DEPARTMENT OF TRANSPORTATION

Construction Manager/General Contractor Interim Report

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Legislative Request

This report is issued to comply with [2012 Laws of Minnesota, Chapter 287, Article 3, Section 62].

Sec. 62. REPORTS ON USE OF CONSTRUCTION MANAGER/GENERAL CONTRACTOR METHOD.

Subdivision 1. Submission of reports.

The commissioner shall report on experience with and evaluation of the construction manager/general contractor method of contracting authorized in Minnesota Statutes, sections 161.3207 to 161.3209. The reports must be submitted to the chairs and ranking minority members of the legislative committees with jurisdiction over transportation policy or transportation finance and in compliance with Minnesota Statutes, sections 3.195 and 3.197. An interim report must be submitted no later than 12 months following the commissioner's acceptance of five construction manager/general contractor contracts. A final report must be submitted no later than 12 months following the commissioner's acceptance of ten construction manager/general contractor contracts.

Subd. 2. Content of reports.

The reports must include: (1) a description of circumstances of any projects as to which construction manager/general contractor requests for qualifications or requests for proposals were solicited, followed by a cancellation of the solicitation; (2) a description of projects as to which construction manager/general contractor method was utilized; (3) a comparison of project cost estimates with final project costs, if available; and (4) evaluation of the construction manager/general contractor method of procurement with respect to implications for project cost, use of innovative techniques, completion time, and obtaining maximum value. The final report must also include recommendations as to continued use of the program and desired modifications to the program, and recommended legislation to continue, discontinue, or modify the program.

Effective Date.

This section is effective the day following final enactment and expires one year following the acceptance of ten construction manager/general contractor contracts.

The cost of preparing this report is $12,000

Executive Summary

Purpose and Scope of the Report

There are several types of contracting methods the Minnesota Department of Transportation uses for constructing projects. These innovative contracting methods incorporate new practices to supplement traditional low-bid, design-bid-build contracting. Innovative contracting can decrease project delivery time, reduce construction time, improve safety, incorporate innovation and reduce costs. The list of innovative contacting methods includes:

- A + B (cost + time) bidding
- Best-Value Contracting
- Construction Manager/General Contractor
- Design-build
- Incentives - Early Completion
- Incentives - No Excuse Bonus
- Indefinite Delivery / Indefinite Quantity
- Lane rental
- Pay for performance
- Warranties

This report is about the Construction Manager/General Contractor method of procurement, referred to as CMGC, and is issued to comply with the requirements of 2012 Laws of Minn., Ch. 287, Art. 3, Sec. 62. Five projects using CMGC were selected by MnDOT, which triggered this interim report about the department's experience and evaluation of the CMGC method. The following points are required in the report including:

- A description of the projects that used the CMGC method
- A comparison of total project cost estimates with final project costs, if available
- An evaluation of CMGC as a method of procurement for the following:
    - Project cost
    - Innovative techniques
    - Completion time
    - Value

What is Construction Manager/General Contractor?

Construction Manager/General Contractor is a contracting method that allows MnDOT to hire a qualified construction contractor early in a project's design phase to perform a "construction manager" role, serving as an advisor to MnDOT and MnDOT's designer. In this role, the construction contractor provides, among other services, input on constructability, risk, cost and schedule during the project's design phase. Once the design is nearing completion, the CMGC contractor is given an opportunity to provide a price proposal to MnDOT to construct the project. If the CMGC contractor's price proposal is acceptable to MnDOT, the CMGC contractor then enters into a construction contract with MnDOT to serve as the "general contractor."

The intent of the CMGC process is to allow for an integrated approach to planning, designing and constructing a project. MnDOT works collaboratively with the designer (consultant or MnDOT staff), the builder (construction contractor) and stakeholders during a project's design phase to develop a plan to meet the project goals and avoid pitfalls that can lead to schedule delays and increased costs during construction. The contractor evaluates the constructability of the design concepts (i.e. to make sure the design can be efficiently constructed) to reduce risk, cost and time and provides innovative solutions to address construction challenges. This is particularly important for unique and/or complex projects that present significant risk.

CMGC is considered an alternative delivery process to the standard design-bid-build process where the builder is not involved until the construction phase of the project.

Benefits

CMGC is unlike the traditional bid-build delivery method because it brings the builder (contractor) into the design process early on when the builder's definitive input can positively impact the project. The contractor's participation and input is expected to improve the constructability of the design and help identify and address pitfalls (including those that can adversely affect the schedule, cost and phasing of the project) early in the process. This reduces the risk of the unknown, thus reducing the cost and potential for project delays. Furthermore, the contractor's input during the design development fosters innovative solutions to the unique and/or complex challenges presented by these projects. And CMGC allows for accelerating the project schedule due to the contractor's early involvement and the ability to overlap the design and construction phases.

Specific benefits of CMGC include:

- Fosters Innovation – collaboration with contractor during design
- Cost/Budget Management – contractors provide real-time cost information
- Design Control – MnDOT retains control of the design
- Reduce Risk – construction risks mitigated collaboratively during design
- Improved Constructability – design only includes features that can be built
- Reduces Time – contractor input and the ability to overlap design and construction helps accelerate the start of construction and reduces construction duration
- Reduces Cost – through innovation, value engineering, risk mitigation, and eliminating unnecessary design elements
- Increases On-Time Completion and Budget Certainty – contractor input during design phase minimizes changes/surprises
- Provides Flexibility – collaborative process that allows MnDOT to make informed decisions to best meet the project goals before entering into a construction contract

Challenges

CMGC has certain challenges associated with the use of this procurement method, including:

- Construction price is negotiated– MnDOT must reach agreement on a 'fair and reasonable' construction price with the contractor. The construction price is not a 'low-bid'.
- CMGC is relatively new to the transportation industry– there are still a number of owners, designers and contractors that have no experience with CMGC and/or a limited understanding of it.

When to Use CMGC

The CMGC procurement method is best suited for unique and/or complex projects that benefit from the combination of the contractor's participation in the design phase and MnDOT-controlled design. These types of projects often involve new and/or non-standard types of designs where it is difficult for MnDOT to develop the technical requirements needed to complete the work without industry input. These types of projects also typically present a high-degree of risk using other delivery methods. CMGC, however, provides an excellent forum to identify and minimize risk due to the early contractor involvement and MnDOT-controlled design.

Projects that are good CMGC candidates typically have one or more of the following characteristics:

- Technically complex new and/or non-standard types of design
- Considerable interaction with third parties, such as railroads and utilities
- Significant risks that are difficult to quantify or define
- Complex construction staging
- Significant schedule or budget constraints

Projects that are identified as CMGC candidates are evaluated by MnDOT using a risk-based project delivery selection matrix. The project delivery selection matrix assists MnDOT in determining the most appropriate delivery method for the project by providing a structured approach to evaluating key criteria for each of the different delivery methods (design-bid-build, design-build, CMGC, etc.). The key criteria include delivery schedule, complexity and innovation, cost and initial risk assessment.

Process

The process for using Construction Manager/General Contractor typically begins in the project's scoping or preliminary design phase. Once a project is designated CMGC, MnDOT issues a Request for Proposals to interested CMGC firms. The firms are then evaluated based on their qualifications, past experience and approach to the project. The evaluation may also include a price component.

Once selected, the CMGC enters into a professional/technical services contract with MnDOT to serve as a construction manager/advisor during the project development. Tasks under this contract include formal constructability reviews, risk assessments, construction cost estimates and schedules at various design milestones (typically 30 percent, 60 percent and 90 percent design). Other tasks include value engineering, construction engineering and assisting with third party coordination (e.g. utilities, railroad).

As the design is finalized, the CMGC submits a price proposal to MnDOT to construct the project. An independent cost estimate and a MnDOT engineer's estimate are completed to validate whether or not the CMGC's price proposal is fair and reasonable. If the CMGC's price proposal is determined fair and reasonable, the CMGC enters into a construction contract with MnDOT. The CMGC construction contract is similar to a typical design-bid-build construction contract.

MnDOT and the CMGC also have the option to negotiate and construct smaller work packages within the project. For example, the CMGC may see a need to purchase materials with long lead times, e.g. steel, in order to optimize the schedule. Or, the CMGC may see a need to relocate utilities, or to construct temporary pavement needed to maintain traffic or establish construction access, in advance of the larger project. This contract mechanism shortens the project schedule and/or reduces cost by advancing these project components before the larger project begins.

If MnDOT and the CMGC are unable to reach price agreement, MnDOT reserves the right to competitively bid the project work. The CMGC is then allowed to bid along with other competitors.

MnDOT's CMGC Program

In 2012, the Minnesota Legislature enacted Minnesota Statute 161.3207 to Minnesota Statute 161.3209 authorizing MnDOT to use the CMGC delivery method. The 2012 law authorized MnDOT to award up to four CMGC projects in any calendar year, not to exceed 10 total CMGC projects. To date, MnDOT has seven CMGC projects. Five of those projects are complete or in the construction phase. Two of the projects are in the design phase and are not included in this interim report.

At no time has MnDOT issued a CMGC request for qualifications or request for proposals and then cancelled the solicitation.

CMGC Projects under Contract

At the time this report was initiated, there were five MnDOT CMGC projects completed or in the construction phase. Each of these five projects are discussed in further detail in this report.

Winona Bridge Project

Location: TH 43 over the Mississippi River in Winona, MN
Project Description: This project rehabilitates and reconstructs the historic Winona Bridge (Highway 43) spanning the Mississippi River in the City of Winona. This project also constructs a new parallel bridge and roadway approaches for each bridge.

The Winona Bridge serves as a vital link, connecting Minnesota Highway 43 to Wisconsin Highway 54, providing direct access between downtown Winona, Latsch Island and communities in Wisconsin. Opened to traffic in 1942, the bridge is eligible for the National Register of Historic Places. At over 2,200 feet in length, the bridge stands as a distinctive element in the community with its steel, riveted through-truss spanning the main channel of the Mississippi River.

Concerns about the structural stability of bridges following the Interstate 35W bridge collapse triggered a closure of the Winona Bridge in 2008 while repairs were made. More recently, inspections revealed the need for additional repairs because the bridge's deterioration had accelerated. In addition, the Minnesota Legislature required that all "fracture critical" bridges be addressed to minimize the risk of future collapse. The Winona Bridge was among these bridges.

The Winona Bridge project was undertaken to repair and address the fracture critical condition of the bridge and to provide a structurally sound bridge crossing the main channel of the Mississippi River at Winona. It was also important to maintain access to Latsch Island and the Wisconsin highway system, to provide adequate capacity to safely accommodate existing and future transportation needs during the design life of the bridge and to maintain traffic to the maximum extent possible during construction.

For the Winona Bridge project a "two-bridge solution" was developed that rehabilitates the historic bridge after a new girder-type bridge is constructed immediately upstream. The two-bridge solution allows traffic to be routed on the new bridge while the historic bridge is rehabilitated. Once complete, the historic bridge will carry two lanes of northbound Highway 43 traffic and the new bridge will carry two lanes of southbound Highway 43 traffic. The new bridge will include a bicycle and pedestrian lane.

Key Risks & Challenges:

- Constructability issues related to repairs of the historic bridge
- Maintaining traffic during construction
- Section 106 (historic review) process

Why CMGC for the Winona Bridge Project?

Historically, bridge repair/rehabilitation projects were difficult to effectively deliver with traditional and alternative delivery methods available to MnDOT, such as design-bid-build and design-build. The traditional design-bid-build method does not allow for contractor input during the design development. This means MnDOT has to make assumptions, and in doing so, takes on risk, regarding matters such as the contractor's construction means and methods. Conversely, the design-build alternative delivery method allows for contractor input during the design development, but the risk of potential scope growth (unforeseen repairs) is difficult to quantify and effectively manage with this method. The design-builder is either required to take this risk, adding significant contingency to their bid, or MnDOT takes this risk while having less control of the design.

CMGC, however, allowed MnDOT to maintain control of the design and to receive contractor input during the design development. This was critical for the Winona Bridge project because the contractor was able to provide feedback critical to the design, such as their construction means and methods to rehabilitate the historic bridge. MnDOT was able to more effectively manage the Section 106 (historic review) process and potential scope growth common to rehabilitation projects. CMGC also allowed MnDOT to accelerate the project schedule through phased construction (work packages). This allowed critical work to begin in the river on the new bridge while needed right of way was secured elsewhere on the project. CMGC also allowed MnDOT to procure long lead time materials and establish site access early. Beginning these activities early reduced the potential need to restrict or close the historic bridge before the new bridge was constructed. This was important because the resulting traffic detour was approximately 70 miles.

Start Construction: July 2014

Construction Substantially Complete: Summer 2019
Contractor: Ames Construction

Project Status: Substantially Complete

Figure 1: Winona Bridge Construction Cost Estimates, Bid & Projected Final Cost Summary*

Winona Bridge Project

Design Milestone	Contractor	Engineer's Estimate	Independent Cost Estimate
30%	NA	NA	NA
60%	$144,039,183.16	NA	$139,883,666.02
90%	$146,156,956.16	NA	$142,430,361.50
Bid	$146,323,808.13	$143,608,955.06	$144,135,197.10
Final Cost**	$145,261,340.05	-	-

**The cost estimates, bid and final cost are for construction and do not include other costs such as right of way acquisition, engineering, utility, etc. like the total project cost (TPC). Project delivered as six work packages.*
***Projected final cost. Work Packages 1-5 are complete. The final work package, Work Package 6 is nearly complete.*

Trunk Highway 53 Relocation Project

Location: TH 53 in Virginia, MN

Project Description: This project relocated a two-mile segment of Highway 53 in Virginia, MN.

Highway 53 is a major transportation corridor between Duluth and International Falls. Portions of Highway 53 are located on land owned by mining companies that conveyed revocable easement rights to the state for use of the right of way decades ago. The landowner wanted access to the segment of land Highway 53 sat on to advance their mining operations. In accordance with the easement agreement, the companies exercised their right to terminate the easement rights for a segment of Highway 53, between Cuyana Drive and Second Avenue. MnDOT was then required to relocate the highway segment outside of the planned mining area.

MnDOT identified a recommended relocation route across an abandoned mine pit, which is now a reservoir supplying fresh water to the City of Virginia. The project included a bridge carrying four lanes of traffic, paved shoulders, a pedestrian trail and an interchange at the intersection of Highway 53 and Highway 135. The bridge is the tallest in Minnesota, spanning over some of the hardest rock on earth.

In accordance with the terms of the easement agreement, MnDOT needed to complete the relocation work by November 2017. By any measure, the resulting design and construction schedule was extraordinarily compressed.

Key Risks & Challenges:

- Highly aggressive schedule
- Significant construction access constraints
- Working in an abandoned water-filled mine pit near an active mine

Why CMGC for the Trunk Highway 53 Relocation?

Relocating TH 53 to vacate the easement in accordance with the agreement required MnDOT to complete the project's environmental review process, final design and construction in approximately two and a half years. This schedule was extraordinarily compressed and required MnDOT to proceed at-risk with final design before the environmental review process was complete. For the design-build method, which involves one contract for both design and construction services, this meant MnDOT would have to enter into a contract for both services before the environmental review process was complete and the environmental commitments were known. This was a major, if not unacceptable, risk because multiple design alternatives were being evaluated as part of the project's environmental review process. For the design-bid-build method, MnDOT would not have the benefit of contractor input during the design development.

This presented a major risk because of the project's significant access constraints and constructability challenges.

CMGC, however, allowed MnDOT to maintain control of the design while proceeding at-risk during the environmental review process. With its two-part contracting system, CMGC allowed for contractor input during the design development without obligating MnDOT to a construction contract before the environmental review process was complete. Together, these benefits were critical to the singularly important goal of completing the project on time.

Start Construction: November 2015

Construction Substantially Complete: September 2017

Contractor: Kiewit Infrastructure Company

Project Status: Complete

Figure 2: Trunk Highway 53 Relocation Project Cost Estimates, Bid & Final Cost Summary*

TH 53 Relocation Project

Design Milestone	Contractor	Engineer's Estimate	Independent Cost Estimate
30%	$202,818,853.60	$116,551,288.83	$103,394,973.83
30% Revised	$165,635,225.08	$140,093,235.99	$146,200,912.57
60% Bridge & 30% Civil	$159,427,819.00	$133,618,539.41	$138,452,241.34
90% Bridge & 60% Civil	$161,028,037.06	$148,544,239.55	$139,211,550.56
90% Bridge & 60% Civil Revised	$158,764,196.06	NA	$142,581,814.53
Bid	$156,039,238.80	$144,897,863.56	$138,002,802.63
Final Cost*	$169,861,929.90		

Overall Risk Contingency	$10,150,000.00		

**The cost estimates, bid and final cost are for construction and do not include other costs, such as right of way acquisition, engineering, utility, etc. like the total project cost (TPC). Project delivered as two work packages.*
Note: The cost estimates in this table do not include contingency for risk.

Smith Avenue High Bridge Project

Location: TH 149 (Smith Avenue) over the Mississippi River in St. Paul, MN

Project Description: This project replaced the Highway 149 (Smith Avenue) bridge deck (driving surface) over the Mississippi River in downtown St. Paul.

Highway 149, known as Smith Avenue within the St. Paul city limits and Dodd Road outside the limits, serves as an important north-south route, connecting the communities of Eagan, Mendota Heights, West St. Paul and St. Paul. Vital to this route is the Smith Avenue High Bridge that carries Highway 149 traffic over the Mississippi River in downtown St. Paul. At over 200 feet in height, this tied arch bridge is one of the tallest bridges in Minnesota.

This project replaced the bridge deck of the Smith Avenue High Bridge because it was nearing the end of its life. This project also replaced the traffic barrier, replaced the ornamental rail and lighting that sits atop the bridge deck, made bridge repairs and included minor roadway work at the bridge approaches.

The Smith Avenue High Bridge's unique post-tensioning system made replacing the bridge deck much more complex and a higher risk than for traditional bridges. The system had to be safely de-tensioned and re-tensioned in sequence with the bridge deck removal and installation. This work required slowly releasing approximately 500,000 pounds of force from external tendons (steel bars) that are stretched and encased in grout to support the bridge. MnDOT did not have the expertise necessary to perform this type of work and there were few, if any, known similar examples nationwide.

Construction access to the bridge was extremely limited, posing additional constructability challenges and risk.

Key Risks & Challenges:

- Safely de-tension the bridge's external grouted tendons
- Significant construction access constraints
- Limiting the bridge closure duration

Why CMGC for the Smith Avenue Bridge Project?

CMGC was selected for this project because it allowed MnDOT to work collaboratively with the contractor and designer to develop and implement a plan to safely, and without harm to the bridge, de-tension the bridge's external post-tensioning system, which consists of grouted tendons. This was critical because MnDOT has no similar experience with this type of work and there were few, if any, known similar examples of this work nationwide.

CMGC also allowed the contractor's construction means and methods to be integrated into the design. This was critical because the bridge deck removal and installation had to be sequenced in stages that aligned with the de-tensioning and tensioning of the bridge's external post-tensioning system.

In addition, CMGC allowed MnDOT to work collaboratively with the contractor and designer to manage third-party risks (e.g., permits, right of way acquisition from landowners adjacent to the project) related to construction access needed for this project.

Neither the design-bid-build or design-build delivery method offered both the early contractor collaboration and MnDOT-controlled design this project demanded.

Start Construction: September 2017

Construction Substantially Complete: November 2018

Contractor: Kraemer North America

Project Status: Complete

Figure 3: High Bridge Project Construction Cost Estimates, Bid & Final Cost Summary*

High Bridge Project

Design Milestone	Contractor	Engineer's Estimate	Independent Cost Estimate
30%	$36,425,676.37	$29,866,506.60	$32,415,844.96
60%	$38,061,645.45	$38,206,594.82	$37,465,968.20
90%	$39,686,079.72	$37,593,577.11	$38,557,686.82
Bid	$45,287,274.35	$42,905,186.84	$43,235,419.08
Final Cost*	$46,642,100.66		

Overall Risk Contingency	$2,800,000.00		

**The cost estimates, bid and final cost are for construction and do not include other costs, such as right of way acquisition, engineering, utility, etc. like the total project cost (TPC). Project delivered as two work packages.*
Note: The cost estimates in this table do not include contingency for risk.

3rd Avenue Bridge Project

Location: Highway 65 (3rd Avenue) Bridge over the Mississippi River in Minneapolis, MN

Project Description: The project rehabilitates the 3rd Avenue Bridge spanning the Mississippi River in downtown Minneapolis.

The 3rd Avenue Bridge carries Highway 65 traffic over the Mississippi River, connecting communities to the north, where Highway 65 is signed locally as Central Avenue, to 3rd Avenue South in downtown Minneapolis. Constructed between 1914 and 1918, the bridge is an example of Melan arch construction, the last of its kind to be constructed in the Twin Cities. The bridge features a reverse s-curve alignment and arch spacing that are intended to avoid dangerous limestone breaks in the river bottom. They also produced an aesthetic form that contributes to the bridge's overall image as a gateway to downtown Minneapolis. At over 100- years-old and located just above the St. Anthony Falls, the bridge is eligible for the National Register of Historic Places and is a contributing element to the St. Anthony Falls Industrial Historic District.

The bridge's condition required significant rehabilitation to keep it in service for years to come. The rehabilitation included structural repairs, refurbishing the ornamental rail, replacing the bridge deck, replacing the traffic barrier and adding lighting. Some minor roadway work is also needed at the bridge approaches.

Under any circumstance, rehabilitating a historic bridge such as this would pose significant risks and challenges; but, for the 3rd Avenue Bridge, the location and access constraints increased the risks and challenges significantly. The increased risks and challenges are due to the bridge's location just above the St. Anthony Falls Lock, which is currently closed and not operational, and a hydro-electrical plant owned by Xcel Energy. And two of the bridge's piers are located below Horseshoe Dam. Together these constraints make access to much of the bridge difficult, and in some cases not feasible, via the river.

Key Risks & Challenges:

- Significant construction access constraints (bridge located over a non-operational lock and dam)
- Constructability issues related to repairs of the historic bridge
- Section 106 (historic review) process
- Limiting the bridge closure duration
- 36 inch water main on bridge

Why CMGC for the 3rd Avenue Bridge Project?

CMGC was selected for the 3rd Avenue Bridge project because it allowed MnDOT to maintain control of the design and the contractor to provide input during the design development. Maintaining control of the design was critical for MnDOT to better manage the Section 106 (historic review) process and potential scope growth common to rehabilitation projects. . Collaboration allowed the construction means and methods to be integrated into the design so that critical bridge work was safely and effectively sequenced and would not adversely affect the historic character of the bridge. Contractor input was critical to identifying construction access needs and coordinating with regulators and landowners to find the most cost effective construction access for the project. The contractor's input was also critical to coordinating with utility owners whose utilities on the bridge had to be relocated with this project. These utilities include a 36" inch water main and large communications duct bank.

Neither the design-bid-build or design-build delivery method offered MnDOT both of the benefits this project demanded: allowing MnDOT to maintain control of the design and the ability to work collaboratively and engage with the contractor during the design development.

Start Construction: Spring 2020

Construction Substantially Complete: Scheduled for Fall 2022

Contractor: Ames Construction

Project Status: In Construction

Figure 4: 3rd Avenue Bridge Project Construction Cost Estimates & Bid Summary*

3rd Avenue Bridge Project

Design Milestone	Contractor	Engineer's Estimate	Independent Cost Estimate
30%	$118,483,305.40	$112,104,070.42	$111,237,344.47
60%	$126,016,004.53	$120,424,813.61	$122,999,461.03
90%	$123,772,108.19	$117,109,422.46	$116,294,273.09
95%	$125,115,015.12	$123,649,736.80	$121,203,895.03
Bid	$129,281,514.92	$127,987,591.69	$124,205,511.52

Overall Risk Contingency	$2,480,000.00		

**The cost estimates and bid are for construction and do not include other costs, such as right of way acquisition, engineering, utility, etc. like the total project cost (TPC). Project delivered as one work package. Final cost not available yet.*
Note: The cost estimates in this table do not include contingency for risk.

Stormwater Storage Facility

Location: Interstate 35W near 42nd Street in Minneapolis, MN
Project Description: This project constructs an underground stormwater storage facility along northbound Interstate 35Wnear 42nd Street in Minneapolis.

I-35W near 42nd Street is a low point in the highway grade and is subject to flooding under certain precipitation events. Flooding happens because of the limited capacity of the existing drainage system that conveys stormwater north to the Mississippi River via deep underground tunnel. To mitigate the potential for flooding, MnDOT explored available options including increasing the existing drainage system's capacity and/or providing stormwater storage during rain events.

Although increasing the drainage system's capacity is feasible, it is cost prohibitive because it requires another long, deep tunnel. Alternatively, constructing ponds for stormwater storage, as is typically done, is not a viable option due to the limited available right of way and pond size needed. As a result, MnDOT evaluated less conventional stormwater storage options and determined that constructing a deep underground stormwater storage facility in the area of 42nd Street is the most cost effective and viable option to mitigate potential flooding of the interstate. This project constructs such a facility.

Key Risks & Challenges:

- Working deep underground presents significant risks to safety, quality, budget and schedule.
- MnDOT has no experience performing similar work; this work is very specialized and unique for the transportation industry.
- Coordination with the adjacent Downtown to Crosstown Project to minimize disruption to the community and traveling public.

Why CMGC for the Stormwater Storage Facility Project?

MnDOT does not have similar experience designing and constructing a deep underground stormwater storage facility. This type of work poses significant risks due to the unknowns of working deep underground. This type of work is also unique and specialized for the transportation industry. Contractor input during the design development was critical to successfully delivering this project.

The design-bid-build method was not appropriate for this project because it does not allow for contractor input during the design development. And although the design-build delivery method allows for contractor input during the design development, it requires MnDOT to properly allocate risk and incorporate the necessary technical requirements to procure the design-builder. This posed a significant risk to the project due to the unique and technically complex nature of the work and MnDOT's lack of experience with it.

CMGC provided a viable solution. Using CMGC allowed MnDOT to maintain control of the design and work collaboratively with a highly qualified contractor during the design development. These attributes were important to effectively managing the high-degree of risk associated with this unique and technically complex project. The ability of MnDOT to maintain control of the design using the CMGC method benefitted the project by coordinating the work between the stormwater storage facility project and the adjacent Downtown to

Crosstown project. This coordination was vital to improving efficiency and minimizing the disruption to the community and traveling public.

Start Construction: Fall 2019

Construction Substantially Complete: Scheduled for Fall 2023

Contractor: Kraemer-Nicholson Joint Venture

Project Status: In Construction

Figure 5: Stormwater Storage Facility Project Construction Cost Estimates & Bid Summary*

Stormwater Storage Facility Project

Design Milestone	Contractor	Engineer's Estimate	Independent Cost Estimate
30%	$49,999,104.65	$52,354,269.63	$43,480,687.07
60%	$59,556,704.39	$60,248,133.55	$57,068,470.07
90%	$67,849,699.69	$67,761,374.42	$64,739,270.56
Bid	$72,301,556.91	$70,593,109.92	$68,468,397.99

Overall Risk Contingency	$6,990,000.00		

**The cost estimates and bid are for construction and do not include other costs, such as right of way acquisition, engineering, utility, etc. like the total project cost (TPC). Project delivered as two work packages. Final cost not yet available.*
Note: The cost estimates in this table do not include contingency for risk.

Evaluation of CMGC Projects under Contract

Evaluation of the CMGC method of procurement on projects involves project cost, use of innovative techniques, completion time and obtaining maximum value.

Project Cost

The implications for project cost were calculated based on the following: cost of the contractor's services during the design development, estimated cost savings due to the contractor's participation in the design development and cost changes during construction. Figure 6 shows the various cost implications for each project.

Figure 6: Project Cost Implications by Project with narrative

CMGC Project	Cost Savings and Narrative
Winona Bridge Project	Cost savings during design development are about $7.5 million. The cost savings are calculated by taking the design efficiencies of $8.48 million and subtracting a cost of $982,844 for the CMGC's pre-construction services. The design efficiencies include: ▪ optimized pile design for the new bridge river foundations to reduce cost ▪ early procurement of the 42 inch pile for the new bridge's river foundations to reduce risk of steel escalation ▪ innovative shoring designs that used readily available materials, such as portable precast concrete barriers and 42 inch pile cutoffs ▪ coordinating cofferdam design, including collaboratively establishing cofferdam elevations, to minimize risk of river flooding ▪ coordinating right of way acquisition with the contractor's construction schedule allowed a local car dealership, whose property was being acquired with this project, to keep their service bays in place while their new building was being constructed, eliminating the cost to temporarily relocate these service bays ▪ allowing the project to make use of readily available materials, such as MnDOT-owned timbers for the contractor's temporary bridge access and contractor-owned formwork to construct the new concrete segmental bridge • integrating contractor's construction engineering and construction means and methods into the design development to mitigate risk and improve efficiency • pre-approval of work platform for construction access • modernizing (lengthening) the approach spans of the historic bridge

CMGC Project	Cost Savings and Narrative
	Final construction cost for the project is not yet available. The projected final cost is estimated at $145.3 million, which is approximately $1 million less than the bid.
Highway 53 Relocation	Cost savings during design development are about $5.0 million. The cost savings are calculated by taking the design efficiencies of $6.6 million and subtracting a cost of $1,619,000 for the CMGC's pre-construction services. The design efficiencies include: ▪ early procurement of bridge girders to reduce risk of steel escalation ▪ optimized the designs for the bridge piers and bridge foundations to improve constructability and efficiency ▪ use of stay-in-place bridge deck forms to reduce formwork costs ▪ modified roadway profile to reduce excavation ▪ use of a causeway (land bridge) for access to reduce risk and improve productivity ▪ integrating contractor's construction engineering into the design development to mitigate risk and improve efficiency Final construction cost for the project is $169.86 million. It is $13.82 million more than the bid and exceeded the risk contingency by $3.4 million. The cost overrun was largely due to added work items directed by MnDOT.
Smith Avenue High Bridge	The cost savings during design development are about $2.46 million. The cost savings are calculated by taking the design efficiencies of $3.2 million and subtracting a cost of $774,000 for the CMGC's pre-construction services. The design efficiencies include: • bridge de-tensioning mock-up to mitigate risk and improve efficiency by testing the bridge de-tensioning procedures prior to performing the work in the construction phase • use of tower cranes for construction to mitigate risk and improve efficiency due to the site constraints • integrating contractor's construction engineering into the design development to mitigate risk and improve efficiency • coordination with project stakeholders, including the City of St. Paul, to establish access to the project site before beginning construction Final construction cost for the project is $46.64 million. It is $1.36 million more than the bid and $1.45 million less than the risk contingency.
3rd Avenue Bridge	The cost savings during design development are about $17.2 million.

CMGC Project	Cost Savings and Narrative
	The cost savings are calculated by taking the design efficiencies of $18.9 million and subtracting a cost of $1,725,307 for the CMGC's pre-construction services. The design efficiencies include: • integrating the contractor's construction means and methods (including sequencing of the work) into the design development to optimize the efficiency of the contractor's construction operations and minimize the risk of damaging the bridge during construction • integrating the contractor's construction engineering and plans for construction access into the design development to ensure adequate construction access to this highly constrained project site and to minimize impacts to sensitive resources and adjacent property owners • coordinating construction access plans with private third party owner and the Federal Energy Regulation Commission to access work on two of the bridge's piers, which are located downstream of the Horseshoe Dam. • testing/mockups during design development to minimize risk and improve efficiency of concrete bridge repairs • coordinating with the City of Minneapolis to integrate the temporary support and reinstallation of their 36 inch water main with the bridge design and contractor's work plans • coordinating the design and the contractor's construction means and methods with utility owners on bridge to minimize risk of damage and/or disruption to their utilities during construction • using Bridge Information Modeling to view, in three dimensions, the step-by-step work needed to rehabilitate the bridge improved constructability and avoided conflicts that would result in significant construction delays • contractor assistance (including providing input on construction means and methods) to obtain the necessary permits during the design development Final cost is not yet available for this report.

CMGC Project	Cost Savings and Narrative
Stormwater Storage Facility	The cost savings during design development are about $6.65 million. The cost savings are calculated by taking the design efficiencies of $7.8 million and subtracting a cost of $1,152,455 for the CMGC's pre-construction services. The design efficiencies include: • modifying the stormwater storage facility from 10 cells to six cells while maintaining the facility's storage capacity • moving the weir, which controls water flow to and from the stormwater storage facility, within the facility • optimizing the retaining wall (soil nail wall) design • early coordination with City of Minneapolis to protect and maintain the city's water main during construction • coordinating the contractor's construction means and methods with design to improve efficiency and minimize risk • early coordination to have an appropriate electrical service installed at/near the project site to minimize risk and reduce cost associated with alternative power sources such as generators • Early work package for construction access and site preparation allowed the outer walls of the stormwater storage facility to be constructed in one construction season, reducing cost Final cost is not yet available for this report.

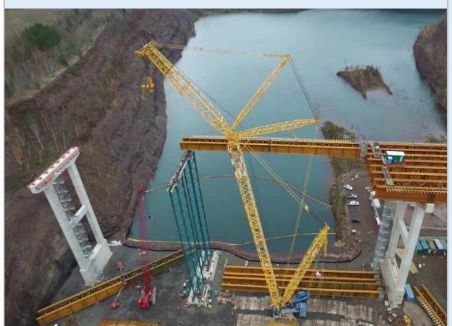
Innovative Techniques

The use of innovative techniques was determined based on identifying techniques or measures that were truly innovative or would not have otherwise been implemented on each CMGC project given normal industry practices. The innovative techniques reported in Figure 7 are included in the cost savings reported in Figure 6.

Figure 7: CMGC Projects and Use of Innovative Techniques

CMGC Project	Use of Innovative Techniques
Winona Bridge Project	Full-scale mock-up of historic bridge repairs: The contractor developed a full-scale mock-up of a truss connection member on the historic bridge. This enabled the contractors, designers and MnDOT to review the access constraints at different bridge repair locations so that construction means and methods could be optimized and design modifications could be made to allow for greater access. Through this process, the

CMGC Project	Use of Innovative Techniques
	contractor developed and tested special tools that could access otherwise inaccessible locations. Together, these measures improved productivity and mitigated risk during construction. <u>Standardized details and material on-hand for unforeseen repairs:</u> A key risk to completing this project on-time and on-budget was the discovery of unforeseen repairs to the historic bridge. Typically, as unforeseen repairs arise, repair details are then developed and reviewed for approval by the historians. Once approved, the needed repair materials are procured. This process can take weeks or months to complete, resulting in significant impacts to the project schedule and cost. To mitigate this risk, pre-approved standard details were developed and materials procured to have on-hand that provided flexibility to address a variety of the potential repairs discovered during construction. This proactive approach minimized costly delays during construction due to unforeseen repairs. <u>Splices for historic bridge repairs:</u> The design of the historic bridge did not allow for splices between some of the long splice members that needed to be repaired. The contractor worked closely with the designer, steel suppliers and steel erectors to establish an alternate splice detail that made the contractor's construction means and methods for installing the splice members more efficient and easier to handle. This eliminated the need for expensive marine equipment that would have been required to install these longer plates and members. <u>Modernized historic bridge approach spans:</u> As the design for the historic bridge progressed, it became evident there was an opportunity to modernize (lengthen) the bridge's approach spans to reduce cost while still achieving a "No Adverse Effect" under the historical requirements for the project. The use of work packages with CMGC was critical to the project schedule. It allowed work on the historic bridge's through-truss to progress while an update to the project's environmental document to allow the approach spans to be modernized was completed. In addition to reducing cost, modernizing the approach spans reduced long-term maintenance and was viewed favorably by the community because it opened up the area beneath the bridge. <u>Integrating the contractor's means and methods to construct the new bridge into the design:</u> The contractor's cast-in-place segmental bridge shop drawings were integrated into the design. This was a first-time implementation for MnDOT. It saved considerable time and eliminated risk associated with shop drawing approval during the construction phase.

<table>
<tr><th>CMGC Project</th><th>Use of Innovative Techniques</th></tr>
<tr><td>Highway 53 Relocation
</td><td><u>Causeway:</u> The contractor proposed constructing a causeway (land bridge) to provide access to construct the new Highway 53 bridge. MnDOT initially believed a causeway was not cost effective or viable. After further evaluation of causeway options and consulting with the appropriate regulatory agencies, a preferred causeway was established and determined to be both cost effective and viable. The proposed causeway mitigated considerable risk associated with performing bridge construction on water and in an environment with considerable wind and freezing temperatures. This was particularly important given the aggressive schedule.

<u>Modified drilled-pile foundations:</u> Contractor proposed using 30 inch diameter drilled pile foundations instead of the more conventional 24 inch diameter drilled pile foundations proposed by the designer. The 30 inch drilled pile foundations required ordering special tooling with an early work package, but it resulted in significant cost and schedule savings for the project because fewer drilled piles were needed.

<u>Stay in place deck forms:</u> Contractor proposed using stay in place metal deck forms in lieu of a traditional wood formed deck. MnDOT was reluctant to adopt this innovation because of concerns about trapping moisture and potential corrosion. Through the collaborative process MnDOT better understood the significant cost and schedule savings stay in place forms provided for this project and concerns regarding corrosion were addressed.

<u>Streamlining environmental process:</u> The project's Environmental Impact Statement was developed using a new parallel federal final EIS and record of decision process which, combined with other environmental process streamlining, significantly reduced the time to complete the environmental process.</td></tr>
<tr><td>Smith Avenue High Bridge
</td><td><u>De-tensioning Mock-up:</u> The bridge's post tensioning system, which helps support the bridge had to be safely de-tensioned to replace the bridge deck. This type of work is rarely done, if at all, anywhere in the country. To safely perform this work and avoid potential issues in construction that could delay the re-opening of the bridge, MnDOT worked collaboratively with the designer and contractor during the design phase to design and test a method to de-tension the bridge's post-tensioning system. Testing of the method was successful and mitigated considerable risk prior to construction. This not only reduced cost but, once in construction, resulted in the safe and efficient de-tensioning of the bridge's post-tensioning system.</td></tr>
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CMGC Project	Use of Innovative Techniques
	<u>Tower cranes:</u> Limited construction access and site constraints required innovative solutions to construct this project. Through the collaborative CMGC process, the use of tower cranes was identified as a possible solution; however, their use opened up the risk to potential conflicts with key utilities. To mitigate this risk, MnDOT and the contractor worked together to perform subsurface utility exploration where the potential conflicts existed. The tower crane footing was then designed and constructed around the utility conflict prior to construction avoiding delay and mitigating significant risk.
3rd Avenue Bridge	<u>Access bridge repairs below dam</u>: This involved developing and coordinating construction access plans with a private third party owner and the Federal Energy Regulation Commission to access repairs to two bridge piers located downstream of the Horseshoe Dam. The coordination and engineering, which included a flood plain analysis, were extensive and required innovative solutions to manage river flow because the lock and dam is no longer operational. <u>Bridge Information Modeling</u>: BrIM was a useful tool in communication during the project's pre-construction phase because it modeled the bridge's construction in three dimensions over the duration of the work. This allowed for reviewing and modifying the construction sequence and performing a detailed analysis of the reconstruction of the bridge's arch spans. It also helped reveal conflicts in the construction sequence and showed where optimizations could be made to keep the bridge closure duration in line with the project goal of two years or less. <u>Anchorage testing</u>: Validating the strength of chemical anchorages (grout/cement adhesive that attaches repaired concrete to the in-place concrete) at the base of the bridge's spandrel columns was necessary to ensure chemical anchorages were a viable option for the bridge repairs. If the strength of the repairs was not adequate, through bolting would be necessary and would likely result in an Adverse Effect to the historic bridge. This, beyond being a detriment to the historic integrity of the structure and a failure of one of the project's primary goals, would require additional environmental review that would delay the project. To address this risk and validate the design, a series of mock-ups were constructed. The mock-ups simulated several sections of the bridges "Melan Arch Rib" and allowed for controlled testing of the proposed anchorages in a setting that closely matches the field conditions. Additionally, the mock-ups provided valuable information to optimize the construction means and methods by allowing the contractor to test several methods of drilling-in anchors to improve productivity. Following

CMGC Project	Use of Innovative Techniques
	the testing, the mock-ups also provided the opportunity to study various removal methods, which resulted in greater cost and schedule certainty for the project.
Stormwater Storage Facility	Modify facility from 10 cells to six cells: After reaching the 30 percent design milestone, MnDOT asked the contractor to review design alternatives that could lower the construction cost. This included expanding the work area to a location near a future auxiliary lane. The contractor proposed an alternative that included six larger diameter cells, capable of holding the same amount of stormwater, instead of 10 cells that were originally planned. This alternative still provided the necessary stormwater storage and it resulted in significant cost savings. Incorporate weir into facility: In the original design, a weir structure, which controls water flow to/from the stormwater storage facility, was going to be constructed outside the cells of the stormwater storage facility. When the stormwater storage facility was then changed to six cells, the location of the weir structure was further reviewed and ultimately placed inside two of the cells. This modification resulted in significant cost and schedule savings.

Completion Time

The implications for project completion time were determined based on the estimated time savings (accelerating start of construction and/or reducing construction duration) due to the contractor's participation in the design development and comparing the actual completion of the project with the scheduled completion of the project.

Figure 8: Project Completion Time Savings

CMGC Project	Time Savings for Project Completion
Winona Bridge Project	The new Winona Bridge and historic Winona Bridge opened to traffic three months ahead of their respective contract completion dates. Construction was accelerated by six months by issuing early work packages for construction of the new bridge's river foundations while needed right of way was being acquired at the bridge approaches. Specifically, the early work packages procured the 42 inch pile for the river foundations, established site access (including dock walls) and constructed the river foundations.

CMGC Project	Time Savings for Project Completion
	The construction duration was reduced by at least 6 months by integrating the contractor's construction engineering (shop drawings for the cast-in-place segmental bridge) into the design development. This work was critical to the overall project schedule. The total time savings: 15 months
Highway 53 Relocation	Relocated Highway 53 opened to traffic two months ahead of the contract completion date. Construction to relocate Highway 53 began three months ahead of schedule and the overall duration was reduced by at least 12 months. This was due to the CMGC process that allowed the letting of an early work package to ensure adequate time to acquire the materials with long lead times critical to the schedule (steel girders and special tooling for the 30 inch drilled pile foundations) and for conducting an early expert review of details and development of bill of materials so the steel fabrication could begin immediately upon having an executed contract. The time savings was also due to CMGC's ability to move seamlessly from completing the environmental review process and final design into the construction phase. This was possible because the typical advertisement and bidding period were not needed in the CMGC process and critical plans and construction engineering, such as that required for the causeway, were completed during the project's design phase. As a result, construction was underway six weeks following the completion of the environmental review process. Together, these measures proved critical to accelerating the start of construction and reducing the overall construction duration. The total time savings: 17 months.
Smith Avenue High Bridge	The Smith Avenue High Bridge opened to traffic one week ahead of the contract completion date. The overall project duration and bridge closure duration were reduced by six months during the design development. This was largely due to the extensive coordination and construction engineering that took place during the design development to sequence the bridge deck deconstruction and construction activities and to establish construction access. The total time savings: Six months

CMGC Project	Time Savings for Project Completion
3rd Avenue Bridge	The 3rd Avenue Bridge project is not complete. The overall project duration and bridge closure duration were reduced by 12 months during the design development. This was largely due to the extensive coordination and construction engineering that took place during the design development to optimize the construction schedule and to obtain the necessary permits and agreements. The start of construction was delayed by six months to avoid conflicts with adjacent projects that would adversely affect the community and stakeholders. The total time savings: NA
Stormwater Storage Facility	The Stormwater Storage Facility project is not complete. The overall project duration remained on schedule during the design development and construction of the stormwater storage facility began on schedule. The project is still in the construction phase. The total time savings: NA

Maximum Value

The implications for obtaining maximum value were determined based on an assessment of how each project performed in meeting the project goals, with a focus on measures that can be objectively evaluated to support the assessment. For each project, these measures include documented cost and time savings during the design development phase and on-time and on-budget performance during the construction phase.

Figure 9: Obtaining Maximum Value through CMGC Procurement Method

CMGC Project	Maximum Value
Winona Bridge Project	The great value of the CMGC process for the Winona Bridge project was having the contractor's input during the design development to address constructability issues and risks with the historic bridge, while allowing MnDOT to maintain control of the design to best manage the Section 106 (historic review) process and potential scope growth (additional repairs) common to rehabilitation projects. The use of work packages and integrating the contractor's constructing engineering into the design development greatly accelerated the project schedule. The value of these measures are evidenced by the project goals having been met, including completing the project: • Ahead of schedule • With no cost increase during construction • While maintaining traffic across the river during construction • With no adverse effect to the historic bridge
Highway 53 Relocation	The great value of the CMGC process for the Highway 53 relocation project was having the contractor's input during the design development to address bridge construction access and constructability issues, while allowing MnDOT to proceed at-risk with final design as the environmental process was being completed. Procuring steel girders, a long-lead time item, with an early work package greatly accelerated the project schedule. The value of these measures are evidenced by the project goals having been largely met, including completing the project: • Ahead of schedule • While minimizing impacts to the community and mine • While minimizing risk to MnDOT related to future mining operations Although there was a greater cost increase during construction than anticipated, the cost increase was largely attributable to unforeseen conditions (contaminated materials and poor soils) associated with the project's location - an abandoned mine pit.

CMGC Project	Maximum Value
Smith Avenue High Bridge	The great value of the CMGC process for the Smith Avenue High Bridge project was having the contractor's input during the design development to establish a plan for de-tensioning and tensioning the bridge's external post-tensioning system and sequencing the bridge deck removal and installation. The project's significant access constraints were addressed collaboratively during the project's pre-construction phase to find the most cost effective and viable option to construct the project. The value of these measures are evidenced by the project goals having been met, including completing the project: • Ahead of schedule • While reducing the bridge closure duration to approximately one year and minimizing the impacts to the community, traveling public and stakeholders • With minimal cost increase during construction • While safely de-tensioning the bridge's post tensioning system and maintaining the integrity of the bridge.
3rd Avenue Bridge	The great value of the CMGC process for the 3rd Avenue Bridge project was having the contractor's input during the design development to address access constraints, constructability challenges, and risks with this historic bridge, while allowing MnDOT to maintain control of the design to best manage the historic review process and potential scope growth common to rehabilitation projects. This required extensive coordination between MnDOT, contractors, designers, utility owners, landowners, regulatory agencies and the City of Minneapolis during the project's design development. The contractor's participation in that effort was essential to: • Identifying and securing needed construction access • Efficiently sequencing the bridge rehabilitation work to minimize the bridge closure duration and impacts to the community, traveling public and environment • Ensuring the construction means and methods would not result in damage or an adverse effect to this historic bridge • Ensuring the temporary support and relocation of critical utilities (including a 36 inch water main) were appropriately integrated into the design and construction means and methods to minimize the risk of damage and/or disruption to these utilities during construction

CMGC Project	Maximum Value
	• Streamlining the permitting process To date, the value of these measures are evidenced by the following: no adverse effect to this historic bridge, the scheduled bridge closure duration was condensed to less than two years, the project is at this time on-schedule, the documented cost savings (Figure 6) during the project's design development. The 3rd Avenue Bridge project is not complete.
Stormwater Storage Facility	The great value of the CMGC process for the Stormwater Storage Facility project was the ability for MnDOT to work collaboratively with a contractor and designer during the project's design development to mitigate the significant risks and best address the many technical challenges and constructability issues associated with designing and constructing a large stormwater storage facility deep underground in a highly constrained urban location. What made the collaboration even more important is that the work was specialized and unique within the transportation industry and MnDOT had no experience with similar work. MnDOT's ability to maintain control of the design proved valuable to coordinating the work with the adjacent Downtown to Crosstown project and to minimizing impacts to the community and traveling public. To date, the value of these measures are evidenced by the following: the project is on-schedule, the documented cost savings (Figure 6) during the project's design development. The Stormwater Storage Facility project is not complete.

Conclusion

The details about MnDOT's five CMGC projects and how they have performed provide valuable insight into the CMGC procurement method.

Project Cost

The documented cost savings for MnDOT's CMGC projects as a result of the contractor's participation in the design development are significantly greater than the cost of the contractor's participation during the design development. The cost savings range from 4 percent to 15 percent of the construction cost for the five projects, with an average savings of 8 percent. By comparison, the cost of the contractor's services during the design development for those projects ranged from 0.7 percent to 1.7 percent of the construction cost, with an average of 1.1 percent.

The price proposals (bids) for constructing MnDOT's five CMGC projects are fair and reasonable. A comparison between the contractor's price proposal (bid) and the engineer's estimate for the five CMGC projects reveals that the differences range between 1.0 percent and 7.7 percent, with an average difference of 3.6 percent. Based on industry standards and MnDOT standards for all projects (not just CMGC), the cost differences are within a fair and reasonable price range.

Among the three CMGC projects completed to date, two of the projects had minimal or no cost increases during construction. The Winona Bridge project's final cost actually decreased from the bid. The Smith Avenue High Bridge project had a cost increase of just under 3.0 percent, but within the project's contingency.

The TH 53 Relocation project had an 8.9 percent cost increase, which was 2.0 percent above the contingency. The TH 53 Relocation project, however, was an anomaly because MnDOT added considerable work to the contract during the project's construction phase.

Innovative Techniques

MnDOT's CMGC projects greatly benefited from innovation. Whether it was MnDOT's first time integrating the contractor's concrete segmental bridge shop drawings into the design development on the Winona Bridge project, or developing and testing de-tensioning procedures for work that had been rarely done (if at all) nationwide on the Smith Avenue High Bridge, or constructing a causeway for construction access that was initially viewed as 'nearly dead on arrival' on the TH 53 Relocation Project, or developing a plan to access bridge repairs adjacent to a dam that is no longer operational on the 3rd Avenue Bridge, or modifying a facility from 10 cells to six cells on the Stormwater Storage Facility project, all of these projects have two things in common. First, the innovative solutions that were developed were critical to successfully delivering these projects. Secondly, these innovations were only made possible because of the CMGC process, which allows MnDOT to work collaboratively with contractors, designers and key stakeholders during the design development.

Completion Time

Among the three CMGC projects completed to date, all three were completed on time or ahead of schedule. Among the five CMGC projects included in this report, four projects realized time savings greater than or equal to six months based on the contractor's participation in the design development, with the fifth project remaining on-schedule. To some extent, these results aren't surprising given the extensive coordination and planning that takes place between MnDOT, contractors, designers and key stakeholders during a CMGC project's design phase. Whether it is streamlining the permitting process or integrating the contractor's construction engineering into the design development, the contractor's participation in the project's planning and development provides, at a minimum, greater schedule certainty and in many instances, reduces the project's duration. Significant time savings (acceleration or reduced construction duration) were achieved for these projects as a result of innovation and the ability to issue early work packages for schedule critical activities.

Maximum Value

MnDOT's CMGC projects were successful in maximizing value, as evidenced by the success of these projects in meeting project goals. Specifically, the projects were completed on time or ahead of schedule, with most of the projects benefiting from significantly reduced construction durations (at least six months). These schedule reductions/optimizations led to reduced costs and reduced impacts to the traveling public and communities where these projects were located. These projects also realized significant cost savings, as noted in Figure 6, and fair and reasonable construction costs, as validated by independent cost estimates. In addition, the early cost certainty as a result of the cost estimates provided by the contractor and independent cost estimators was invaluable to planning for and meeting budget/funding requirements to successfully deliver these projects.

When assessing the performance of these projects under the CMGC delivery method, it is important to remember that CMGC was selected for these projects because they are some of MnDOT's most unique, complex and high-risk projects to deliver. Projects of this nature are prone to issues, including cost overruns and schedule delays, which makes the performance of these projects under CMGC an even greater accomplishment. It is a testament to CMGC's ability to maximize value for unique, complex and high-risk projects through careful planning, innovation and risk mitigation between MnDOT, contractors, designers and stakeholders during the design development.