of Trans Plan & Devlpmt I Total		$141.69	$149.83		$51.31	$47.00		$36.74	$33.66		$53.65	$69.17
Dir of Trans Plan & Devlpmt II Total	$139.37			$56.20			$40.25			$42.93		
Dir of Transportation Ops I Total		$136.02			$49.60			$35.52			$50.90	
Director of Construction I Total		$139.08			$49.61			$35.52			$53.95	
Director of Construction II Total	$152.97			$55.11			$39.46			$58.41		
Director of Maintenance I Total		$135.67			$51.31			$36.74			$47.63	
Director of Maintenance II Total	$165.63			$53.21			$38.10			$74.32		
Director of Operations I Total			$135.56			$47.26			$33.85			$54.45
Director of Operations II Total	$138.50			$53.95			$38.63			$45.91		
District Engineer Total	$190.29	$157.85	$167.45	$77.24	$63.07	$63.07	$55.31	$45.17	$45.17	$57.74	$49.61	$59.22
Transportation Engineer I Total	$77.98			$27.95			$20.01			$30.02		
Transportation Engineer II Total	$84.63	$81.58	$86.62	$27.27	$25.69	$27.54	$19.53	$18.40	$19.72	$37.83	$37.49	$39.36
Transportation Engineer III Total	$85.36	$126.47	$87.45	$29.41	$34.61	$29.21	$21.06	$24.78	$20.92	$34.89	$67.08	$37.31
Transportation Engineer IV Total	$91.47	$100.12		$32.37	$36.78		$23.18	$26.34		$35.93	$37.00	
Transportation Engineer V Total	$102.08	$94.35		$35.77	$36.01		$25.62	$25.79		$40.70	$32.54	
Transportation Engineer VI Total	$110.84	$116.79	$115.25	$38.77	$41.98	$42.56	$27.76	$30.06	$30.48	$44.32	$44.75	$42.21
Transportation Engr Supvr I Total	$98.42		$95.56	$38.40		$32.86	$27.50		$23.53	$32.52		$39.18
Transportation Engr Supvr II Total	$109.03	$107.95	$130.01	$34.57	$36.45	$35.81	$24.76	$26.10	$25.65	$49.71	$45.40	$68.55
Transportation Engr Supvr III Total	$124.04	$123.12	$110.31	$43.63	$42.56	$42.22	$31.24	$30.48	$30.23	$49.17	$50.09	$37.85
Transportation Engr Supvr IV Total												
Transportation Engr Supvr V Total	$123.51			$44.91			$32.16			$46.44		
Transportation Engr Supvr VI Total	$132.30			$47.66			$34.13			$50.52		
Weighted Average Cost per hour of PE	$103.27	$118.30	$112.12									
Weighted Average Cost with G&A	$108.95	$124.81	$118.29									
	245.78%	287.89%	293.68%									

Table 6.
Texas State University-San Marcos
Approach 2 – 2011

Table 6 Texas State Univeristy-San Marcos Approach 2 - 2011																
	Average Total Cost Per Productive Hour				Average Base Hourly Base Pay				Average Fringe Benefits Paid				Average General and Administrative			
Job Title	Dallas	Beaumont	Odessa	Waco	Dallas	Beaumont	Odessa	Waco	Dallas	Beaumont	Odessa	Waco	Dallas	Beaumont	Odessa	Waco
Adv Project Devlpmt Dir I Total			$ 114.09				$ 40.51				$ 30.69				$ 42.89	
Adv Project Devlpmt Dir II Total	$ 141.23				$ 48.08				$ 36.43				$ 56.72			
Area Engineer I Total		$ 121.57	$ 89.18	$ 104.96		$ 42.03	$ 32.33	$ 43.07		$ 31.85	$ 24.50	$ 32.64		$ 47.69	$ 32.35	$ 29.25
Area Engineer II Total	$ 138.63	$ 124.04	$ 115.74	$ 115.11	$ 48.21	$ 43.73	$ 42.58	$ 42.23	$ 36.53	$ 33.13	$ 32.26	$ 32.00	$ 53.89	$ 47.18	$ 40.89	$ 40.88
Area Engineer III Total	$ 121.48	$ 135.39			$ 47.17	$ 46.09			$ 35.74	$ 34.92			$ 38.56	$ 54.38		
Assistant Area Engineer I Total	$ 104.21				$ 36.34				$ 27.53				$ 40.33			
Assistant Area Engineer II Total	$ 121.97			$ 104.11	$ 41.77			$ 39.12	$ 31.65			$ 29.64	$ 48.55			$ 35.34
Deputy District Engineer Total	$ 167.26			$ 138.23	$ 58.98			$ 54.70	$ 44.69			$ 41.45	$ 63.60			$ 42.07
Dir of Trans Plan & Devlpmt I Total	$ 119.21	$ 149.41	$ 185.00	$ 94.76	$ 38.38	$ 51.24	$ 48.53	$ 38.31	$ 29.08	$ 38.83	$ 36.77	$ 29.03	$ 51.75	$ 59.34	$ 99.70	$ 27.42
Dir of Trans Plan & Devlpmt II Total	$ 126.55				$ 52.34				$ 39.66				$ 34.56			
Dir of Transportation Ops I Total		$ 131.04		$ 132.15		$ 50.38		$ 49.81		$ 38.17		$ 37.74		$ 42.49		$ 44.60
Director of Construction I Total	$ 160.07	$ 147.29		$ 147.39	$ 55.86	$ 50.83		$ 53.56	$ 42.32	$ 38.52		$ 40.58	$ 61.89	$ 57.94		$ 53.26
Director of Maintenance I Total	$ 164.49	$ 149.08		$ 132.48	$ 53.16	$ 51.17		$ 45.23	$ 40.28	$ 38.77		$ 34.27	$ 71.06	$ 59.14		$ 52.98
Director of Operations I Total	$ 222.63		$ 137.71		$ 48.17		$ 48.55		$ 36.50		$ 36.78		$ 137.96		$ 52.38	
Director of Operations II Total	$ 142.39				$ 55.56				$ 42.10				$ 44.72			
District Engineer Total	$ 191.19		$ 172.59	$ 181.64	$ 76.94		$ 63.00	$ 72.07	$ 58.29		$ 47.74	$ 54.61	$ 55.96		$ 61.86	$ 54.96
Transportation Engineer I Total	$ 76.44	$ 78.15		$ 69.09	$ 26.44	$ 25.94		$ 24.95	$ 20.03	$ 19.66		$ 18.90	$ 29.97	$ 32.55		$ 25.23
Transportation Engineer II Total	$ 81.89	$ 86.88	$ 85.01	$ 81.38	$ 28.12	$ 27.64	$ 27.91	$ 27.77	$ 21.30	$ 20.94	$ 21.14	$ 21.04	$ 32.48	$ 38.30	$ 35.96	$ 32.57
Transportation Engineer III Total	$ 89.05	$ 99.17	$ 92.15	$ 84.72	$ 30.09	$ 33.68	$ 29.33	$ 29.35	$ 21.55	$ 25.52	$ 22.22	$ 21.02	$ 37.42	$ 39.96	$ 40.61	$ 34.36
Transportation Engineer IV Total	$ 94.09	$ 106.31		$ 89.52	$ 32.29	$ 37.12		$ 33.13	$ 24.47	$ 28.13		$ 25.10	$ 37.33	$ 41.06		$ 31.29
Transportation Engineer V Total	$ 103.57	$ 112.53		$ 101.34	$ 35.85	$ 37.99		$ 39.51	$ 27.16	$ 28.79		$ 29.94	$ 40.57	$ 45.75		$ 31.89
Transportation Engineer VI Total	$ 109.89	$ 128.58	$ 121.14	$ 103.85	$ 41.42	$ 39.94	$ 42.52	$ 40.91	$ 31.39	$ 30.27	$ 32.22	$ 31.00	$ 37.08	$ 58.38	$ 46.40	$ 31.94
Transportation Engr Supvr I Total	$ 111.97			$ 103.74	$ 42.12			$ 34.93	$ 31.92			$ 26.47	$ 37.94			$ 42.34
Transportation Engr Supvr II Total	$ 94.08	$ 112.71	$ 109.54	$ 95.88	$ 35.03	$ 40.02	$ 34.81	$ 39.51	$ 26.54	$ 30.32	$ 26.38	$ 29.94	$ 32.52	$ 42.38	$ 48.35	$ 26.44
Transportation Engr Supvr III Total	$ 128.05	$ 118.89	$ 112.08	$ 112.87	$ 43.77	$ 42.83	$ 42.53	$ 43.33	$ 33.17	$ 32.45	$ 32.22	$ 32.83	$ 51.12	$ 43.60	$ 37.33	$ 36.71
Transportation Engr Supvr IV Total	$ 115.12				$ 43.67				$ 33.09				$ 38.37			
Weighted Average Cost per hour of PE	101.87	112.36	114.06	97.25												
Weighted Average Cost with G&A	$ 107.47	$ 118.54	$ 120.33	$ 102.60												
	242.40%	286.50%	292.46%	245.75%												

Table 7
Assumptions for Approach 2

			Dallas	Beaumont	Odessa	Waco
1)						
Human Resource Expense is fixed and constant for every individual						
2)						
The Cost Per Computer, Software, and all Peripheral equipment is						
Annual Software costs	1480.79					
Times 5 years	5					
	7403.95					
Plus one time cost	2409.28					
Total cost for 5 years	9813.23					
Replaced every 5 years	5					
	$ 1,962.65					
Cost per Computer on a Yearly Basis			$ 1,962.65	$ 1,962.65	$ 1,962.65	$ 1,962.65
3)						
The Average Office Size is (in Square Feet)			120	120	120	120
The Cost Per Square Foot of Office Space is		2010	$ 15.11	$ 12.36	$ 11.64	
		2011	$ 13.71	$ 11.75	$ 10.50	$ 12.85
Miscellaneous Overhead Per Person			5.50%	5.50%	5.50%	5.50%
Employees at TxDot are efficient and produce billiable hours at a an efficiency rate equal to while at the office			75%	75%	75%	75%

Table 8.
Costs of Engineering Project Team Roles FY2010

Project Team Role	**Average of all TxDOT Offices Per Hour Costs**	**Range Across 3 Offices and Average of 3 Offices Per Hour Costs**
Design Team Leader (PE) *(Professional or Engineer VI, VII)*	$ 137.69	$128.49 - $155.34
Design Team Member (PE) *(Professional or Engineer III, IV, V, VI)*	$ 112.08	$107.92 - $116.03
Engineering Assistant (Grad. Engr. Non-PE) *(Professional or Engineer I,II, III)*	$ 92.67	$ 84.63 - $ 97.07
Lead Design Technician or Specialist (Non Engr.)	$ 99.44	$ 83.02 - $ 98.61
Mid-grade Design Technician (Non Engr.)	$ 81.74	$ 79.80 - $ 89.15
Entry Level Design Technician (Non Engr.)	$ 63.89	$ 60.12 - $ 71. 35

Table 9.
Costs of Engineering Project Team Roles FY2011

Project Team Role	Average of all TxDOT Offices Per Hour Costs	Range Across 4 Offices and Average of 4 Offices Per Hour Costs
Design Team Leader (PE) *(Professional or Engineer VI, VII)*	$143.41	$135.87 - $158.87
Design Team Member (PE) *(Professional or Engineer III, IV, V, VI)*	$116.44	$112.85 - $121.99
Engineering Assistant (Grad. Engr. Non-PE) *(Professional or Engineer I,II, III)*	$98.12	$ 86.55 - $ 101.37
Lead Design Technician or Specialist (Non Engr.)	$103.07	$ 87.80 - $ 114.65
Mid-grade Design Technician (Non Engr.)	$84.79	$ 80.29 - $ 87.96
Entry Level Design Technician (Non Engr.)	$66.60	$ 63.25 - $ 73.15

Table 10.
Professional Grade Descriptions

GRADE	Professional I/II	Professional III	Professional IV	Professional V
General Characteristics	This is the entry level for professional work.	Independently evaluates, selects, and applies standard techniques, procedures, and criteria, using judgment in making minor adaptations and modifications.	Plans and conducts work requiring judgment in the independent evaluation, selection, and substantial adaptation and modification of standard techniques, procedures, and criteria.	Requires the use of advanced techniques and the modification and extension of theories, precepts, and practices of her/his field and disciplines.
Direction Received	Receives close supervision on new aspects of assignments.	Receives instructions on specific assignment objectives, complex features, and possible solutions.	Independently performs most assignments with instructions as to the general results expected.	Supervision and guidance relate largely to overall objectives, critical issues, new concepts, and policy matters.
Typical Duties & Responsibilities	Using prescribed methods, performs specific and limited portions of a broader assignment of an experienced professional.	Performs work which involves conventional types of plans, investigations, surveys, structures, or equipment with relatively few complex features.	Plans, schedules, conducts or coordinates detailed phases of the professional work in a part of a major project or in a total project of moderate scope.	One or more of the following: (1) In a supervisory capacity, plans, develops, coordinates, and directs a large and important project or a number of small projects with many complex features. (2) As individual researcher or worker, carries out complex or novel assignments requiring the development of new or improved techniques and procedures. (3) As staff specialist, usually performs as a staff advisor and consultant as to a technical specialty, a type of facility or equipment, or a program function.
Responsibility for Direction of Others	May be assisted by a few aides or technicians.	May supervise or coordinate the work of others who assist in specific assignments.	May supervise or coordinate the work of other professionals who assist in specific assignments.	Supervises, coordinates, and reviews the work of a small staff of professionals.
Typical Position Titles	Staff or Junior Engineer/Scientist	Engineer/Scientist	Engineer/Scientist	Senior Engineer/Scientist
Education	Bachelor's Degree			
Registration Status	Certified Engineer/Scientist in Training		Registered Professional Engineer/Scientist	
Typical Professional Attainments	Member of Professional and Technical Societies		Member of Professional Society; Member of Technical Society.	Member of Professional Society; Member of Technical Society; Publishes professional papers.

Source: Texas Council of Engineering Companies (TCEC) annual salary survey.

GRADE	Professional VI	Professional VII	Professional VIII	Professional IX
General Characteristics	Plans and develops projects concerned with unique or controversial problems which have an important effect on major organization programs.	Makes decisions and recommendations that are recognized as authoritative and have an important impact on extensive professional activities.	Make decisions and recommendations that are recognized as authoritative and have a far-reaching impact on extensive professional and related activities of the company.	A professional at this level is either: (1) in charge of programs so extensive and complex as to require staff and resources of sizable magnitude; or (2) is an individual researcher or consultant who is a national and/or international authority and leader.
Direction Received	Supervision received is essentially administrative.	Supervision received is essentially administrative.	Receives general administrative direction.	
Typical Duties & Responsibilities	One or more of the following: (1) In a supervisory capacity (a) plans, develops, coordinates, and directs a number of large and important projects or a project of major scope and importance, or (b) is responsible for the entire program of her/his profession of an organization when the program is of limited complexity and scope. (2) As individual researcher or worker conceives, plans, and conducts research in problem areas of considerable scope and complexity. (3) As a staff specialist serves as the technical specialist.	One or both of the following: (1) In a supervisory capacity is responsible for an important segment of the professional program of an organization. Generally requires several subordinate organizational segments or teams. Recommends facilities, personnel, and funds required to carry out programs. (2) As individual researcher and consultant is a recognized leader and authority in her/his organization in a broad area of specialization or in a narrow but intensely specialized field. Selects research problems to further the organization's objectives.	One or both of the following: (1) In a supervisory capacity is responsible for an important segment or a very extensive and highly diversified program. (2) As individual researcher and consultant, formulates and guides the attack on problems of exceptional difficulty and marked importance to the organization or industry.	
Responsibility for Direction of Others	Plans, organizes, and supervises the work of a staff of professionals and technicians.	Directs several subordinate supervisors or team leaders, some of whom are in positions comparable to Professional VI.	Supervise several subordinate supervisors or team leaders.	
Typical Position Titles	Senior or Principal Engineer/Scientist	Principal Engineer/Scientist, Department Manager, Director or Assistant Director of Research, Consultant, Professor, Distinguished Professor or Department Head	Chief Engineer, Bureau Engineer/Scientist, Director of Research, Department Head or Dean, County Engineer, Senior Advisor, Senior Consultant	Director of Engineering, General Manager, Vice President, President, Partner, Dean, Director of Public Works
Education	Bachelor's Degree			
Registration Status	Registered Professional Engineer/Scientist			
Typical Professional Attainments	Member of Professional Society; Member of Technical Society; Publishes professional papers			

Table 11.
Engineering Grade Descriptions

	1001 Engineer I/II	1003 Engineer III	1004 Engineer IV	1005 Engineer V
Equivalent Federal General Schedule Grade*	GS-5, 7	GS-9	GS-11	GS-12
General Characteristics	This is the entry and second level for professional work. Performs assignments designed to develop professional engineering work knowledge and abilities, requiring application of standard techniques, procedures, and criteria in caring out a sequence of related engineering tasks. Limited exercise of judgment is required on details of work and in making preliminary selections and adaptations of engineering alternatives.	Independently evaluates, selects, and applies standard engineering techniques, procedures, and criteria, using judgment in making minor adaptations and modifications. Assignments have clear and specified objectives and require the investigation of a limited number of variables. Performance at this level requires developmental experience in a professional position or equivalent graduate level education.	As a fully competent engineer in all conventional aspects of the subject matter of the functional area of the assignments, plans and conducts work requiring judgment in the independent evaluation, selection, and substantial adaptation and modification of standard techniques, procedures, and criteria. Devises new approaches to problems encountered. Requires sufficient professional experience to assure competence as a fully trained worker. Completion of all requirements for a doctoral degree may be substituted for experience.	Applies intensive and diversified knowledge of engineering principles and practices in broad areas of assignments and related fields. Makes decisions independently on engineering problems and methods, and represents the organization in conferences to resolve important questions and to plan and coordinate work. Requires the use of advanced techniques and the modification and extension of theories, precepts and practices of his/her field and related sciences and disciplines. The knowledge and expertise required for this level of work usually result from progressive experience.
Direction Received	Supervisor screens assignments for unusual or difficult problems and selects techniques and procedures to be applied on non-routine work. Receives close supervision on new aspects of assignments.	Receives instruction on specific assignment objectives, complex features, and possible solutions. Assistance is furnished on unusual problems and work is reviewed for application of sound professional judgment.	Independently performs most assignments with instructions as to the general results expected. Receives technical guidance on unusual or complex problems and supervisory approval on proposed plans for projects.	Supervision and guidance related largely to overall objectives, critical issues, new concepts, and policy matters. Consults with supervisor concerning unusual problems and developments.
Typical Duties & Responsibilities	Using prescribed methods, performs specific and limited portions of a broader assignment of an experienced engineer. Applies standard practices and techniques in specific situations, adjusts and correlates data, recognizes discrepancies in results, and follows operations through a series of related detailed steps or processes.	Performs work which involves conventional types of plans, investigations, surveys, structures, or equipment with relatively few complex features for which there are precedents. Assignments usually include one or more of the following: Equipment design and development, test of materials, preparation of specifications, process study, research investigations, report preparation, and other activities of limited scope requiring knowledge of principles and techniques commonly employed in the specific narrow area of assignments.	Plans, schedules, conducts, or coordinates detailed phases of the engineering work in a part of a major project or in a total project of moderate scope. Performs work which involves conventional engineering practice but may include a variety of complex features such as conflicting design requirements, unsuitability of conventional materials, and difficult coordination requirements. Work requires a broad knowledge of precedents in the specialty area and a good knowledge of related specialties.	One or more of the following: (1) In a supervisory capacity, plans, develops, coordinates, and directs a large and important engineering project or a number of small projects with many complex features. A substantial portion of the work supervised is comparable to that described for Engineer IV. (2) As individual research or worker, carries out complex or novel assignments requiring the development of mew or improved techniques and procedures. Work is expected to result in the development of new or refined equipment, materials, processes, products, and/or scientific methods. (3) As staff specialist, develops and evaluates plans and criteria for a variety of projects and activities to be carried out by others. Assesses the feasibility and soundness of proposed engineering evaluation tests, products, or equipment when necessary data are insufficient or confirmation by testing is advisable. Usually performs as a staff advisor and consultant as to a technical specialty, a type of facility or equipment, or a program function.
Responsibility for Director of Others	May be assisted by a few aids or technicians.	May supervise or coordinate the work of technicians and others who assist in specific assignments.	May supervise or coordinate the work of engineers, other professionals, technicians, and others who assist in specific assignments.	Supervises, coordinates, and reviews the work of a small staff of engineers, other professionals, and technicians. Estimates personnel needs, and schedules and assigns work to meet completion date. Or, as individual researcher or staff specialist, may be assisted on projects by other engineers, other professionals, or technicians.
Typical Position Titles	Junior Engineer, Associate, Detail Engineer, Engineer-in-Training, Assistant Research Engineer, Construction Inspector.	Engineer or Assistant Engineer, (Project, Plant, Office, Design, Process, Research) Inspector, Engineering Instructor.	Engineer or Assistant Engineer, (Resident, Project, Plant, Office, Design, Process, Research) Chief Inspector, Assistant Professor.	Senior or Principal Engineer, (Resident, Project, Office, Design, Process, Research) Assistant Division Engineer, Associate Professor, Project Leader.

* Shown for comparison of job characteristics and responsibility levels only, not to indicate desirable salary levels.

Equivalent Federal General Schedule Grade*	GS-13	GS-14	GS-15	Senior Executive Service GA-16, 17, 18
General Characteristics	Has full technical responsibility for interpreting, organizing, executing, and coordinating assignments. Plans and develops engineering projects concerned with unique or controversial problems which have an important effect on major organization programs. This involves exploration of subject area, definition of scope and selection of problems for investigation and development of novel concepts and approaches. Maintains liaison with individuals and units within or outside his/her organization, with responsibility for acting independently on technical matters pertaining to his/her field. Work at this level usually requires extensive progressive experience.	Makes decisions and recommendations that are recognized as authoritative and have an important impact on extensive engineering activities. Initiates and maintains extensive contacts with key engineers and officials of other organizations and companies, requiring skill in persuasion and negotiation of critical issues. At this level, individuals will have demonstrated creativity, foresight, and mature engineering judgment in anticipating and solving unprecedented engineering problems, determining program objectives and requirements, organizing programs and projects, and developing standards and guides for diverse engineering activities.	Makes decisions and recommendations that are recognized as authoritative and have a far reaching impact on extensive engineering and related activities of the organization. Negotiates critical and controversial issues with top level engineers and officers of other organizations. Individuals at this level demonstrate a high degree of creativity, foresight, and mature judgment in planning, organizing, and guiding extensive engineering programs and activities of outstanding novelty and importance.	An engineer in this level is either (1) in charge of programs so extensive and complex as to require staff and resources of sizeable magnitude (e.g., research and development, a department of government responsible for extensive engineering programs, or the major component of an organization responsible for the engineering required to meet the objectives of the organization); or (2) is an individual researcher or consultant who is recognized as a national and/or international authority and leader in an area of engineering or scientific interest and investigation.
Direction Received	Supervision received is essentially administrative, with assignments given in terms of broad general objectives and limits.	Supervision received is essentially administrative, with assignments given in terms of broad general objectives and limits.	Receives general administrative direction.	
Typical Duties & Responsibilitie s	One or more of the following: (1) In a supervisory capacity, (a) plans, develops, coordinates, and directs a number of large and important projects or a project of major scope and importance, or (b) is responsible for the entire engineering program of an organization when the program is of limited complexity and scope. The extent of his/her responsibilities generally require a few (3 to 5) subordinate supervisors or team leaders with at least one in a position comparable to Engineer V. (2) As individual researcher or worker, conceives, plans, and conducts research in problem areas of considerable scope and complexity. The problems must be approached through a series of complete and conceptually related studies, are difficult to define, require unconventional or novel approaches, and require sophisticated research techniques. Available guides and precedents contain critical gaps, are only partially related to the problem or may be largely lacking due to the novel character of the project. At this level, the individual researcher generally will have contributed inventions, new designs, or techniques which are of material significance in the solution of important problems. (3) As a staff specialist, serves as the specialist for the organization (division or company) in the application of advanced theories, concepts, principles, and processes for an assigned area of responsibility (i.e., subject matter, function, type of facility or equipment, or product). Keeps abreast of new scientific methods and developments affecting his/her organization for the purpose of recommending changes in emphasis of programs or new programs warranted by such developments.	One or both of the following: (1) In a supervisory capacity, is responsible for (a) an important segment of the engineering program of an organization with extensive and diversified engineering requirements, or (b) the entire engineering program of an organization when it is more limited in scope. The overall engineering program contains critical problems requiring major technological advances and opening the way for extensive related development. The extent of his/her responsibilities generally requires several subordinate organizational segments or teams. Recommends facilities, personnel, and funds required to carry out programs which are directly related with and directed toward fulfillment of overall organization objectives. (2) As individual researcher or consultant, is a recognized leader and authority in his/her organization in a broad area of specialization or in a narrow but intensely specialized field. Selects research problems to further the organization's objectives. Conceives and plans investigations of broad areas of considerable novelty and importance for which engineering reprecedents are lacking in areas critical to the overall engineering program. Is consulted extensively by associates and others with a high degree of reliance placed on his/her scientific interpretations and advice. Typically, will have contributed inventions, new designs, or techniques which are regarded as major advances in the field.	One or both of the following: (1) In a supervisory capacity, is responsible for (a) an important segment of a very extensive and highly diversified engineering program, or (b) the entire engineering program when the program is of moderate scope. The programs are of such complexity that they are of critical importance to overall objectives, include problems of extraordinary difficulty that often have resisted solution, and consist of several segments requiring subordinate supervisors. Is responsible for deciding the kind and extent of engineering and related programs needed for accomplishing the objectives of the organization for choosing the scientific approaches, for planning ad organizing facilities and programs, and for interpreting results. (2) As individual researcher or consultant, formulates and guides the attack on problems of exceptional difficulty and marked importance to the organization or industry. Problems are characterized by their lack of scientific precedents and source material, or lack of success of prior research and analysis so that their solution would represent an advance of great significance and importance. Performs advisory and consulting work for the organization as a recognized authority for broad program areas or in an intensely specialized are of considerable novelty and importance.	
Responsibility for Director of Others	Plans, organizes, and supervises the work of a staff of engineers, other professionals, and technicians. Evaluates progress of the staff and results obtained, and recommends major changes to achieve overall objectives. Or, as individual research or staff specialist, may be assisted on individual projects by other engineers, other professionals, or technicians.	Directs several subordinate supervisors or team leaders, some of whom are in positions comparable to Engineer VI or, as individual researcher, staff specialist, or consultant, may be assisted on individual projects by other engineers, other professionals, or technicians.	Directs several subordinate supervisors or team leaders, some of whom are in positions comparable to Engineer VII. As an individual researcher, staff specialist, or consultant, may be assisted on individual projects by other engineers, other professionals, or technicians.	
Typical Position Titles	Senior or Principal Engineer, Division or District Engineer, Production Engineer, Assistant Division, District or Chief Engineer, Consultant, Professor, City or County Engineer.	Principle Engr, Division/ District Engr, Depart Mgr, Director or Assist Director of Research, Consultant, Professor, Assistt Chief or Chief Engineer, City or County Engr.	Chief Engr, Bureau Engr, Director of Research, Depar Head or Dean, County Engr, City Engr, Director of Public Works, Sr Fellow, Sr Staff, Sr Advisor, Sr Consultant, Engr Mgr.	Director of Engineering, General Manager, Vice President, President, Partner, Dean, Director of Public Works, Exec Director

APPENDIX C – DETAILED CALCULATION METHODS

TASK 1: DETERMINE TOTAL TXDOT COST TO THE TAXPAYER PER ENGINEERING EMPLOYEE.

Approach 1

TxDOT supplied PE costs for each fiscal year ("PEcost8XX" where XX is the FY). To determine Preliminary Engineering Cost per Hour under Approach 1, direct labor costs and indirect costs were combined and divided by direct labor hours.

Direct Labor Costs

Direct labor costs were derived by combining the direct labor costs from salaried employees only divided by the total composite rate and multiplying times a portion of the composite rate, including the salary without longevity rate, benefit replacement rate, longevity rate, and overtime pay rate.

Direct Labor Hours

Direct labor hours were also derived by combining reported direct labor hours from regular full time employees.

1. For Direct Labor Hours, use above spreadsheet to get hours from Salaries-Reg Full Time YTD hours column.
2. For direct labor (base rate), get YTD amount from Salaries-Reg Full Time
    a. Use Salaries-Reg Full Time YTD amount and divide by Composite Rate (provided in "COMPRATE XX" document)
    b. Take 2(a) times (Salary w/o Longevity rate + Benefit Replacement rate + Longevity rate + Overtime Pay rate) (All rates found in "COMPRATE XX" document)

Indirect Costs

Indirect costs were comprised of benefits, space costs, division and district G&A, residential engineering overhead, and other indirect costs.

Benefits for the salaried employees were derived by taking direct labor costs calculated as described above and subtracting salaries for regular full-time employees minus salaries for regular full-time employees divided by the composite rate.

3. For benefits:
    a. Take Salaries-Reg Full Time YTD amount minus 2(a)
    b. Take 2(b) end product minus 2(a)
    c. Subtract 3(b) from 3(a)

Space was calculated by multiplying the assumptions for cost per square foot for each district (Dallas, Beaumont, and Odessa) times the average office space and then dividing by average hours per employee. (We used Approach B)

4. For space:
    a. Approach A
        i. Take Cost per square foot for each office times Office Space Utilized by PE and CE to get Cost per office
        ii. Add all 3 districts Cost per Office together, then divide by total hours from all the offices to get Cost of Office Space per Hour
    b. Approach B
        i. Take Cost per Square Foot times Average office size (assumed to be 120 square feet) to get Cost per PE/CE Office
        ii. Average all districts Cost per PE/CE Office
        iii. Add all hours from all 3 districts and divide by number of employees in all 3 districts to get average hours per employee
        iv. Take 4(b)(ii) divided by 4(b)(iii)

Division & District G&A was derived by taking reported Total PE and CE Division & District G&A divided by total PE and CE direct labor (base rate) to get the percentage that should be multiplied by PE and CE individually to get the separate PE Division & District G&A and CE Division & District G&A.

5. For Division & District G&A:
    a. Take Total PE and CE Division & District G&A and divide by Total PE and CE Direct Labor (base rate)
    b. That will equal 164.9%
    c. Take PE Direct Labor (base rate) and multiply by 164.9% to get PE Division & District G&A
    d. Take CE Direct Labor (base rate) and multiply by 164.9% to get CE Division & District G&A

All other costs were taken directly from “PEcost 8XX,” including other indirect costs, residential engineering overhead, rental equipment, materials and supplies, travel, in house survey, in house lab and core tests, in house photogram services, advertisement, inter agency professional fees.

6. Take all other costs directly from “PEcost8XX,” including:
    a. Indirect Costs
        i. Other
        ii. Res Eng Overhead
    b. Reimburseable Costs
        i. Rental Equipment
        ii. Materials and Supplies (subtract other financing fees if applicable)
        iii. Travel
        iv. In House Survey
    c. Additional TxDOT Costs
        i. In House Lab & Core Tests
        ii. In House Photogram Services

        iii. Advertisement
        iv. Inter Agency Prof Fees

Total overhead was calculated as described above and combining benefits, space, division and district G&A, residential engineering overhead, and other indirect costs.

7. Total Overhead equals 3 + 4 + 5 + 6(a)

Total overhead and direct labor costs are then combined and divided by direct labor hours to get engineering costs per hour.

8. To get per hour costs:
    a. Add 2 + 7 together to get Total Engineering Costs
    b. Take Total Engineering Costs divided by Direct Labor Hours

Overhead rates were derived by taking total overhead divided by direct labor costs.

9. To get Overhead rate, take total overhead (7) divided by Direct Labor (base rate) (2)

Approach 2

Assumptions

Many assumptions were made in calculating engineering per hour costs with Approach 2, including the cost of technology, office space, and human resources.

1. Assumptions:
    a. Cost per computer was taken from the spreadsheet provided by TxDOT called Engineering Wrks Cost.
    b. Average office space in square feet was assumed to be 120.
    c. The cost per square foot was taken from the Chamber of Commerce for Odessa and the Real Estate Center of Texas A&M for Beaumont and Dallas.
        i. Odessa – www.odessachamber.com/available.php - average lease rates range from $6 to $15 per square foot. Averaged these two numbers to come up with $10.50.
        ii. Beaumont – Averaged the highs and lows of Class A and Class B suburban office rent/square foot/year on page 40 of the 2011 Texas Metro Market Overview-Beaumont-Port Arthur
        iii. Dallas – Used the rental rate analysis of Class B Mesquite/Rockwall for Dec-10 on page 101 of 2011 Texas Metro Market Overview – Dallas-Fort Worth-Arlington

Cost of technology was determined by using approximate costs per computer reported by TxDOT, which includes annual software costs of $1,480.79 plus the one-time cost of $2,409.28 for the five year life of the computer, which makes an annual cost of $1,962.65 per computer. This was multiplied by the number of computers in each district and then added to the technicians' salaries, cost of office space times number of computer techs, and cost of human resources times number of computer technicians for each district to arrive at the cost of technology for each district. This sum was then divided by the number of computers in the district to arrive at the cost per computer.

2. Cost of Technology was based on the following two computations added together and then divided by the numbers of computer in the district
    a. Total cost for computers (cost per computer from assumptions times the total number of computers in the district)
    b. Cost of computer techs (wage cost for computer techs plus (cost of office space times number of computer techs) plus (cost of human resources times number of computer techs).

3. Cost of office space is average office size assumption times cost per square foot assumption.

4. Cost of human resources per individual is
    a. the wages expense for HR specialists plus (cost of office space times number of human resource employees) plus cost per computer from assumptions
    b. Take 4(a) divided by the number of employees for the district

Cost per Productive Hour

Cost per productive hour was computed for each job title. In order to calculate these costs per hour, many factors were taken into consideration, including salary costs, training costs, cost for offices, cost for computers, cost for human resources, number of employees with the job title, number of full-time equivalent employees, number of hours from all employees with the job title, number of hours spent training, number of hours charged as leave, efficiency rate.

Cost per productive hour was calculated by dividing total cost for employees with a certain job title by total productive hours for that job title.

Total cost for employees with a certain job title was calculated by adding cost of wages, cost for offices, cost for computers, cost for human resources, and costs for training for that job title. Cost of wages was determined by adding all wages, including the payroll additive, for all employees with that job title. Cost of offices was determined by taking the cost per office times the number of full-time equivalent employees. Cost for computers was determined by taking the cost per computer times the number of full-time equivalent employees. Cost for human resources was determined by taking the cost for human resources per individual times the number of employees. Costs for training were taken directly from the training costs provided by TxDOT, which were separated by job title.

Total productive hours were determined by taking the amount of hours worked by employees with the job title and subtracting hours spent training and hours charged to 9000 level accounts, which are leave accounts. This sum is then multiplied by 75% to get total productive hours.

To separate cost per productive hours into base pay, fringe benefits, and general and administrative costs, cost of wages was divided by 1 plus the payroll additive. This base pay was then divided by total productive hours to get base pay per hour. To calculate fringe benefits per hour, base pay per hour was multiplied by the payroll additive. To calculate general and administrative costs per hour, subtract base pay per hour and fringe benefits per hour from cost per productive hour.

After cost per hour for each job title was found, the cost per hour for all job titles was averaged to get the average total cost per productive hour.

TASK 2: DETERMINE THE TYPICAL TOTAL ANNUAL COST TO THE TAXPAYER FOR THE RELEVANT EMPLOYEES IDENTIFIED

TxDOT provided monthly salary data per design team classification. In order to get annual costs for relevant employees, the monthly salary data for each classification was multiplied by 12 months. Then, this total was divided by the 75% utilization rate and multiplied by the overhead rate calculated in Approach 1 for the appropriate year. This number was then divided by 2080 hours to get per hour salary costs.