

# CMGC Process Report – Design Phase

## I-70; Bridge Deck Repairs F-I70-3(50)112 Eagle Canyon Bridge



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For

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December 7, 2009

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## Purpose

The purpose of this report is to fulfill the Design Phase requirements outlined in the Memorandum of Understanding (MOU) between the Utah Department of Transportation (UDOT) and the Federal Highway Administration (FHWA) for Alternative Contracting Process – SEP 14; Construction Manager / General Contractor (CMGC) contracts dated May 5, 2007. The CMGC Design Phase report provides the following information:

- A discussion of the how acquiring the services of a contractor during the design phase assisted the team and improved constructability and quality. (MOU, Section 1)
- A discussion of the selection process of the Contractor in the design phase. (MOU, Section 1)
- A “. . . detailed comparison of the UDOT prepared ICE and the negotiated price for construction. (MOU, Section 4.1)
- A “discussion of each of the evaluation criteria”. (MOU, Section 4.1)

The MOU identifies the Evaluation Criteria to be used when assessing the contractor’s involvement in the design phase as follows:

- Design and Constructability
- Innovation
- Project Schedule
- Risk
- Learning opportunities
- Environmental Stewardship
- Benefit to the Public

Furthermore, the UDOT has outlined additional information that is required in this report for internal evaluation. This information includes a comparison of schedule, performance and observations of those involved concerning the successes and difficulties associated with the CMGC process.

This report focuses on the implementation of the CMGC process on the I-70; Bridge Deck Repairs; UDOT Structure number 2C-495; Eagle Canyon project number F-I70-3(50)112, located in UDOT Region 4 area. This project constitutes the “bridge project” for this region in accordance with Section 3 of the MOU.

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## Project Overview

This project, located in Eagle Canyon, Emery County, Utah, involved replacing the bridge deck of the east bound lanes of I-70. There are two bridge structures over Eagle Canyon, one for each direction of traffic. Only the bridge deck on the east bound lanes is part of the project. The existing deck is failing, with evidence of ruts, potholes and cracks. The overall purpose of the project is to extend the life of the bridge and improve traveling safety to the public. (Eagle Canyon Environmental Study, dated June 2, 2007).

The project includes funding from both federal and state sources. A Categorical Exclusion document was approved on January 8, 2009. Table 1 summarizes the project information for the yearend report that will be provided to the Federal Highway Administration:

**TABLE 1 – Project Overview Information Summary**

<b>Project Type:</b>	Bridge
<b>Project Number:</b>	F-I70-3(50)112
<b>PIN:</b>	6625
<b>Funding:</b>	Federal and State
<b>Commission Approved Funding (ePM, screen 495):</b>	\$7,500,000

To improve the condition and safety of the I-70 eastbound structure crossing over Eagle Canyon, the eastbound structure will be closed and all eastbound traffic will be diverted to the westbound lanes via a crossover. The westbound structure will be utilized for both east and westbound traffic throughout the construction period. This project requires two crossovers to divert traffic off the eastbound lanes west of the bridge under construction and then back onto the eastbound lanes after passing the construction site. It is estimated that the temporary closure of the bridge will last eight weeks. The total length of the project is 4.5 miles. Key elements in the construction project include 485 feet of bridge deck, a staging area, and an east and west traffic crossover (Eagle Canyon Environmental Study, dated June 2, 2007).

To accelerate the construction of the bridge deck, the bridge deck will be replaced with pre-cast panels that will be reattached to the existing structure. Initially these panels were to be fabricated on site, however due to construction timing and quality control requirements it was determined that the panels will be fabricated at a pre-casting yard in Salt Lake County.

## Design costs

UDOT contracted with Horrocks Engineers on June 25, 2009 to provide design services including:

- Preliminary engineering

- Final structure design
- Final roadway design (Median Crossovers and MOT)
- Preparation of the PS&E plan

For the Independent Cost Estimation (ICE), UDOT contracted with Stanton Constructability Services. And finally, Granite Construction was selected to represent the contractor’s interest in the design stage. Their scope was to perform constructability alternatives, risk assessment and offer design input. Table 2 below shows the breakdown of design costs:

**Table 2 – Design Fee Breakdown**

<b>Designer’s Fee (Horrocks)</b>	\$300,674.34
<b>CMGC Design Fee</b>	\$111,152.00
<b>ICE Preparer’s Fee</b>	\$19,647.18
<b>Total Design Costs</b>	\$431,473.52
<b>CMGC fee as a Percent of Total:</b>	25.76%

### Construction Costs

UDOT contracted with Granite Construction Company to provide construction services under the CMGC process for \$ 5,294,135.21.

### Project Goals

UDOT determined that success on this project required a balance of the following outcomes:

- A high level of safety for motorists, with minimal inconvenience.
- A high quality, durable product constructed in the least time possible.
- Completion of the project within the project budget.

Key project elements affect the balance of these goals including overall constructability, project construction phasing, and impacts to motorists. UDOT recognized that achieving balance of the project goals required that the Contractor work closely with the design team during the design phase.

### Price Component

To establish standard pricing comparisons, UDOT included in the RFP a Contractor Price Submittal (RFP-Appendix D) which identifies standardized services or supplies and set quantities.

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As part of the review of the procurement process (See Contractor Price Proposal below) these costs were compared. Items on the lists included:

- Remove Bridge Deck
- Precast Concrete Full Barrier (New Jersey Shape)
- Precast concrete panel

### **Cost Model**

The explanation of cost was broken down in the instructions for the RFP's Approach to Price Proposal (RFP-Appendix E). As part of the proposal, a breakdown of the unit price was required for each of the price component items listed in the RFP Appendix D. The breakdown included the following elements:

- Labor
- Equipment
- Material
- Trucking
- Other-(Description required)
- Overhead
- Profit

Furthermore, the RFP Appendix D stated that the unit prices reported would be held throughout the project unless justification was expressly stated in the proposal. Justification was required for the following:

- Identify reasons for increase in unit price:
- Identify reasons for decrease in unit price:
- Identify amount of quantity change that would justify a change in unit price:
- Identify assumptions used to create unit cost:

### **Applicability of the CMGC Process**

In accordance with the original MOU between UDOT and FHWA, each project selected for the CMGC contracting process must evaluate how the criteria for selection were impacted by the project. It is important to note that in accordance with the MOU, additional characteristics that make the project a good candidate for the CMGC process can be justified by UDOT. The CMGC process was the preferred method of addressing this project based on the following:

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- Design and Constructability
  - Innovation
  - Project Schedule
  - Risk
  - Benefit to the Public

### **Design and Constructability**

The Eagle Canyon Bridge Repairs benefitted from contractor input during design. Traditional methods of design require that the designer anticipate a construction method to be implemented on the bridge deck and design to that method. Once a contractor is on board their means and methods would be evaluated to determine if the assumptions made by the designer were accurate. As a member of the design team, Granite construction guided the design to suite their means and methods of construction. As a result the redundancy of design evaluation was eliminated. Furthermore, because of the age of the bridge, Granite began to point out that traditional methods of construction could endanger the integrity of the bridge itself. Horrocks looked at the loading induced on the structure of the bridge utilizing traditional methods and found that the existing structure could not withstand the concentrated loads that would occur during construction. Therefore alternative methods of construction were discussed during design. With traditional Design Bid Build methods these issues would have been determined during construction and resulted in time delays and perhaps increased costs as the resulting construction became schedule driven.

Granite helped identify structural deficiencies and provided recommendations which lead to the most constructive and effective design solutions. For example, excessive point loads on the bridge deck during construction meant that placement of precast bridge panels by traditional cranes could not be used. Alternative methods included a traditional gantry system erected on the bridge or the use of an oversized crane that could reach all sections of the bridge from the abutments. Once the oversize crane was deemed the most cost effective, the crane was reserved during the design phase to ensure its availability once construction began. As the parameters were set for the accessibility of the crane, allowable panel weights were determined based on the crane's capacity. This resulted in the use of light-weight concrete for the precast panels, optimization of panel size and the removal of the side barriers from the precast panels. The barriers would be added as cast in place elements after the bridge deck was set.

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## Innovation

One of the key strengths of the CMGC process is to utilize the contractor's experience to provide alternative solutions. Some innovations save cost to the project, others increase constructability and shorten construction schedule.



**Figure 3 Precast Yard - Expedites the Installation Process**

## Innovation Used

The Eagle Canyon bridge project incorporated many innovations to the design that were beneficial to the project including:

- Utilization of an established precast yard.
- Utilization of an oversized crane for panel placement.
- Elimination of sheer studs in the design
- Optimization of precast panel size and shape
- Use of lightweight concrete for precast deck panels

## *Precast Yard*

By utilizing Granite's existing precast yard, construction on the precast panels could begin immediately after the Notice to Proceed was issued. Traditional projects may have utilized a precast yard on site which would require acquisition and clearing and grubbing of an acceptable

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space prior to beginning the precast process. Besides saving time from the construction schedule, there was approximately a \$25,000 savings by utilizing the existing precast yard.

### *Oversized Crane*

Once it was determined that the standard cranes could not be used, and the oversized crane was the most cost effective alternative. Preliminary estimates showed that the cranes would cost about \$164,000/week rental fees which encouraged to contractor to utilize a seven day work week while the rental was taking place. Furthermore, the crane required a deposit of \$140,000 to secure its availability. UDOT evaluated the use of the oversized crane and determined that the deposit was necessary to meet the schedule set by the team. Approval to acquire the crane was given.

Some of the benefits realized with the oversized crane included: higher capacities at longer reach lengths so the actual panel setting process could precede more quickly, higher production rates as multiple panels could be delivered to areas of shorter reaches, and the design of uniform panels for placement rather than reducing panel sizes with longer reach lengths. This innovation shortened the overall project schedule by one month and saved the project approximately \$47,500.

### *Shear Studs*

As part of the regular design process the contractor questioned the need for the use of shear studs in the bridge deck. As the suggestion was analyzed by the designers and confirmed through UDOT Structures personnel it was deemed that the shear studs could be eliminated. Removing the shear studs saved approximately \$65,000.

### *Optimization of Pre-cast Panel Design*

Granite applied their experience in the construction of precast panels to make suggestions optimizing the precast design and the associated duct work in each panel. Their suggestions included:

- Use of post tensioning strands verses traditional rebar. This became affordable because 5 panels could be set at once.
- Minimizing the number and changing the shape of the strand ducts resulted in additional cost savings.
- Simple changes to the overall panel sizes and shapes resulted in a more efficient pre-casting process due to standardized forming.

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### ***Lightweight Concrete***

Because of the length of the bridge and the structural deficiencies inherent in the bridge, the use of lightweight concrete was key to ensuring that the middle panels could be reached without surcharging the bridge deck. Further weight reductions were instituted by removing the barriers from the sides of the panels. These barriers would be added on after the deck was set utilizing traditional cast in place methods.

### **Money Saved by Innovation**

Eric Wells of Granite Construction indicated that approximately \$154,000 was saved by implementing the innovations outlined above.

### **Impact to Quality**

Quality was enhanced on the project in several ways. First, precast panels were constructed in a controlled environment where quality was more closely inspected. Second, since deficiencies in the structure were identified prior to construction, the project scope included shoring up the structure so that the bridge was not load rated. Finally the steel portions of the bridge were painted. This was due to the tracking of risk during design (see discussion on risk below).

### **Project Schedule**

More time was required during design to address deficiencies that were identified due to the contractor's involvement in design. However, Granite Construction estimates a total project savings of three months was achieved due to addressing deficiencies during design rather than once construction had begun. Horrocks also indicated that though the preliminary design time was expanded, there was virtually an elimination of validation checks that would have been required during construction. Under normal design-bid-build methods, the contractors proposed means and methods would need to be reviewed and checked against the bridge capacity. Due to CMGC, the means and methods were addressed in the preliminary design stage.

### **Risk**

The contractor created a risk matrix which was referenced and updated regularly throughout the design process. Some of the risks included on this matrix are:

- Ability of bridge to carry wide loads
- Possibility of cracked structural steel on flanges of bridge supports
- The presence of Nelson studs on the bridge deck, which would increase the time and cost of demolition

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- Presence of lead paint on the girders, which would increase the time and cost of demolition
  - Cracking of lightweight concrete panels from lifting and during shipping
  - Possibility of concrete deck sections crumbling during demolition, rather than remaining in large pieces
  - Worker safety due to fall hazards and difficulty of constructing worker platforms (false decks)
  - The capability of the bridge to hold the weight of the crane
  - Safety of trail users in canyon below due to possibility of falling debris

The risk matrix was reviewed during the regular design meetings and action items were assigned and reported on until each risk was addressed. Some items were discussed and the team determined that resolving the risk during design was not feasible and that alternative plans should be made to address the risk if the issue occurred during construction.

### **Wide Loads on Bridge**

The original Maintenance of Traffic (MOT) for the project required that crossovers be built to divert both the west bound and eastbound traffic across the west bound bridge while the work commenced on the east bound bridge. There was a concern that oversized loads might get trapped in the construction zone if they were not diverted prior to entering the west bound bridge. Several discussions ensued about the probability of creating a “pinch point” in the temporary traffic control prior to entering the crossovers to catch wide loads and stop them from entering the construction zone. However, as the team investigated the transportation laws for wide loads it was determined that all wide loads need special permits that can be restricted at the point of entry into the state and that the permitting agencies, once contacted and informed of the project, would restrict wide load traffic from entering I-70.

### **Cracking of Structural Steel Flanges**

The possibility of finding cracked structural steel flanges of the bridge supports once the deck was removed was a risk identified by the team. Additional detailing was added to the design drawings to address these issues so that repairs could be performed quickly and efficiently if encountered on the project.

### **The Presence of Nelsen Studs**

Another risk discussed was the use of Nelson Studs in the existing bridge deck. If Nelson Studs were used in the original design, the removal of the existing deck would be significantly more complex. To determine their presence required destructive investigative methods. It was decided that verification of the Nelson Studs would become apparent during construction and

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the probability of their existence was low. UDOT took ownership of this risk and will address it if it comes up during construction.

### **Lead Based Paint**

Once the issue of lead based paint on the existing bridge structure was identified, the process of testing the paint was set into motion. It was found that the existing paint was indeed lead based paint. Hazardous materials mitigation was implemented during the design process and the decision was made to repaint all of the steel on the bridge structure as part of the hazardous materials mitigation. This decision resulted in the need to build platforms below the bridge so that paint work could be performed. Though this added cost to the project the public benefited in many ways including hazardous waste mitigation early on in the project, treatment of hazardous waste on the bridge, increase worker safety due to the platform work below the bridge, and use of the platform for heaters if cold weather concrete methods would be required.

### **Worker Safety**

Safety is paramount to every contractor's efforts. A constant reminder was present in the meetings that the workers and the public below the bridge may be exposed to falling hazards and errant debris. Once it was determined that the platform would be required to paint the bridge structure, the added benefit of a secondary platform for safety was evident.

### **Safety of Trail Users**

The issue of falling debris was discussed during the design meetings. It was determined that a popular ATV trail is located under the Eagle Canyon Bridge structures. Coordination with the BLM by the design team helped the team to realize that the proposed schedule of construction was to begin bridge demolition on the same week that a RV convention would be utilizing the trail. Adjustments were made to the schedule and the BLM allowed the team to close the trail during the week of demolition.

### **Benefit to the Public**

As with most CMGC projects the public is the greatest benefactor. The overall benefits to the public include:

- Reduction of risks previously mentioned which lead to early hazardous waste mitigation (see Lead Based Paint), increased public safety (see Worker Safety and also Safety to Trail Users), and enhanced design to minimize delays in construction if risks occur (see Cracking of Structural Steel Flanges).

- Identification of structural deficiencies early on in design which lead to corrective actions to enhance the capacity of the bridge. Also the design became a linear process that allowed the designers to focus on the contractor’s methods. As opposed to the iterative design approach of evaluating the means and methods of the contractor once they have been selected.
- Higher quality deck surface with pre-cast panels and post tensioned strands.
- The shortened construction schedule due to contractor input reduced the impact to traffic.

**Procurement of CMGC Services**

The procurement process for the Eagle Canyon Bridge Repairs project followed UDOT’s standard process for evaluation of the Statement of Qualifications from each contractor. However, after the evaluation was completed by the selection committee, the resulting scores were very close and required that the selection committee conduct personal interviews with the final two contestants. The results of the selection process are described below.

**Project Milestones**

**TABLE 3 – Project Milestones**

Stage	Date
Begin Design	August 4, 2008
Environmental Document	January 8, 2009
CMGC RFP Advertised	January 17, 2009
Contractor Selected	March 30, 2009
Contractor Design Services NTP	April 16, 2009
Bid Opening	August 11, 2009
Construction NTP	September 3, 2009

**Selection of Committee Members**

The Selection Committee Members are listed below in Table 4

**TABLE 4 – Selection Committee Members**

Name	Title	Organization/Firm	Voting Members
Monte Aldridge	Project Manager	UDOT Region 4	Yes
Nathan Lee	Region Director	UDOT Region 4	Yes
Kris Peterson	Director of Construction	UDOT Project Development	Yes
Rudy Alder	Innovative Contracting Manager	UDOT Project Development	Yes
Steve Ogden	District Engineer	UDOT Region 4	Yes

Name	Title	Organization/Firm	Voting Members
Fred Doehring	UDOT Structures	UDOT Project Development	Yes
Lyndon Friant	Resident Engineer	UDOT Region 4	Yes
Mike Seare	Kiewit Construction	AGC	No
Robert Jacobs	Stanley Consultants	ACEC	No

### Evaluation/Selection Criteria

The contractors were compared on the following criteria which were scored individually as outlined below. The selection criteria included:

- Project Team/Capability of the Contractor
- Project Approach
- Project Innovations
- Contractor Price Submittal
- Approach to Price Proposal

The Request for Proposals required that each participant provide required information for the selection criteria so that the panel could compare the proposals on an equal basis. The scoring of each criterion and the final results for winning contractor are show in Table 5. Ultimately Granite was selected to participate in the CMGC process.

**Table 5 – Procurement of Winning Proposal – Granite Construction**

Criteria	Possible Points	Points Awarded	Comments
Project Team/Capability of the Contractor	15	13.15	Evaluation of team experience
Project Approach	30	23.62	Team’s approach evaluated against the project goals
Project Innovations	25	20.17	Evaluation of teams proposed innovations verses their likelihood of success
Contractor Price Submittal	15	15	Unit price of major bid items. Rated using a standard deviation comparison to other candidates.
Approach to Price Proposal	15	13.14	Provide logic and reasoning that was used to obtain the unit prices listed above. Evaluated on reasonableness.
<b>Totals</b>		85.08	

The Contractor Price Submittal and the Approach to Price Submittal are key elements of the selection process. These criteria are used to ensure that pricing is fair and reasonable and that future pricing discussions with the contractor are based on an agreed standard. The intent is to select the major bid items that represent a good portion of the overall project costs. Table 6 indicates the bid items that were investigated during the procurement process.

**TABLE 6 – Bid Items Included in Contractor’s Price Submittal Section of RFP**

UDOT Spec.	Description	Est. Quantity (Provided in RFP)	Unit	Winning Proposal Unit Price	2008 State Ave. Price	Awarded Bid Unit Price
2210	Remove Bridge Deck	16520	Sq. ft.	\$12.38	NA	\$11.51
2844	Precast Concrete Full Barrier (New Jersey Shape)	17200	Lin. ft.	\$23.67	\$49.85	Not Used in Design
3339	Precast Concrete Panel	16520	Sq. ft.	\$91.73	\$44.60	\$88.32

During design a Measurement and Payment meeting was held to discuss what assumptions would be used to determine the price of each item. It was determined that the cost of the precast concrete panels would incorporate the cost of the oversized crane since it was required to place the panels. This was done to ensure that the correct costs were assigned to the bid item rather than hiding the oversized crane costs in the mobilization costs. These numbers suggest that the additional cost of having the oversized crane, and transporting the precast panels from the precast yard to the remote area of the project, cost an additional \$47.13 per square foot of bridge deck, a total cost of \$770,000.

The Awarded Bid Unit Price column indicates that during the design process unit prices were reduced from the anticipated price of the winning proposal. This reduction in unit prices would account for a savings of over \$70,000 based on the estimated quantities listed in Table 6. Unit prices were reduced despite the fact that several assumptions listed in the Approach to Price Proposal were violated. These violations include:

- The existing structure could handle the loading that Granite would use in removing the bridge deck.
- Removed concrete rubble would be buried within right of way.
- Hauling costs were estimated as if pre-cast panels were cast on site.

- Parapets were estimated as part of the panels. Cast-in-place procedures for parapets after the panels were set would increase the unit costs.

Despite these violations to the original price estimations, the unit price decreased from the original proposal. Reduction of this unit price indicates that the contractor was willing to work as a member of the team to reduce costs wherever possible.

### Selection Results

Based on the scoring of the original proposals and the personal interviews, Granite Construction was selected to perform CMGC services for this project.

### Analysis of Performance

One incentive for the CMGC process is the quick turnaround and savings that can be achieved when the process runs smoothly. Ideally, the contractor that is on board during the design process is brought on to do the actual construction. This portion of the report will focus on the overall performance of the project in terms of performance schedule.

### Proposed Construction Schedule

The Notice to Proceed with Granite Construction for design services was dated September 3, 2009. The duration of the project was set at 90 working days.

### Cost Comparison

The proposed bid presented by the contractor was compared with the Engineer’s Estimate prepared by the Designer and an Independent Cost Estimate (Stanton Constructability) in accordance with UDOT’s standard procedure. The engineer estimate was used as the baseline for comparison. Results are shown in Table 7 below:

**TABLE 7 – Cost Comparison of Accepted Bid**

	<b>Engineer’s Estimate</b>	<b>ICE</b>	<b>Bid</b>
Cost	\$4,846,002.00	\$5,009,366.68	\$5,294,135.21
Percent of Eng. Est.		3.4%	9.2%
Percent of ICE	-3.3%		5.7%

Since the proposed bid was no more than 110% of the ICE or the Engineer’s Estimate, the bid was deemed appropriate for the bridge rehabilitation project and approval was given to move forward with the project.

Table 8 below gives a detailed comparison of the Independent Cost Estimate (ICE) and the accepted bid price for construction broken down by project components of Roadway and Structures. The entire bid breakdown and the ICE are included in the Appendix of this report.

**TABLE 8 – Agreed Price vs. Independent Cost Estimate**

<b>Project Component</b>	<b>BID</b>	<b>ICE Price</b>	<b>Percent Change</b>
Roadway	\$1,828,633.73	\$1,521,449.00	20.2%
Structures	\$3,465,501.48	\$3,487,917.68	-0.6%
<b>Total</b>	<b>\$5,294,135.21</b>	<b>\$5,009,366.68</b>	5.7%

Price analysis of the Eagle Canyon Bridge project based on state average prices from 11/10/2008 to 11/9/2009 was performed as a standard analysis for all CMGC projects. This procedure is done to identify what the project would have cost if the quantity of the bid items were assessed the state average price rather than the agreed upon unit price of the accepted bid. Due to the unusual location of the bridge and the parameters of the project itself the bid unit prices were substantially higher. By comparing 18 of the 23 bid items the ratio of Actual Bid Prices to the State Average Prices was 2.0 (see Appendix B for comparison results). This suggests that the remote nature of the project resulted in an increase in cost.

**Delivery Process and Timeline**

Figure 1 below illustrates the timeline of the CMGC design process for this project up to the end of the Design Phase scope and the anticipated construction schedule. This is identified in the MOU as the 90% design completion stage and is the point in which the contractor can begin preparing their bid for construction services. For ease of reference the NTP for the construction services was the ending date of the graph. Please note that the days shown herein are total days (not working days as agreed upon in the contract); this is intended to make the design time and construction time more comparable.

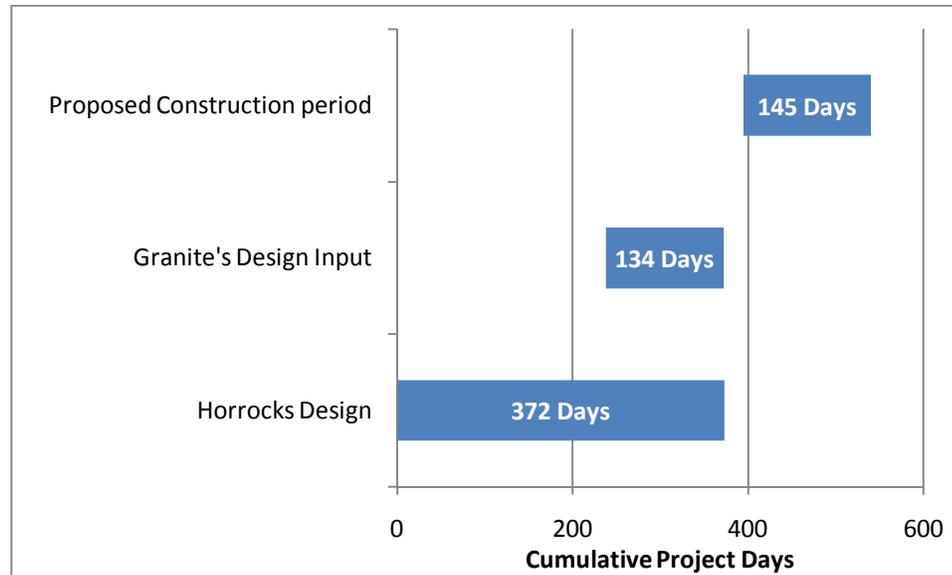


Figure 4 – Projects Proposed Timeline

## Lessons Learned

Data collection for this report included personnel interviews of representatives from the design team including Monte Aldridge the UDOT, Project Manager; Larry Reasch the Horrocks, Project Manger; and Eric Wells the Project Manager for Granite Construction. Notes from the interviews are contained in Appendix A and key lessons learned by the team are summarized below.

- There needs to be a way to track if the innovations identified during the RFP were incorporated into the project (Monte Aldridge).
- It would be helpful to have a master document to track the decision process, similar to what is used in the value engineering process (Horrocks).
- If you bring the contractor in early in the process, you benefit from their feedback, but it is difficult to compare the final prices to the prices in their original proposal, since the project often changes during design (Horrocks).
- A master advertising checklist would be helpful, which would allow for a shorter checklist for the smaller phases of the project (Horrocks).
- Would have been informative if the UDOT PM witnessed the RFP development of another CMGC project to prepare them for the upcoming project (Monte Aldridge).
- Because of the time delay between the RFP and construction there seemed to be an opportunity for UDOT to capitalize on lower market values. Higher market prices are

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tracked by the contractor but if the market values go down, there is no incentive for the contractor to lower unit prices beyond what was presented in the RFP (Monte Aldridge).

- Particularly on CMGC projects, it would be helpful to have the same UDOT PM throughout.
- The relationship between the designer and contractor was good on this project, which is critical to the success of CMGC projects.
- In general, the UDOT PM needs to be a strong leader on CMGC projects.
- Ongoing M&P discussions were critical to a smooth bid opening- it was worth it to go through each item, even if it takes a while. The ICE was very involved in project meetings
- The project team, and particularly the UDOT PM, would benefit from a more thorough understanding of the process at the end of design, where preparations are being made for advertisement.
- On a project with this remote location, and the complexity of working over a canyon, the bid items should never be compared to statewide averages.

## Conclusion

The design stage of the Eagle Canyon Bridge Repairs project pointed out that this was a prime project for CMGC contracting method. Due to the remote nature and the unique structure at Eagle Canyon, many issues and pitfalls would have occurred if traditional contracting methods were used. As anticipated, the remoteness and complexity of the project resulting in higher than average unit pricing; however, due to contractor influence during design, savings of over \$150,000 were achieved due to contractor innovations. Furthermore the construction schedule was reduced with the innovation of an oversized crane. The crane is also expected to increase productivity, and not surcharge the existing structure. Finally, structural retrofits required on the bridge structure were identified early and enabled structural and other enhancements that would have resulted in delays and change orders during construction with traditional contracting methods. Total estimated savings to the project was 3 months.

The team efforts of Horrocks and Granite Construction enabled the project to proceed with relative ease. Risks were discussed on a weekly basis throughout the design process and mitigated where it was possible. Innovations suggested by the contractor, like the simplified design of the precast panels, helped reduce costs with no reduction project quality.

## **APPENDIX – A – Personal Interview Notes**

**CMGC Interview Questions**

UDOT Project Manager- Monte Aldridge  
 Designer-Larry Reasch (Horrocks)  
 Contractor-Eric Wells, Matt Stepan (Granite)

**Project Description:** **Eagle Canyon Bridge**  
**Pin:** 6625  
**Project Phase:** Design (Design Phase)  
**Anticipated construction cost:** **\$7,500,000**  
**Anticipated construction time:** **90 Days**  
**Construction notice to proceed date:** **September 3, 2009**

**Design**

<p>What benefits did you see in design because of contractor participation?</p>	<ul style="list-style-type: none"> <li>• Contractor was able to turn the design into an iterative process where the design and the methodology are tailored to one another (Monte Aldridge).</li> <li>• Suggestions by contractor reduced risks and minimized delays associated with change orders that would have developed during construction (Monte Aldridge).</li> <li>• The contractor provided input on methods of construction, enabling the engineers to tailor the design to their methods (Horrocks).</li> <li>• Input from the contractor changed the designer’s perceptions of how to build the project (Horrocks).</li> <li>• Contractor involvement improved the quality of the end product. Through this process, the team found deficiencies in the bridge that could be addressed in the design phase. Now the bridge won’t have to be load rated (Horrocks).</li> <li>• The contractor tracked down the sub-consultants ahead of time (Granite).</li> </ul>
<p>Describe the nature and value of contractors’ design suggestions?</p>	<ul style="list-style-type: none"> <li>• Constructability and cost were focus of the contractor during the design process (Monte Aldridge).</li> <li>• The design was tailored to meet the contractor’s methods enhancing constructability. Major design was not effected but the details were tailored for constructability and cost savings. (Horrocks).</li> </ul>

	<ul style="list-style-type: none"> <li>• The original design had cranes sitting on the bridge, which may have resulted in failure of the structure. The contractor recommended the use of an oversized crane (Granite).</li> <li>• The contractor recommended the use of lightweight concrete in the panels, which helped lighten the load on the bridge (Granite).</li> <li>• Due to contractor input, the number of conduits in each panel was decreased (Granite).</li> <li>• Granite was able to use their casting bed in SLC, rather than having to build a new one near the site (Granite).</li> <li>• UDOT chose to paint the entire bridge as part of the project, because through coordination with the contractor, they knew that they would have adequate funds (Granite).</li> </ul>
<p>How did you evaluate and decide which suggestions to use?</p>	<ul style="list-style-type: none"> <li>• Alternatives were evaluated by the team where the decisions were finally agreed upon. Contractor was asked to provide analysis illustrating impact to cost and schedule to the project (Monte Aldridge, Granite).</li> <li>• Recommendations were incorporated through open dialogue, particularly on construction, demolition and erection methods. (Horrocks).</li> </ul>
<p>What Challenges came up during design and did you resolve them?</p>	<ul style="list-style-type: none"> <li>• Conventional crane operative capabilities could not install the bridge panels as anticipated by the designer. Contractor suggested the use of an oversized crane or gantry system device for installing precast panels. Oversized crane was evaluated and found to be the most cost effective due to installation times verses daily costs (Monte Aldridge, Granite).</li> <li>• Original precast parapets could not be added to the precast panels because the weight was too great. Parapets were then designed as cast in place after deck was installed (Monte Aldridge).</li> <li>• Current structure was found to be deficient based on current standards. Surcharging the structure itself with the standard crane loads was deemed not safe. UDOT Structures was contacted to determine if additional structural work would need to be performed and the contractor was directed to begin planning for under bridge access (Monte Aldridge, Horrocks).</li> </ul>

	<ul style="list-style-type: none"> <li>• Because of the structural deficiencies, the project included stiffening the posts and columns (Granite).</li> <li>• The risk of shear studs in the deck was identified and discussed as a team. It was determined that since verification would require destructive methods, it was determined that team would proceed with design and address risk if encountered in construction (Horrocks).</li> </ul>
<p>What is the cost savings anticipated and or produced by contractor’s suggestions?</p>	<ul style="list-style-type: none"> <li>• No process was initiated to track cost comparisons throughout the project though significant suggestions were tracked on an individual bases (crane alternatives) (Monte Aldridge).</li> <li>• Overall, contractor involvement may not have resulted in cost savings compared to the original design. However, the bridge will be higher quality because the team was able to address the structural deficiency issues (Horrocks).</li> <li>• Contractor recommendation resulted in the following cost savings (from Granite):             <ul style="list-style-type: none"> <li>○ \$16,000 for decreasing the number of conduits in the panels</li> <li>○ \$47,500 using the big crane compared to the next viable option (the option originally proposed wasn’t feasible)</li> <li>○ \$25,000 for using the contractor’s existing casting yard</li> <li>○ \$65,000 for elimination of shear studs.</li> </ul> </li> </ul>
<p>How did the contractor communicate cost changes that corresponded with design changes?</p>	<ul style="list-style-type: none"> <li>• Formalized comparisons of the crane alternatives were presented by the contractor to verify most reasonable direction (Monte Aldridge).</li> <li>• Smaller alternatives were evaluated by contractor and direction was given by quick estimates (Monte Aldridge).</li> <li>• The contractor provided costs for various alternatives (Horrocks).</li> <li>• The contractor brought pricing options to design meetings, and also regularly emailed options to the team (Granite).</li> </ul>
<p>Was there any work besides design that was required of the contractor prior to construction?</p>	<ul style="list-style-type: none"> <li>• The contractor verified crossover locations, and performed several field visits to better understand the site conditions (Horrocks).</li> <li>• Coordination with sub consultants, including bringing the</li> </ul>

	crane contractors to meetings (Granite).
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**Constructability**

<p>How was constructability improved by involvement of the contractor in design?</p>	<ul style="list-style-type: none"> <li>• Contractor suggested the use of an over-sized crane to be able to maintain standardized panel installation throughout the bridge deck rather than reducing panel sizes with greater reach requirements (Monte Aldridge).</li> <li>• Contractor analyzed the use of post tensioned strands verses bar. It was found the post tensioned strands resulted in better quality product because it limited the number and size of the blockouts, also when 5 panels were post-tensioned with strands the cost became more affordable then bars (Monte Aldridge).</li> <li>• The design was customized to the contractor’s methods (Horrocks).</li> <li>• It was determined to paint the entire structure of the bridge which increased cost due the need to build a platform under the bridge. However, this platform enhanced safety during construction and also provided a place to set heaters if cold weather concreting methods are needed (Horrocks)</li> <li>• CMGC puts constructability at the forefront of design (Granite).</li> </ul>
<p>What constructability issues identified by the contractor were included in design?</p>	<ul style="list-style-type: none"> <li>• Post tensioned strands (Monte Aldridge).</li> <li>• Oversized crane (Monte Aldridge).</li> <li>• The team collaborated constantly to design to the construction methods on everything from the casting yards to shipping and placing panels (Horrocks).</li> <li>• Use of lightweight concrete &amp; taking the parapet off of the panel by casting them in place allowed for the panels to be light enough to be moved by the crane (Granite).</li> <li>• Contractor recommended adding a half inch to each panel to make them easier to form (Granite).</li> <li>• Contractor recommended post tensioning of panels with round ducts instead of square and reduced the ducts per panel from 11 to 8. Round ducts saved stressing time by allowing contractor to stress all 4 strands at once in each</li> </ul>

	<p>ducts (Granite).</p> <ul style="list-style-type: none"> <li>• Contractor recommended eliminating blockouts (by switching to a non-composite deck design), eliminating the need for cast-in-place tie in sections. Use of lightweight concrete on the panels &amp; taking the parapet off of the panel by casting them in place allowed for the panels to be light enough to be moved by the crane (Granite).</li> <li>• Contractor recommended adding a half inch to each panel to make them easier to form (Granite).</li> <li>• Contractor coordinated with local UDOT Maintenance Station for use of facility to help store materials and equipment (Horrocks)</li> </ul>
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**Innovations**

<p>What innovations were used to reduce cost?</p>	<ul style="list-style-type: none"> <li>• Salvaging of steel from removed bridge deck (Monte Aldridge).</li> <li>• Utilization of oversized crane (Monte Aldridge).</li> <li>• Elimination of shear studs saves \$65,000 (Granite)</li> <li>• Use of lightweight concrete &amp; taking the parapet off of the panel by casting them in place allowed for the panels to be light enough to be moved by the crane (Granite).</li> <li>• Contractor recommended adding a half inch to each panel to make them easier to form (Granite).</li> <li>• Contractor recommended post tensioning of panels with round ducts instead of square and reduced the ducts per panel from 11 to 8. Round ducts saved stressing time by allowing contractor to stress all 4 strands at once in each ducts (Granite).</li> </ul>
<p>What innovations were used to reduce schedule?</p>	<ul style="list-style-type: none"> <li>• Oversized crane could install the bridge deck components faster and maintain a uniform size throughout (Monte Aldridge).</li> <li>• The big crane will make it possible to complete the project in one construction season (Horrocks).</li> <li>• The big crane will save one month in construction (Granite).</li> </ul>
<p>What innovations were used to improve quality?</p>	<ul style="list-style-type: none"> <li>• Post tensioning strands reduces the number and size of blockouts (Monte Aldridge).</li> <li>• Pre-cast panels were constructed in the controlled</li> </ul>

	<p>environment of a pre-cast yard rather than on site (Monte Aldridge, Granite).</p> <ul style="list-style-type: none"> <li>• The use of lightweight concrete reduces the load to the bridge deck (Granite).</li> </ul>
What technology innovations were used?	<ul style="list-style-type: none"> <li>• Dealing with slurry issues when cutting up the existing deck for removal (Monte Aldridge).</li> <li>• The large crane increases production rates, and improves safety (Granite, Horrocks).</li> </ul>
What innovations were used to reduce impacts to the public?	<ul style="list-style-type: none"> <li>• The use of the oversized crane reduced the time of construction and also reduced the risks associated with the capacities of smaller cranes including, inadequate boom reaches, varying of panel design to fit crane capacities, crane reactions were not imposed on the structure (Monte Aldridge, Horrocks, and Granite).</li> </ul>

**Project Schedule**

How much time was saved in design?	<ul style="list-style-type: none"> <li>• Felt that time spent in design saved time during construction and reduced risk. The contractor’s influence during design minimized the number of assumptions of the design team and resulted in a more feasible design (Monte Aldridge).</li> <li>• We saved two months in design time due to contractor input, and overall, the project saved more time because of discovering the bridge inadequacies in design, rather than during construction (Granite).</li> </ul>
How much cost was saved in design?	<ul style="list-style-type: none"> <li>• There were some savings due to less iteration on analysis and design because of contractor input (Horrocks).</li> <li>• With traditional design build methods, before construction could proceed, the contractor’s proposed methods of construction would have been submitted after design for evaluation and approval. CMGC enabled this step to be skipped because the primary design was tailored to the methods of construction (Horrocks)</li> </ul>

**Risk**

How did the team	<ul style="list-style-type: none"> <li>• Risk matrix was created by designer and evaluated at</li> </ul>
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<p>identify, evaluate, and track project risk?</p>	<p>design meetings. The designer assigned evaluation of possible solutions to different members of the team and updated the matrix as information was presented (Monte Aldridge, Horrocks, and Granite).</p> <ul style="list-style-type: none"> <li>• The team was able to identify probably every major risk, and mitigate many of them. The detailed tracking of the risk was a huge benefit (Horrocks).</li> <li>• It was good to have the contractor help look at risk because they consider risk differently than designers or UDOT does (Horrocks).</li> </ul>
<p>Which contractor suggestions helped you to reduce risk and control cost?</p>	<ul style="list-style-type: none"> <li>• Oversized crane and use of post tensioned strands (Monte Aldridge).</li> <li>• The openness of the contractor in sharing construction techniques reduces risk by making the design more realistic (Horrocks).</li> <li>• The discovery of bridge inadequacies saved delays in construction, as much as a construction season (Horrocks, Granite).</li> <li>• The big crane reduced the risk of damaging the bridge during construction (Granite).</li> </ul>

**Environmental Stewardship**

<p>How did bringing the contractor on early alleviate environmental concerns?</p>	<ul style="list-style-type: none"> <li>• Team realized the risk of possible falling debris on ATV trail below bridge during construction. BLM was contacted and asked to have trail closed during construction hours (Monte Aldridge).</li> <li>• Placing a deck under the bridge for painting helps ensure the debris doesn’t fall into the canyon (Horrocks).</li> </ul>
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**Benefits to Public**

<p>How did the public benefit from the CM/GC process?</p>	<ul style="list-style-type: none"> <li>• Reduced overall risks (Monte Aldridge).</li> <li>• Identified bridge structural deficiencies early on in project (Monte Aldridge, Granite).</li> <li>• Higher quality deck surface with pre-cast panels and post tensioned strands (Monte Aldridge).</li> <li>• The shortened schedule due to contractor input reduces</li> </ul>
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	impact to drivers (Horrocks, Granite).
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**Lessons Learned**

<p>What did you learn in the CM/GC process?</p>	<ul style="list-style-type: none"> <li>• There needs to be a way to track if the innovations identified during the RFP were incorporated into the project (Monte Aldridge).</li> <li>• It would be helpful to have a master document to track the decision process, similar to what is used in the value engineering process (Horrocks).</li> <li>• If you bring the contractor in early in the process, you benefit from their feedback, but it is difficult to compare the final prices to the prices in their original proposal, since the project often changes during design (Horrocks).</li> <li>• A master advertising checklist would be helpful, which would allow for a shorter checklist for the smaller phases of the project (Horrocks).</li> </ul>
<p>Was there anything you would change during the RFP portion of the project?</p>	<ul style="list-style-type: none"> <li>• Would have been informative if the UDOT PM witnessed the RFP project of another CMGC project to prepare them for the upcoming project (Monte Aldridge).</li> <li>• Wouldn't change anything on this job. The interview process was good, as it helped differentiate between contractors. It's good to have the designers involved in the selection committee to help validate the ideas that the contractors put forth (Horrocks).</li> </ul>
<p>Would you have used different selection criteria?</p>	<ul style="list-style-type: none"> <li>• Nothing</li> </ul>
<p>Would you change the way you selected based on price?</p>	<ul style="list-style-type: none"> <li>• Pricing data was provided in each of the contractor's technical submission this was corrected in future projects (Monte Aldridge).</li> <li>• The system using standard deviations from the average is great (Horrocks).</li> <li>• Discussing prices in the CMGC selection process is too risky. It is too difficult to maintain the prices in the proposals through design because of the changes are made to the design during the design process. In the end you may not</li> </ul>

	<p>be making valid comparisons at bid opening (crane price included in panel prices). (Horrocks)</p>
<p>What changes would you have made in the way you developed the RFP?</p>	<ul style="list-style-type: none"> <li>• Some of the questions were redundant (repeated in multiple sections) (Granite).</li> </ul>
<p>What changes would you make in the selection process?</p>	<ul style="list-style-type: none"> <li>•</li> </ul>
<p>How would you improve the RFP development?</p>	<ul style="list-style-type: none"> <li>• Because of the time delay between the RFP to construction there seemed to be an opportunity for the UDOT to capitalize on lower market values. Higher market prices are tracked by the contractor but if the market values go down, there is no incentive for the contractor to lower unit prices beyond what was presented in the RFP (Monte Aldridge).</li> </ul>

**General Notes/Other Items**

<p>Did you set a committed advertising date and did you meet your schedule?</p>	<ul style="list-style-type: none"> <li>• Reschedule of date had to do with the realization of the lower capacity of the structure than anticipated (Monte Aldridge, Granite).</li> <li>• The team missed the advertisement date due to some redesign after discovering design deficiencies, and a misunderstanding of what it would take to get through the advertisement process (Horrocks).</li> <li>• There should be a different advertising process for early procurement items and the standard project bidding. The work because redundant and oftentimes does not apply to purchasing of materials (Horrocks)</li> </ul>
<p>Describe negotiation problems and their resolution.</p>	<ul style="list-style-type: none"> <li>• At the bid opening, the mobilization seemed high, but it turned out that the ICE missed some assumptions (Horrocks).</li> <li>• Contractor knew measurement and payment requirements at bidding. When questions concerning bid items came up Granite could defend their bid to the point that the ICE and</li> </ul>

	<p>UDOT agreed that the contractor was valid in his assumptions and bid (mobilization and delineators). This understanding of the whole project at bidding is unique to the CMGC process (Horrocks).</p>
<p>How would you rate the CMGC process prior to the beginning of the project?</p>	<ul style="list-style-type: none"> <li>• Less work for UDOT PM because of the support from the Complex with RFP process. This support will probably always be required for CMGC because the process is used infrequently (Monte Aldridge).</li> <li>• Felt that minimization of risk on project was more valuable than the perceived costs (Monte Aldridge).</li> <li>• Very high rating. CMGC was the right choice for this project. CMGC is the way to go for projects that have a fixed budget and unknown scope, difficult constructability issues, and high risk. Engineers and contractors mitigate risk differently, so it's good to get them both together (Horrocks).</li> <li>• We really like the CMGC process (Granite).</li> </ul>
<p>Other items</p>	<ul style="list-style-type: none"> <li>• It would be nice if there was a master Advertizing Check list so that once the ROW and Utility clearances have been made there is no need to readdress those issues (Horrocks)</li> <li>• There needs to be more options for who is contracted to do the ICE (Horrocks).</li> <li>• CMGC process is good for projects with difficult constructability issues and for projects with fixed budgets and loose scope. Also good for projects with high risk as Designers and Contractors address risk differently (Horrocks).</li> </ul>

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## Group Debrief

### Design Benefits

- The process resulted in a combined solution that the engineer and design, and the contractor can build.
- The team agreed to build a non-composite bridge deck, which is not the traditional method. This design resulted in the elimination of Nelson studs and pockets, saving time and money.
- Through the collaboration of the CMGC process, the designer took a more thorough look at issues that would have been left to the contractor in a traditional process. The result was the discovery of structural deficiencies in the existing bridge. If these deficiencies were discovered in construction, the resulting construction delays of 45-60 days would have been much costlier than discovering the deficiencies in design.
- The designer was able to refine the design and cost because the contractor supplied knowledge regarding the information of materials, such as joints and post-tensioning systems.
- The designers were able to learn, and obtain a better understanding of the estimating process.
- The contractor provided feedback on varying lightweight concrete types, which the engineers used to optimize their design.
- The contractor discovered the need for more grout ports, avoiding the need for a change order.
- Contractor involvement reduced the number of design alternatives that had to be considered.

### Design Challenges

- Some of the Federal regulations were cumbersome. For example, the project team didn't anticipate the one-week delay imposed by the FHWA on the bid-opening time.
- The advertisement checklist is not set up for projects with multiple phases (multiple bid-openings). It would be more efficient to be able to set up a master advertisement checklist for the entire project, with abbreviated checklists for each phase.
- It would be helpful if the UDOT structural review team was more involved and collaborative on CMGC projects. Recognizing that resources are limited, ideally they would get involved early and provide continuous review, rather than at major milestones only.

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### Constructability

- The contractor provided the bridge erection method and the engineers designed accordingly.
- Contractor input resulted in fewer block-outs, saving time and money.
- In a traditional project, the engineers would have had to make blanket assumptions about the methods used for removing the old bridge deck. CMGC allowed for customizing the design based on the contractor's methods.

### Innovations

- Early collaboration between UDOT and the contractor allowed for various cost saving measures, such as the use of the median for the disposal of debris and the use of a nearby UDOT maintenance facility for the storage of construction materials.
- The bridge erection techniques and scheme were unique, such as the use of an oversized crane to remove and replace bridge deck panels. This crane allowed for keeping equipment off the bridge, avoiding overloading the structural steel of the bridge. This oversized crane also increased worker safety by keeping them off the bridge. The crane rental costs more than traditional equipment, however, it allows for faster construction, saving time and labor costs.
- The contractor recommended using an X formation for the traffic crossovers, rather than paving the entire median, saving on pavement costs.
- Based on contractor input, the number of conduits in the bridge was reduced from 11 to 8.
- Open cost discussions reassured the PM that they could stay within the programmed budget, and plan in the design stage to use cost savings for betterments. The contractor provided options and their associated costs to UDOT, who then was able to decide on the best option. For example, the contractor provided various options for painting the bridge, from spot painting to full coverage.
- The contractor provided input on the planned storing and shipping of bridge deck panels, which allowed the designers to optimize their design, rather than have to create a design that would accommodate the numerous possible shipping and storage scenarios.

### Lessons learned

- The current ICE does a fine job, but UDOT would benefit from innovation and open-mindedness that the competition of multiple providers would bring.
- Particularly on CMGC projects, it would be helpful to have the same UDOT PM throughout.

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- The relationship between the designer and contractor was good on this project, which is critical to the success of CMGC projects.
  - In general, the UDOT PM needs to be a strong leader on CMGC projects.
  - Ongoing M&P discussions were critical to a smooth bid opening- it was worth it to go through each item, even if it takes a while. The ICE was very involved in project meetings
  - The project team, and particularly the UDOT PM, would benefit from a more thorough understanding of the process at the end of design, where preparations are being made of advertisement.
  - On a project with this remote location, and the complexity of working over a canyon, the bid items should never be compared to statewide averages.

## **APPENDIX – B – ICE vs Bid Comparison; Pricing Analysis**

Utah Department of Transportation Abstract of Bids Project No: F-170-3(50)112 Project Name: I-70; EAGLE CANYON BRIDGE Desc of Construction: REPLACEMENT OF BRIDGE DECK Estimate Completion date on or before County: EMERY (15)		Engineer's Estimate		Bidder: INDEPENDENT COST ESTIMATE (STANTON) 8013 HUNTER MEADOWS CIRCLE SANDY,UT 84093		08/17/2009 Page 1 of 1 Bidder: GRANITE CONSTRUCTION COMPANY 1000 N. WARM SPRINGS RD. SALT LAKE CITY,UT 84116	
No.	Item No. Description Qty Unit	Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
<b>10 - ROADWAY</b>							
1	012850010 Mobilization 1 Lump	400,000.00	\$ 400,000.00	529,000.00	\$ 529,000.00	680,997.00	\$ 680,997.00
2	013150010 Public Information Services 1 Lump	10,000.00	\$ 10,000.00	5,800.00	\$ 5,800.00	5,750.00	\$ 5,750.00
3	015540005 Traffic Control 1 Lump	550,000.00	\$ 550,000.00	502,000.00	\$ 502,000.00	707,527.00	\$ 707,527.00
4	015720020 Dust Control and Watering 163 1000 gal	65.00	\$ 10,595.00	79.00	\$ 12,877.00	5.75	\$ 937.25
5	017210010 Survey 1 Lump	25,000.00	\$ 25,000.00	58,000.00	\$ 58,000.00	18,231.00	\$ 18,231.00
6	020560005 Borrow (Plan Quantity) 1412 cu yd	22.00	\$ 31,064.00	34.00	\$ 48,008.00	23.18	\$ 32,730.16
7	020560020 Granular Borrow 4216 Ton	23.00	\$ 96,968.00	18.00	\$ 75,888.00	20.70	\$ 87,271.20
8	023160020 Roadway Excavation (Plan Quantity) 1234 cu yd	40.00	\$ 49,360.00	18.00	\$ 22,212.00	22.83	\$ 28,172.22
9	02631000* Storm Drain System 1 Lump	70,000.00	\$ 70,000.00	43,600.00	\$ 43,600.00	60,554.00	\$ 60,554.00
10	027210010 Untreated Base Course 1621 Ton	30.00	\$ 48,630.00	29.00	\$ 47,009.00	25.30	\$ 41,011.30
11	027410060 HMA - 3/4 inch 1264 Ton	110.00	\$ 139,040.00	125.00	\$ 158,000.00	103.50	\$ 130,824.00
12	028410086 W-Beam Guardrail 72 inch Wood Post 515 ft	50.00	\$ 25,750.00	37.00	\$ 19,055.00	67.24	\$ 34,628.60
<b>Subtotal</b>			\$ 1,456,407.00		\$ 1,521,449.00		\$ 1,828,633.73
<b>20 - STRUCTURES</b>							
13	022210015 Remove Bridge 1 Each	25,000.00	\$ 25,000.00	21,700.00	\$ 21,700.00	36,157.00	\$ 36,157.00
14	03154001* Concrete Bridge Deck Removal(Est. Lump 1 Lump Qty: 16514 sq ft)	275,000.00	\$ 275,000.00	324,500.00	\$ 324,500.00	190,000.00	\$ 190,000.00
15	032110010 Reinforcing Steel - Coated (Plan Quantity) 48276 lb	1.50	\$ 72,414.00	1.18	\$ 56,965.68	1.03	\$ 49,724.28
16	03310001D Structural Concrete(Est. Lump Qty: 92 cu yd) 1 Lump	73,600.00	\$ 73,600.00	56,000.00	\$ 56,000.00	57,939.00	\$ 57,939.00
17	03312001* Structural Concrete - Lightweight(Est. Lump 1 Lump Qty: 160 cu yd)	136,000.00	\$ 136,000.00	87,500.00	\$ 87,500.00	97,248.00	\$ 97,248.00
18	03339010* Full Depth Precast Concrete Deck Panel(Est. 1 Lump Lump Qty: 16318 sq ft)	1,400,000.00	\$ 1,400,000.00	1,543,000.00	\$ 1,543,000.00	1,441,178.00	\$ 1,441,178.00
19	033720010 Thin Bonded Polymer Overlay, Type I 16690 sq ft	6.90	\$ 115,161.00	7.00	\$ 116,830.00	7.18	\$ 119,834.20
20	039240070 Abutment Backwall Repair 2 Each	10,000.00	\$ 20,000.00	3,100.00	\$ 6,200.00	9,365.00	\$ 18,730.00
21	05120001D Structural Steel(Est. Lump Qty: 23576 lb) 1 Lump	294,700.00	\$ 294,700.00	207,000.00	\$ 207,000.00	322,110.00	\$ 322,110.00
22	058320010 Expansion Joint 66 ft	420.00	\$ 27,720.00	367.00	\$ 24,222.00	343.00	\$ 22,638.00
23	099920010 Cleaning and Overcoating Structural Steel 1 Lump	950,000.00	\$ 950,000.00	1,044,000.00	\$ 1,044,000.00	1,109,943.00	\$ 1,109,943.00
<b>Subtotal</b>			\$ 3,389,595.00		\$ 3,487,917.68		\$ 3,465,501.48
<b>Total:</b>			<b>\$ 4,846,002.00</b>		<b>\$ 5,009,366.68</b>		<b>\$ 5,294,135.21</b>
<b>Percent of Engineer's Estimate:</b>					<b>3.37%</b>		<b>9.25%</b>

