Minnesota Department of Transportation

RESEARCH SERVICES

Office of Policy Analysis, Research & Innovation

Lump Sum Estimating: Discovery and Simulation

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Minnesota State University, Mankato

June 2012

Research Project
Final Report 2012-15

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The lump sum bidding process is designed to reduce cost overruns so as to minimize cost growth of projects and to share the risk of additional material quantities with contractors. This research used a test contractor to bid a unit priced contract as a lump sum contract. The contractor was engaged as a "lump sum test contractor" on SP5007-25. The test contractor submitted a lump sum bid prior to the actual bid letting deadline. For the lump sum bid, all quantities were verified, according to the plans. The results were compared to the unit priced bids that were submitted by contractors during the actual bid process. Phase two of this project was a time study of work categories performed by field inspectors and a time study of work categories performed by inspectors on the same jobs during the winter shutdown season. The time study was followed by a survey, which was sent to MnDOT inspectors and Project Engineers in an effort to discern attitudes toward the lump sum bidding process. Finally, feedback about the survey results was solicited from project engineers.

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Lump Sum Estimating: Discovery and Simulation

Final Report

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EXECUTIVE SUMMARY

The lump sum bidding process is designed to reduce cost overruns so as to minimize cost growth of projects and to share the risk of additional material quantities with contractors. This research used a test contractor to bid a unit priced contract as a lump sum contract and then created a survey that was sent to MnDOT inspectors and project engineers in an effort to discern attitudes toward the lump sum bidding process.

The contractor was engaged as a "lump sum test contractor" on SP5007-25. The test contractor submitted a lump sum bid prior to the actual bid letting deadline. Three contractors bid on the actual project. The lowest bid and thus winner of the MnDOT project was Minnowa Construction with a price of $621,677. The lump sum bid totaled $682,266, placing the bid between the second and third bidders. For the lump sum bid, all quantities were verified, though with some difficulty, according to the plans. After going through the lump sum bid process, the consensus was that more time and care needed to be placed on the bid process during lump sum bidding, that accuracy of the plans needed to improve, and that some items would not be agreeable to the contractor to bid as lump sum. Establishing a high degree of accuracy for all items from the documents as provided was a difficult task. The result of the exercise demonstrated that accurate lump sum bidding is possible, though some improvements to the quality of plans would be highly recommended.

The results of the time study showed that the use of inspector time is dependent on the category of work being performed on the job site at the time. Information on the tasks actually performed by the MnDOT project inspectors, since they do not fill out a time card with details of inspection tasks, is unavailable. Anecdotal comments suggest that 80% of an inspector's time is spent reviewing material quantities and processing paperwork so contractors get paid for the materials that are put in place on the job site.

Recommended next steps include a side-by-side cost comparison of projects that are let as lump sum with similar projects let as unit priced. Also, a full study of inspector time would be an excellent decision making tool.

CHAPTER 1: LUMP SUM BACKGROUND

The 1925 MN Highway Department handbook lists 325 bid items for road construction. What is now known as the Materials Control Schedule became more complicated over the years and the current version, published in 2005, lists 9,700 bid items that could be used in the construction of a highway or bridge project. The increase in the number of bid items has exponentially increased the required documentation. Findings under the State Aid for Local Transportation (SALT) Schedule of Materials Control (SMC) project (MnDOT Contract #96885) suggest that there are a number of material requirements that do not justify the cost of inspection. Without a doubt, the expansion of the materials control process has complicated internal estimating for MnDOT as well as the bidding process for contractors. The current bid item process specifies materials that need to be used, assuming that by using specified materials, the final project will meet the required quality standards.

There are several bidding methods used by MnDOT in the construction process. Historically, and by legislative action, unit price bidding was the only method allowed. In recent years, Design Build project delivery (authorized by the MN State Legislature) has been used successfully for a few of MnDOT's largest projects. Other methods used in Minnesota (also needing legislative approval) include A+B, CM at risk, incentives and disincentives and lump sum.

Alternative Contracting (2010) states, "The lump sum bidding technique is designed to reduce quantity overruns as well as the costs associated with contract administration. It allows construction personnel to spend more time on inspection and less time on paperwork." The method is currently used in multiple states, typically on projects that have few variables.

In lump sum bidding, contractors deliver a single price. The single price could be for the entire project, for each bid item or for a group of bid items. The key is that a lump sum bid is delivered, rather than a unit price for each bid item. Several states have begun to work with lump sum bidding. Figure1-1 1 reviews the states with lump sum experience and the specific bid items to which the lump sum process has been applied. Florida has had the most experience with lump sum bidding.

	Mobilization	Structural Steel	Concrete Structures	Cleaning/ Painting Steel	Demolition/ Removal of Str.	Maintenace of Traffic	Landscaping & Maintenance	Clearing & Grubbing	Lighting	Traffic Signals	Temporary Structures/ Falsework	Structural Excavation	Signage	Surveying	Pavements/ Curbs/ Paths	Reinforcement Steel	Piles/Test Piles	Irrigation Systems	Portland Cement	Timber Structures	Railings/ Guardrails/ Fencing	Pavement Markings	Bridge Drainage System
Arizona		X	X		X	X		X				X				X							
California	X			X			X	X										X					
Colorado	X				X		X	X	X	X				X									
Florida	X	X		X		X		X	X		X											X	X
Indiana		X	X	X	X	X	X	X		X	X	X			X								
Iowa	X			X	X	X				X				X									X
Maryland	X	X	X	X	X	X	X	X				X	X			X			X	X	X		
Michigan	X					X	X																
Minnesota	X			X	X		X	X	X	X		X											
N. Carolina	X	X		X	X	X		X	X		X	X		X	X								
Pennsylvania	X		X		X	X		X	X	X	X		X	X			X						
Texas	X			X	X	X					X		X					X					
Washington	X	X	X	X	X	X	X	X		X		X	X	X									
Wisconsin				X		X			X		X	X									X		
Total	**12**	**6**	**5**	**10**	**10**	**11**	**10**	**10**	**6**	**6**	**6**	**7**	**4**	**5**	**2**	**2**	**1**	**2**	**1**	**1**	**2**	**1**	**2**

Figure 1-1: Bid items by state that have been used as lump sum (Alternative payment and progress reporting, 2008)

The most common bidding process used by MnDOT is still unit pricing, where the owner (in this case the State) issues a request for bids to contractors, which includes an expected quantity of materials, calculated by the MnDOT engineers, that will need to be put in place. Contractors bid on the project, with the lowest total bid winning the project. The bid is then certified by the state (for accuracy, etc.) and the contractor performs the work. The contractor is paid for work based on the number of units of each item that are put in place. The contractor will only get paid for the actual units that are put in place, so the inspector must verify all quantities. Each truck load of gravel hauled and each cubic yard of concrete mixed for the project must be measured by the inspector. If the contractor puts in place more units than were originally estimated by MnDOT, the contractor gets paid for the additional units. If the contractor puts in fewer units than originally estimated, they get paid only for the amount actually put in place. According to the standard MnDOT contract, changes are negotiated when the number of units on any one bid item is either 25% over or 25% under the original quantity given to the contractor. No changes to the unitary rate occur until the actual number of units varies by 25% from the original quantity.

The unit priced process places the DOT at a distinct disadvantage by requiring the prediction of unit quantities for all projects. In a 2007 Florida DOT study, the cost growth for Lump Sum projects was the lowest for all types of bidding methods. With 549 lump sum projects in the study, the cost growth was only 1.54%. In the same study, with 1908 traditional design-bid-build projects, cost growth was at 9.36%. One issue of note in the Florida study was that the lump sum process required a higher quality of the bidding documents and that adjustments needed to be made to the design process if the project was intended to be lump sum (Ellis, 2009).

Adding to the cost growth with traditional contracting methods, contractors are also skilled at producing what is termed an “unbalanced” bid. The contractor starts by reviewing MnDOT quantities, looking for items they think MnDOT has under quantified. The contractor inflates the price of these under quantified items, resulting in a higher overall profit, even though the bid total is lower. Unbalanced bids are rejected, when spotted prior to certification. If the winning

bid is deemed unbalanced, the DOT must either give the bid to the second lowest bidder or rebid the entire project. Both actions have costs and delays associated with them. Only lump sum estimating is able to remove the issue of quantity from the bids. In lump sum estimating, contractors deliver a single price for the project, rather than a unit price. The lump sum may be only one total amount for the entire project or it may be a price for each bid category. Minnesota is considering using the lump sum process for roadways which do not have unusual construction issues and bridges that are too small to qualify for Design-Build. Other methods of bidding, including A+B and incentives, have shown promise as motivators to get projects completed more quickly. However, most of the processes use the unit pricing methodology, do not address the issue of the unbalanced bid, and do not address the issue of the DOT responsibility for measuring the put in place quantities.

Changing to lump sum project delivery will also change the testing and inspection process. The process is clearly written in the quality control plan for each job. The quality plan is split into quality control (QC), the testing of work as it progresses, and quality assurance (QA), the testing of the work after completion. Currently, MnDOT takes responsibility for almost all of the testing and inspections. Under lump sum guidelines, which would be similar to the design-build guidelines, the quality control responsibility would belong to the contractor while the quality assurance would belong to the DOT (Current Design Build Practices for Transportation, 2009). On a small ($2 million) bridge project, there are several quality control procedures carried out by inspectors each day. MnDOT inspectors are also responsible for the quality assurance (QA) for the project, meaning they must perform all QC/QA procedures during the construction process. If the MnDOT inspector is not on the job site, work often must stop completely (Standard Specifications for Construction, 2005).

The use of lump sum bidding would require changes to the bidding process. The bidding documents supplied by the DOT would not have plan quantities on them. The contractor would need to do their own quantity take off for individual items. The contractor would hold the risk for estimating how much material is needed for that particular item. Under current practices with MnDOT, contractors download 11” X 17” pdf files for plan sheets. The plan sheets are insufficient for accurate quantity take off work (Wadd, 2010). The pdf files are also not usable for importing into take-off software that is designed to improve both speed and accuracy of quantity take off work. In order for contractors to accurately compute the quantities in a timely manner, the original versions of the files will need to be released by MnDOT. The need to perform the quantity take off work will cause some contractors to stop doing DOT work, since some contractors don’t know how to do take offs. It will cause other contractors to hire additional help, especially during the busy spring bidding season.

Using the lump sum method, the contractor will need to submit a CPM schedule in order to track tasks and the percentage that they are complete. Creating a CPM schedule that works for both MnDOT and the contractors will be challenging. Current MnDOT practice is in transition from requiring a simple bar chart schedule on most projects to requiring Oracle Primavera P6 schedules for all projects. Using the previous requirements, contractors were able to draw a schedule by hand. Only if there were special scheduling provisions added to the specifications would a full CPM schedule be required (Contract Administration Manual, 2009). Following the transition to CPM scheduling, MnDOT will require a schedule using Primavera P6 software. (Wiener, 2010). Since the contractor will be paid for completion of the tasks rather than

according to the quantities put in place, it will be essential to have an accurate measure of the completion percentage for each job that an accurate CPM schedule allows.

CHAPTER 2: PROJECT BACKGROUND

This project began with a lump sum bid simulation as Task 1A. The results of Task 1A were reported in April, 2011. The project chosen was a small bridge project in Mower County. It was chosen as a sample lump sum project in order to create a comparison to the actual project that was being bid at the same time. The "test contractor" did not use any subcontract quotes from suppliers who bid on the actual job, in order to ensure neutrality. The test contractor submitted the lump sum bid prior to the actual bid letting deadline. Three contractors bid on the actual project. The lowest bid and thus winner of the MnDOT project was Minnowa Construction with a price of $621,677. The lump sum bid totaled $682,266, placing the bid between the second and third bidders. For the lump sum bid, all quantities were verified, though with some difficulty, according to the plans. After going through the lump sum bid process, the consensus was that there was more time and care placed on the bid process during lump sum bidding, that accuracy of the plans needed to improve, and that some items would not be agreeable to the contractor to bid as lump sum. The result of the exercise demonstrated that accurate lump sum bidding is possible, though some improvements to the quality of plans would be highly recommended. Two construction projects were chosen for the field based time assessment. The projects were the mill, regrade and repave of Highway 83 in the Mankato District and the 2011 work on the construction of Highway 14 from Mankato to Owatonna. Task 1B included several days of site visits with the inspectors and project managers, which included discussions of tasks and time spent on those tasks. The two jobs selected for the office based study were the same as used for Task 1B, the Highway 83 project and the Highway 14 project.

Based on the information obtained in Tasks 1B and 1C, Task 1D was to perform an electronic survey of field personnel. The purpose of this survey was to assess MnDOT employee task priorities, their attitudes towards switching to a lump-sum bidding system, and what effects a switch might have on their task priorities. A total of 60 Participants were asked questions regarding their job classification, which tasks they typically work on, and how much time they spend on these tasks. Similarly, participants were asked to imagine how much time they would spend on these tasks if MnDOT were to switch to a lump-sum bidding process.

CHAPTER 3: LUMP SUM BID

Task 1A utilized a test contractor to develop a lump sum proposal for a small bridge project in the Rochester District, SP 5007-25. The research compared the unit price bidding process to the lump sum bidding process. Project SP 5007-25 was let by MnDOT on February 26. 2010, and let on a unit price basis. The test contractor had the identical bidding documents as the actual contractors who bid on the project. The test contractor developed his own quantity take offs based on the information contained in the plans. The lump sum bid was developed using the quantities developed by the test contractor. The test contractor also developed pricing for the District 6 Quality Manual. Details of the bid results are contained in Appendix A.

The objectives for Task 1A were to track labor costs for the lump sum bidding process. In order to accomplish the objective, the test contractor broke out hours spent among the following tasks: jobsite investigations, plan & specification review, quantity take off, subcontractor solicitation and estimating. The test contractor then submitted a Lump Sum Proposal with item descriptions and cost details using test contractor's quantity take off work. Costs were developed for Risk Based Inspection/Quality Management Program with an independent testing agency. Included in the costs was an itemized estimate of services provided. Finally, supporting information including subcontractor feedback, observations made by test contractor regarding lump sum bidding process and comparison to unit price bidding was provided.

Table 3-1 contains a summary of the hours, broken out into the seven categories, spent performing the Lump Sum bid for SP 5007-25.

Table 3-1: Recap of time spent estimating SP 5007-25

Description	Quantity	Unit	Notes
Pre-jobsite investigation	4	Hours	Estimate only, no job site visit
Plan and specification review	16	Hours	
Quantity Take off	24	Hours	As possible from the plans provided
Subcontractor solicitation	7	Hours	
Estimating	16	Hours	
Preparation of supporting documentation	16	Hours	
Misc meetings and discussion	7	Hours	
Totals	**90**	**Hours**	

Agtek takeoff software with a digitizer board was utilized as much as possible for quantification of items for the SP 5007-25 project. For the estimate portion of the work, Bid 2 Win estimating software was used. The bid form was populated with the takeoff quantities generated and verified using the plans and the software, except where noted. For the bid items that were not generated/verified by the test contractor, the tabulations listed on the plan sheet were used.

Finally, as a double check, a hand scale was used on the plan sets to spot check both the contractor work and the MnDOT supplied quantities.

Quantities digitized using the Agtek software and the digitizer board include: Removals, Grading, Erosion Control, Bituminous Paving, Utilities and the Bridge Approach Panels. However, establishing a high degree of accuracy for all items from the documents as provided was a difficult task. First, when working with a 1"=50' scale, there is a 5% to 15% error introduced. Also, the degree of detail on the plans to simply digitize or scale them for all quantities from the 2D surface would be next to impossible. The quantities generated for the takeoff with Agtek and the digitizer board were within 5% to 10% (within the margin of error at 50 scale) of the Statement of Estimated Quantities provided by MnDOT, with only a few exceptions. From the bidder's standpoint, electronic drawing files that could be downloaded to an estimating software program would be essential. In addition, a full size set of drawings to a scale of 1"=20' would be required to achieve a higher degree of accuracy for either scaling the project for quantities or using a digitizer board. Also, the degree of detail on the plan sheet would need to reflect the actual limits of placement, removals, etc. of each item of work. In addition, Quantity Tabulations and Bill of Materials for some items such as the substructure of the bridge would still need to be included.

It is believed that there is a greater standard of care in bidding lump sum for a project, as there is no recourse or claim for additional work, other than changed/latent conditions or plan changes. The contractor must build the project to the line and grade as shown on the plans. In addition, a common practice of "plugging numbers" and "abstract bidding" may be reduced with a Lump Sum system of bidding. Plugging a number is when a contractor does not have quoted price for a certain item of work. Thus, the contractor simply uses historical data, abstracts, crystal, balls, etc. to plug the "hole" in his bid. In theory, the Lump Sum process should force a Contractor and for that matter the owner, to "Build" his/her project prior to building it in the field. At the very least, the project should be thought through more thoroughly with the Lump Sum process.

During the Lump Sum bid for SP 5007-25 subcontractor quotes were solicited. Reaction was mixed to the Lump Bidding. Although many of these contractors have bid Lump Sum work before in the private sector, the initial reaction included concern that bidding Lump Sum for MnDot projects was going to be a challenge due to the extra time needed to perform the quantity takeoff. Also, concern was expressed over plans sheets that would not be detailed enough to accurately reflect project specific requirements.

Other subcontractors expressed ideas on how the process would initiate better communication during the bid process. For example, the subcontractor for Quality Assurance shared ideas on how to decrease the number trips for their inspectors if the contractor could stage multiple concrete pours at one time. While, this may not always work, at least the discussion occurred and it was an opportunity for cost savings.

The Quality Manual bid was divided into three parts. A certified subcontractor was solicited for Quality Assurance while the test contractor was deemed responsible for Quality Control. The Quality Assurance was approximately 60% of the cost of the program. The certified subcontractor was agreeable to the work and believed the requirements to be reasonable. An additional $1800 was allowed for program development by the contractor.

The test contractor submitted his lump sum bid prior to the actual letting date and time. The ultimate goal of this pilot project was to provide a comparison to a unit priced project and evaluate the cost effectiveness of changing to a lump sum bidding process.

The lump sum simulation for SP5007-25 demonstrated that the lump sum concepts are viable. The bid total for the lump sum contractor was less than $200 off the engineer's estimate on a project valued at over $600,000. The largest discrepancies in prices between the lump sum contractor and MnDOT were for items that were already listed in the Schedule of Values as lump sum. The lump sum contractor bid was $62,000 more than the winning contractor, but was $2,300 less than the second place contractor.

The lump sum process also identified bid items that could have created an unbalanced bid. The clearest example is item 2452.510 Steel H Piling. The Engineer's estimate was $10 per foot. The lump sum bid was $28.15 per foot while the two contractors actually bidding on the job used $1 per foot. The true costs of the pilings were obviously buried in another bid item or items that could possibly bring back a higher return to the contractor. The lump sum bidding process removes the motivation for creation of an unbalanced bid by the contractor, since there would be no reward for the practice.

The Quality Manual was also bid by the lump sum contractor using subcontract services that would be typical of any contractor bidding on such a project. The manual bid at a $58,275 with $34,055 going to a certified subcontractor and the remainder as added expenses for the contractor.

This lump sum estimating project demonstrated that the results of a lump sum process could be very similar to the results of the traditional unit priced process. The proposal quantities as determined by the lump sum contractor were not significantly different from the proposal quantities measured by MnDOT. The variability of quantities was as likely in one direction as the other and the net result was close to zero. Items with the largest variability were also items with the lowest unit prices, minimizing the cost impact. The net result of the lump sum bid was within $200 of the engineer's estimate, an amazing result, considering all applicable bidding rules were followed.

CHAPTER 4: LUMP SUM SURVEY

Through discussion with MnDOT Project Engineers and Project Inspectors, MSU developed categories to be used in a time study. Two construction projects were chosen for the time study. The two projects were the mill, regrade and repave of Highway 83 in the Mankato District and the 2011 work on the construction of Highway 14 from Mankato to Owatonna.

Task 1B included several days of site visits with the inspectors and project managers, which included discussions of tasks and time spent on those tasks. Research was conducted in the field to determine where Project Inspectors spend their time and the creation of some method to track that time. The Project Engineers and Project Inspectors were very cooperative in their efforts to provide the researchers with the needed information. The results of the time study have shown that the use of inspector time is dependent on the category of work being performed on the job site at the time. The job shadowing and talks with construction personnel resulted in a Time Study Site Interview Form (Appendix A). This form includes nine main work categories broken down by Plan Review, Quantifying Work Done, Inspection, Testing, Clerical Work, and Computers. For example, if a Project Inspector is performing in Work Category 005 Erosion Control, a majority of the time spent in this work category was classified as Inspection and Quantifying Work done.

Task 1C included discussions of office work for the same projects, which occurred following the close of the construction season. The role of the DOT inspector will change with lump sum contracts. Once the number of units put in place is no longer the basis for payment, the role of the inspector will change. MnDOT will need to develop guidance and training for inspectors to move from an era of counting quantities to an era of risk-based inspection. The contractor no longer will have an amount of material specified, so there will need to be significantly more attention paid to the Quality Control (QC) and Quality Assurance (QA) Plans. The inspector will need to have guidance for necessary inspections because the contractor (and not the internal MnDOT estimating department) will produce the quantities of materials needed.

Task 1D of the Lump Sum Project, MnDOT Agreement 97281, was to perform an electronic survey of field personnel. The purpose of this survey was to assess MnDOT employee task priorities, their attitudes towards switching to a lump-sum bidding system, and what effects a switch might have on their task priorities. A copy of the survey is contained in Appendix B.

A total of 60 Participants responded to the questions regarding their job classification, which tasks they typically work on, and how much time they spend on these tasks. Similarly, participants were asked to imagine how much time they would spend on these tasks if MnDOT were to switch to a lump-sum bidding process.

When participants were asked to think about their current project and compare how much time *should be* spent on a task and how much time *is* spent on each task the two the response rankings differed. Based on the average rankings of tasks in regards to the amount of time that *should be* spent on each task; tasks were ranked from the most amount of time that should be spent to the least amount time that should be spent. The five tasks were ranked in the following order: Inspection, Plan Review, Quantifying Work, Material Testing, Clerical Work, and Computers.

When participants were asked to rank the tasks in regards to time that *is* spent on each task, results ranked the tasks in the following order: Inspection, Quantifying Work, Plan Review, Clerical Work, Material Testing, and Computers.

Participants were then asked to rank tasks after switching to a lump-sum bidding system, the amount of time that *should be* and the amount of time that *is* spent were identical. Ranking was as follows: Inspection, Plan Review, Quantifying Work, Material Testing, Clerical Work, and Computers.

Overall, results indicate that a majority of participants believe that switching to a lump-sum bidding process would require less time doing Quantifying Work, less time doing Clerical Work, and the same amount or more time doing Inspection work.

CHAPTER 5: SUMMARY

This lump sum estimating project demonstrated that the bid results of a lump sum process could be very similar to the bid results of the traditional unit priced process. The proposal quantities as determined by the lump sum contractor were not significantly different from the proposal quantities measured by MnDOT. The variability of quantities was as likely in one direction as the other, and the net result was close to zero. Items with the largest variability were also items with the lowest unit prices, minimizing the cost impact. The net result of the lump sum bid was within $200 of the engineer's estimate, an amazing result, considering all applicable bidding rules were followed.

The next step in the lump sum process will be to compare as-built costs for a bridge built using a lump sum contract to the as-built costs for a bridge built using the unit priced contract. The final costs would be analyzed to review how the lump sum process could have affected any cost growth.

The survey demonstrated that there would be some time savings for the field inspector on lump sum projects. Inspectors would not need to collect load tickets and seed certificates, but could instead focus on inspections of work as it was put in place. The survey also showed there would be some time savings for inspectors as winter jobs of checking measurements were performed. Under a lump sum bid, the verification by a second MnDOT employee of summer calculations would not be necessary. Information on the tasks actually performed by the MnDOT project inspectors, since they do not fill out a time card with details of inspection tasks, is unavailable. Anecdotal comments suggest that 80% of an inspector's time is spent reviewing material quantities and processing paperwork so contractors get paid for the materials that are put in place on the job site. Additional research to determine time allocation for field inspectors would be necessary to improve the understanding of time spent on counting quantities of materials.

Current practices for contracting have been in place for 85 years or longer. Updating the unit price bidding process using an online bidding format has been very successful. Additional research on the estimating, bidding, and project management practices for the industry would be of great benefit to the industry.

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APPENDIX A

LUMP SUM ESTIMATE SUMMARY

To:	MN Dept of Transportation								
Address:	St. Paul, MN								
Project Name: T.H. 105 Grading and Bridge 2110				Pilot Project Lump Sum Proposal SP 5007-25					
Project Location: T.H. 105 Mower County				Bid Date:	2/26/2010				
		Lump Sum		Lump Sum	Lump Sum	Mn/DOT	Minnowa	Minnowa	Qty
Item #	Description	Est Qty	Unit	Unit Price	Total Price	Qty	Unit Price	Total Price	Difference
2021.501	MOBILIZATION	1.00	LS	30,000.00	30,000.00	1.00	18,000.000	18,000.00	0.00
2031.602	COMBINATION FIELD AND OFFICE	1.00	EACH	3,500.00	3,500.00	1.00	4,000.000	4,000.00	0.00
2051.501	MAINTENANCE & RESTORATION OF HAUL R	1.00	LS	2,500.00	2,500.00	1.00	1.000	1.00	0.00
2101.501	CLEARING	0.71	ACRE	6,500.00	4,615.00	0.60	2,000.000	1,200.00	0.11
2101.502	CLEARING	8.00	EACH	445.00	3,560.00	8.00	100.000	800.00	0.00
2101.506	GRUBBING	0.71	ACRE	3,825.00	2,715.75	0.60	2,000.000	1,200.00	0.11
2101.507	GRUBBING	8.00	EACH	250.00	2,000.00	8.00	50.000	400.00	0.00
2104.501	REMOVE PIPE CULVERTS	84.00	LF	14.55	1,222.20	74.00	7.000	518.00	10.00
2104.501	REMOVE FENCE	474.00	LF	3.20	1,516.80	490.00	2.000	980.00	-16.00
2104.501	REMOVE GUARD RAIL	683.00	LF	2.70	1,844.10	702.00	3.000	2,106.00	-19.00
2104.505	REMOVE BIT PAVEMENT (FULL DEPTH)	1,639.00	SY	4.70	7,703.30	1,636.00	2.000	3,272.00	3.00
2104.509	REMOVE MARKER	4.00	EACH	38.00	152.00	4.00	30.000	120.00	0.00
2104.509	REMOVE SIGN TYPE C	1.00	EACH	54.00	54.00	1.00	30.000	30.00	0.00
2104.513	SAWING BIT PAVEMENT	46.00	LF	6.50	299.00	44.00	5.000	220.00	2.00
2104.523	SALVAGE ENERGY ABSORBING TERM	4.00	EACH	245.00	980.00	4.00	400.000	1,600.00	0.00
2104.523	SALVAGE SIGN TYPE C	6.00	EACH	70.00	420.00	6.00	30.000	180.00	0.00
2106.607	EXCAVATION COMMON	4,614.00	CY	4.16	19,194.24	4,380.00	3.000	13,140.00	234.00
2106.607	COMMON EMBANKMENT	3,303.00	CY	3.16	10,437.48	2,947.00	1.500	4,420.50	356.00
2106.607	SELECT GRAN EMBANK MODIFIED 10%	2,890.00	CY	19.35	55,921.50	2,822.00	14.000	39,508.00	68.00
2118.501	AGG SURFACING CLASS 2	52.00	TON	41.00	2,132.00	46.00	18.000	828.00	6.00
2123.509	DOZER	20.00	HR	102.00	2,040.00	20.00	140.000	2,800.00	0.00
2211.501	AGG BASE CLASS 5	953.00	TON	15.85	15,105.05	1,048.00	11.250	11,790.00	-95.00
2221.501	AGG SHOULDER CLASS 2	96.00	TON	21.70	2,083.20	93.00	18.750	1,743.75	3.00
2232.501	MILL BIT SURFACE (1.5")	123.00	SY	7.00	861.00	127.00	18.000	2,286.00	-4.00
2301.553	BRIDGE APPROACH PANELS	311.00	SY	128.00	39,808.00	305.00	130.000	39,650.00	6.00
2360.501	TYPE SP 12.5 WEAR COURSE MIX (3,B)	532.00	TON	84.70	45,060.40	522.00	70.000	36,540.00	10.00
2501.602	18" SAFETY APRON	6.00	EACH	260.00	1,560.00	6.00	300.000	1,800.00	0.00
2501.603	18" PIPE CULVERT	76.00	LF	34.00	2,584.00	76.00	30.000	2,280.00	0.00
2511.501	RANDOM RIP RAP CLASS IV	164.00	CY	64.00	10,496.00	164.00	50.000	8,200.00	0.00
2540.602	MAIL BOX SUPPORT	2.00	EACH	135.00	270.00	2.00	165.000	330.00	0.00
2554.501	TRAFFIC BARRIER DESIGN SPECIAL	100.00	LF	67.75	6,775.00	100.00	65.000	6,500.00	0.00
2554.509	GUIDE POST TYPE B	6.00	EACH	54.00	324.00	6.00	45.000	270.00	0.00
2554.523	ENT TREATMENT-TANGENT TERM	4.00	EACH	2,565.00	10,260.00	4.00	2,275.000	9,100.00	0.00
2563.601	TRAFFIC CONTROL	1.00	LS	20,000.00	20,000.00	1.00	4,800.000	4,800.00	0.00
2564.531	SIGN PANELS TYPE C	9.00	SF	38.25	344.25	9.00	40.000	360.00	0.00
2564.537	INSTALL SIGN TYPE C	3.00	EACH	100.00	300.00	3.00	125.000	375.00	0.00
2564.553	CLEARANCE MARER X4-4	4.00	EACH	90.00	360.00	4.00	135.000	540.00	0.00
2572.501	TEMP FENCE	98.00	LF	12.15	1,190.70	100.00	1.500	150.00	-2.00
2573.501	BALE BARRIER	187.00	LF	3.25	607.75	230.00	2.000	460.00	-43.00
2573.502	SILT FENCE, TYPE HD	522.00	LF	2.00	1,044.00	550.00	1.650	907.50	-28.00
2573.502	SILT FENCE, TYPE MACHINE SLICED	801.00	LF	1.60	1,281.60	850.00	1.550	1,317.50	-49.00
2573.505	FLOATATION SILT CURTAIN	300.00	LF	14.70	4,410.00	350.00	9.000	3,150.00	-50.00
2573.507	TEMP PIPE DOWNDRAIN	45.00	LF	25.40	1,143.00	50.00	3.000	150.00	-5.00
2573.512	TEMP DITCH CHECK TYPE 3	262.00	LF	5.50	1,441.00	204.00	3.000	612.00	58.00
2573.513	TEMP DITCH CHECK TYPE 7	61.00	CY	60.10	3,666.10	69.00	40.000	2,760.00	-8.00
2573.540	FILTER LOG TYPE ROCK LOG	90.00	LF	5.40	486.00	90.00	3.600	324.00	0.00
2575.501	SEEDING	2.50	ACRE	220.00	550.00	2.50	200.000	500.00	0.00
2575.502	SEED MIX 150	56.00	LB	2.20	123.20	56.00	1.600	89.60	0.00
2575.502	SEED MIX TYPE 250	77.00	LB	1.90	146.30	77.00	2.220	170.94	0.00
2575.505	SODDING TYPE LAWN	939.00	SY	2.70	2,535.30	932.00	3.200	2,982.40	7.00
2575.511	MULCH TYPE 1	3.00	TON	195.00	585.00	3.00	125.000	375.00	0.00
2575.519	DISK ANCHORING	1.40	ACRE	65.00	91.00	1.40	45.000	63.00	0.00
2575.523	EROSION CONTROL CAT 5	4,276.00	SY	1.00	4,276.00	5,324.00	1.170	6,229.08	-1,048.00
2575.525	EROSION STABILIZATION CLASS 3	106.00	SY	6.50	689.00	108.00	5.500	594.00	-2.00
2575.532	FERTILIZER TYPE 1	610.00	LB	0.55	335.50	610.00	0.430	262.30	0.00
2575.532	FERTILIZER TYPE 3	39.00	LB	0.66	25.74	39.00	0.450	17.55	0.00
2575.571	RAPID STABILIZATION 3	6.00	MGAL	430.00	2,580.00	6.00	325.000	1,950.00	0.00
2582.501	PAVEMENT MESSAGE PAINT	2.00	EACH	305.00	610.00	2.00	150.000	300.00	0.00
2582.502	4" SOLID LINE WHITE	150,691.00	LF	0.05	7,534.55	150,691.00	0.035	5,274.19	0.00
2582.502	4" SOLID LINE YELLOW	15,212.00	LF	0.05	760.60	15,212.00	0.035	532.42	0.00
2582.502	4" BROKEN LINE YELLOW	13,791.00	LF	0.05	689.55	13,791.00	0.035	482.69	0.00
2582.502	4" DOUBLE SOLID LINE YELLOW	6,652.00	LF	0.10	665.20	6,652.00	0.070	465.64	0.00
SUBTOTAL					**346,465.36**			**252,008.05**	

2104.601	REMOVE REGULATED WASTE	1.00	LS	4,900.00	4,900.00	1.00	1,700.000	1,700.00	0.00
2401.501	STRUCTURAL CONCRETE	97.00	UNIT	560.00	54,320.00	97.00	600.000	58,200.00	0.00
2401.512	BRIDGE SLAB CONCRETE	3,202.00	SF	11.30	36,182.60	3,202.00	20.000	64,040.00	0.00
2401.513	TYPE F RAILING CONCRETE	245.00	LF	70.65	17,309.25	245.00	60.000	14,700.00	0.00
2401.541	REIN BARS	31,340.00	LB	1.08	33,847.20	31,340.00	1.100	34,474.00	0.00
2401.601	STRUCTURE EXCAVATION	1.00	LS	15,085.00	15,085.00	1.00	15,000.000	15,000.00	0.00
2402.590	ELASTOMERIC BEARING PAD	14.00	EACH	270.00	3,780.00	14.00	100.000	1,400.00	0.00
2405.502	PRESTRESSED CONCRETE BEAMS	562.00	LF	160.00	89,920.00	562.00	155.000	87,110.00	0.00
2442.501	REMOVE EXIST BRIDGE	1.00	LS	18,825.00	18,825.00	1.00	20,000.000	20,000.00	0.00
2452.510	STEEL H-PILING DRIVEN	605.00	LF	28.15	17,030.75	605.00	1.000	605.00	0.00
2452.511	STEEL H-PILING DELIVERED	605.00	LF	11.00	6,655.00	605.00	26.000	15,730.00	0.00
2452.520	STEEL H-TEST PILE 30'	2.00	EACH	2,500.00	5,000.00	2.00	6,000.000	12,000.00	0.00
2452.520	STEEL H-TEST PILE 45'	2.00	EACH	2,700.00	5,400.00	2.00	7,000.000	14,000.00	0.00
2452.602	PILE TIP PROTECTION	26.00	EACH	110.00	2,860.00	26.00	100.000	2,600.00	0.00
2511.501	RANDOM RIP RAP CLASS iv	441.00	CY	60.00	26,460.00	441.00	60.000	26,460.00	0.00
2511.515	GETEX TYPE iv	550.00	SY	1.59	874.50	550.00	3.000	1,650.00	0.00
SUBTOTAL					**338,449.30**			**369,669.00**	
QMQC									
2011.601	QUALITY MGMT (CERT SUB)	1.00	LS	34,055.00	34,055.00				
2011.601	QUALITY MGMT CONTRACTOR	38.00	DY	590.00	22,420.00				
2011.601	CONSTRUCTIONQUALITY MGMT PROGRAM	1.00	LS	1,800.00	1,800.00				
SUBTOTAL					**58,275.00**				
SURVEY									
2011.601	CONTRUCTION LAYOUT & STAKING	1.00	LS	11,500.00	11,500.00				
SUBTOTAL					**11,500.00**				
Lump Sum Bid Total (without QA/QC)		**684,914.66**		**with QA/QC**	**754,689.66**	**Low Bid Contractor Total**		**621,677.05**	

APPENDIX B

TIME STUDY SITE INTERVIEW FORM

Lump Sum Time Study
Data Collection Form

Job Type _____ Contractor _____

Job _____ Date _____

Mn/DOT Employee _____ Position _____ Hours in work week _____

MNSU Researcher _____

Effort in Hours

	Work Category	Plan Review	Quantifying Work Done	Inspection	Testing	Clerical Work	Computers
001	Binuminous mainline paving						
002	Bituminous Ancillary paving						
003	Structural Concrete						
004	Misc Concrete						
005	Erosion Control						
006	Grading & Base						
007	Landscape						
008	Metallic						
009	Pipe						
010							
		%	%	%	%	%	%

Percent of work week spent in the above categories. Must equal 100%.

Majority of Time Spent

___ Plan Review

___ Quantifying Work D

___ Inspection

___ Testing

___ Clerical Work

___ Computers

Priority Ranking

___ Plan Review

___ Quantifying Work D

___ Inspection

___ Testing

___ Clerical Work

___ Computers

Notes:

APPENDIX C

LUMP SUM SURVEY

The purpose of this study is to examine task priorities. No one other than members of the research team will have direct access to your responses. Survey results will be summarized at the group level. Please answer each question honestly and to the best of your ability. Feel free to skip any questions that make you uncomfortable.

Q1. Personal Information

Current Job (1)

SP Number (2)
Date (3)
Hours in a Typical Work Week (4)

Q2. What is the contract amount for the project under which you are currently working?

- ❍ Less than $1,000,000 (1)
- ❍ $1,000,000 - $5,000,000 (2)
- ❍ $5,000,000 - $20,000,000 (3)
- ❍ Greater than $20,000,000 (4)

Q3. What is your job classification?

- ❍ Resident Engineer (1)
- ❍ Project Engineer (2)
- ❍ Lead Inspector (3)
- ❍ Inspector (4)

Q4. Think about your current project. Please rank each of the following such that: 1 is the task you spend most of your time performing and 6 is the task you spend the least amount of time performing.

_____ Plan Review (1)
_____ Quantifying Work Done (2)
_____ Inspection (3)
_____ Material Testing (4)
_____ Clerical Work (Counting load tickets and all associated processes) (5)
_____ Computers (Logging on, setup, and trouble shooting) (6)

Q5. Think about how much time you SHOULD be spending on each task. That is, what is a better use of your time? Please rank each of the following such that: 1 is the task you should

spend most of your time performing 6 is the task you should spend the least amount of time performing.

_____ Plan Review (1)
_____ Quantifying Work Done (2)
_____ Inspection (3)
_____ Material Testing (4)
_____ Clerical Work (Counting load tickets and all associated processes) (5)
_____ Computers (Logging on, setup, and trouble shooting) (6)

Q6. Which of the following tasks did you work on in a typical year?

- ❑ Grading and Base Construction (1)
- ❑ Bituminous Construction (2)
- ❑ Concrete Construction (3)
- ❑ Landscaping and Erosion Control (4)
- ❑ Chemical Items (5)
- ❑ Metallic Materials and Metal Projects (6)
- ❑ Pipe Work (7)
- ❑ Brick, Stone, and Masonry (8)
- ❑ Electrical & Signal Equipment (9)
- ❑ Bridge Work (10)
- ❑ None of the above (11)

Q7. How many hours per week do you spend doing each of the following tasks?
_____ Plan Review (1)
_____ Quantifying Work Done (2)
_____ Inspection (3)
_____ Testing (4)
_____ Clerical Work (Counting load tickets and all associated processes) (5)
_____ Computers (Logging on, setup, and trouble shooting) (6)

Q8. Think about each of the following tasks. If MNDOT were to change to a lump sum bidding system, what would happen to the amount of time you spend on QUANTIFYING WORK DONE?

	I would spend less time quantifying work done (1)	It would stay the same (2)	I would spend more time quantifying work done (3)
Grading and Base Construction (1)	❑	❑	❑
Bituminous Construction (2)	❑	❑	❑
Concrete Construction (3)	❑	❑	❑
Landscaping and Erosion Control (4)	❑	❑	❑
Chemical Items (5)	❑	❑	❑
Metallic Materials and Metal Projects (6)	❑	❑	❑
Pipe Work (7)	❑	❑	❑
Brick, Stone, and Masonry (8)	❑	❑	❑
Electrical & Signal Equipment (9)	❑	❑	❑
Bridge Work (10)	❑	❑	❑

Q9. Think about each of the following tasks. If MNDOT were to change to a lump sum bidding system, what would happen to the amount of time you spend DOING CLERICAL WORK?

	I would spend less time doing clerical work (1)	It would stay the same (2)	I would spend more time doing clerical work (3)
Grading and Base Construction (1)	❑	❑	❑
Bituminous Construction (2)	❑	❑	❑
Concrete Construction (3)	❑	❑	❑
Landscaping and Erosion Control (4)	❑	❑	❑
Chemical Items (5)	❑	❑	❑
Metallic Materials and Metal Projects (6)	❑	❑	❑
Pipe Work (7)	❑	❑	❑
Brick, Stone, and Masonry (8)	❑	❑	❑
Electrical & Signal Equipment (9)	❑	❑	❑
Bridge Work (10)	❑	❑	❑

Q11. Think about each of the following tasks. If MNDOT were to change to a lump sum bidding system, what would happen to the amount of time you spend DOING INSPECTION WORK?

	I would spend less time inspecting (1)	It would stay the same (2)	I would spend more time inspecting (3)
Grading and Base Construction (1)	❑	❑	❑
Bituminous Construction (2)	❑	❑	❑
Concrete Construction (3)	❑	❑	❑
Landscaping and Erosion Control (4)	❑	❑	❑
Chemical Items (5)	❑	❑	❑
Metallic Materials and Metal Projects (6)	❑	❑	❑
Pipe Work (7)	❑	❑	❑
Brick, Stone, and Masonry (8)	❑	❑	❑
Electrical & Signal Equipment (9)	❑	❑	❑
Bridge Work (10)	❑	❑	❑

Q12. What materials typically run over plan quantities?

Q13. What materials typically run under plan quantities?

Q14. What materials run closest to plan quantities?

Q15. Changing from unit pricing to a lump sum bidding process would:

	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
allow me to spend time on more important tasks (1)	❍	❍	❍	❍	❍
improve the quality of my work (2)	❍	❍	❍	❍	❍
lower the cost of most projects (3)	❍	❍	❍	❍	❍
lower my job security or lower the need for my job (4)	❍	❍	❍	❍	❍
make contractors more accountable (5)	❍	❍	❍	❍	❍
cause change orders to become more frequent (6)	❍	❍	❍	❍	❍

Q16. Do you believe that inspecting while quantifying is a good practice?

❍ Yes (1)
❍ No (2)

Q17. Please explain why you do or do not believe inspecting while quantifying is a good practice.

Q18. How many hours per week would a lump sum bidding process free up so that you could do more important work?

Q19. Imagine that MNDOT changed to a lump-sum bidding system. Now rank each of the following such that 1 is the task you would spend most of your time performing and 6 is the task you would spend the least amount of time performing.

_____ Plan Review (1)
_____ Quantifying Work Done (2)
_____ Inspection (3)
_____ Testing (4)
_____ Clerical Work (Counting load tickets and all associated processes) (5)
_____ Computers (Logging on, setup, and trouble shooting) (6)

Q20. Imagine that MNDOT changed to a lump-sum bidding system. How many hours per week would you spend doing each of the following tasks?

_____ Plan Review (1)
_____ Quantifying Work Done (2)
_____ Inspection (3)
_____ Testing (4)
_____ Clerical Work (Counting load tickets and all associated processes) (5)
_____ Computers (Logging on, setup, and trouble shooting) (6)