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CANADIAN CONSULTING ENGINEERING AWARDS 2011

G37 Interchange — Stage 1 Detour

Category:	Project Management
Client/Owner:	The City of Calgary Transportation Infrastructure
Subconsultants:	Thurber Engineering Ltd. ENMAX Power Services Corporation HFP Acoustical Consultants Corp. K-3 Project Management Ltd.
General Contractor:	PCL Construction Management Inc.

May 2011

G37 Interchange — Stage 1 Detour

FROM CONCEPT TO COMPLETION IN FIVE MONTHS

On November 6, 2009, ISL Engineering and Land Services Ltd. and CH2M HILL Canada Ltd. were selected by The City of Calgary to provide engineering consulting services for the planning, design and construction administration for the grade separation of Glenmore Trail at 37 Street SW (the G37 Project.) At that time, the scope of work required refining the opening day concept plan, previously developed by ISL and endorsed by Calgary City Council in early September 2009, followed by design of detailed plans to start construction in Spring 2010 and open the interchange by Fall 2010. These tight timelines required a running start, innovative approaches and concentrated, dedicated team work.

As leading local consultants, our firms pooled the resources necessary to provide a cohesive, complete team for the City. The project design team included members with specific responsibility for Project Management, Quality Management, Alternate Delivery, Transportation Planning, Roadway Design and Construction, Structural Design and Construction, Drainage and Utility Design, Geotechnical Engineering, Noise Analysis, Road Safety Audit, Erosion and Sediment Control Plans, Streetlighting, and Partnering. Eventually, this single project team concept was extended to include the general contractor, PCL Construction Management Inc., and their major subcontractors Lafarge Canada Inc. and Armtec Canada (formerly Con-Force Structures), as well as the major third party contractor ENMAX Power Corporation via "Integrated Project Delivery" (IPD). Through partnering and the application of IPD method, all of these firms became a single project team committed to delivering the project on-time and on-budget.

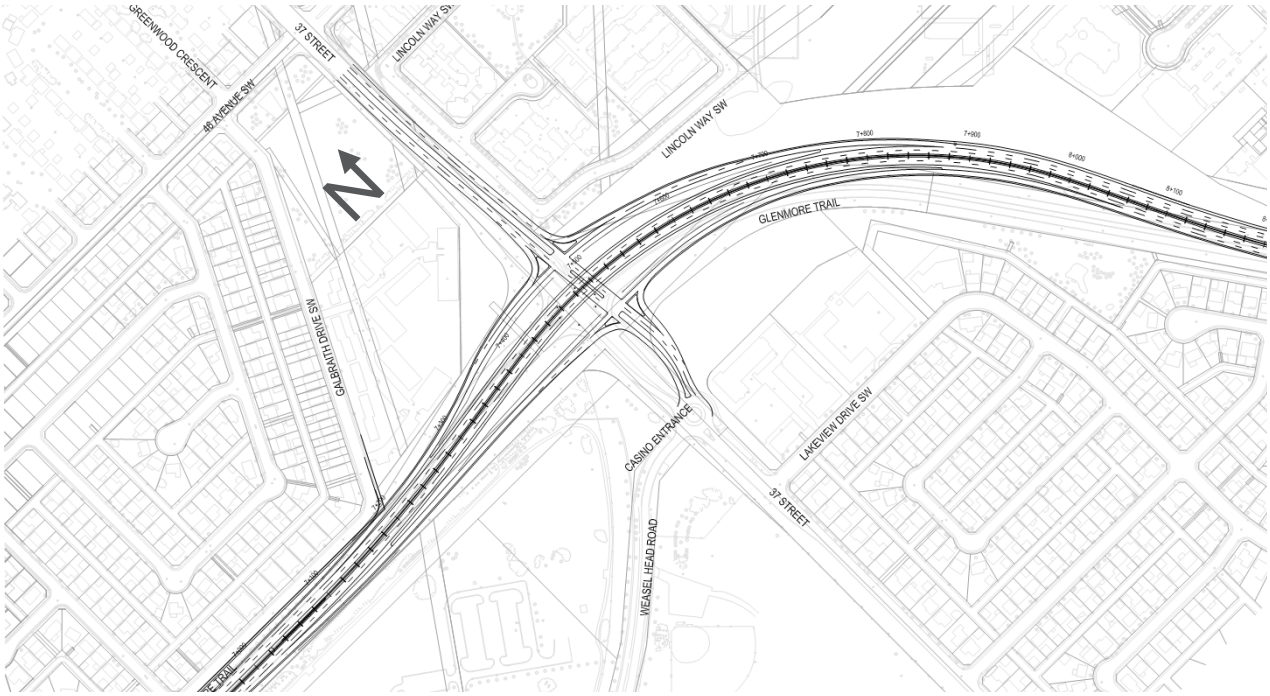
Council's desired construction schedule called out for interaction with the contracting industry to develop and execute an alternate delivery strategy. Modifications to both traditional (design-tender-construct) and alternate (qualify-design-build) delivery strategies were considered. A specialized Alternate Delivery team developed a contracting strategy that identified and considered all aspects of the evolving scope. ISL and CH2M HILL brought hands-on experience from the City's successful Glenmore Causeway Upgrades Project "fast-track" contracting and from the Glenmore Trail / 18 Street SE Interchange Project "Modified Design / Build" process. Both projects are prior Consulting Engineers of Alberta Award winners for Transportation Infrastructure.

External agencies and stakeholders (utilities and the Tsuu T'ina Nation) had great potential for unknown affects on schedule. Therefore ENMAX and ATCO Gas were engaged early and directly to negotiate and design temporary relocations to abate any potential delay. The City consulted the Tsuu T'ina Nation on an advisory basis and upon being informed the project would provide for access to their Grey Eagle Casino at all times, the First Nation raised no objection to City plans.

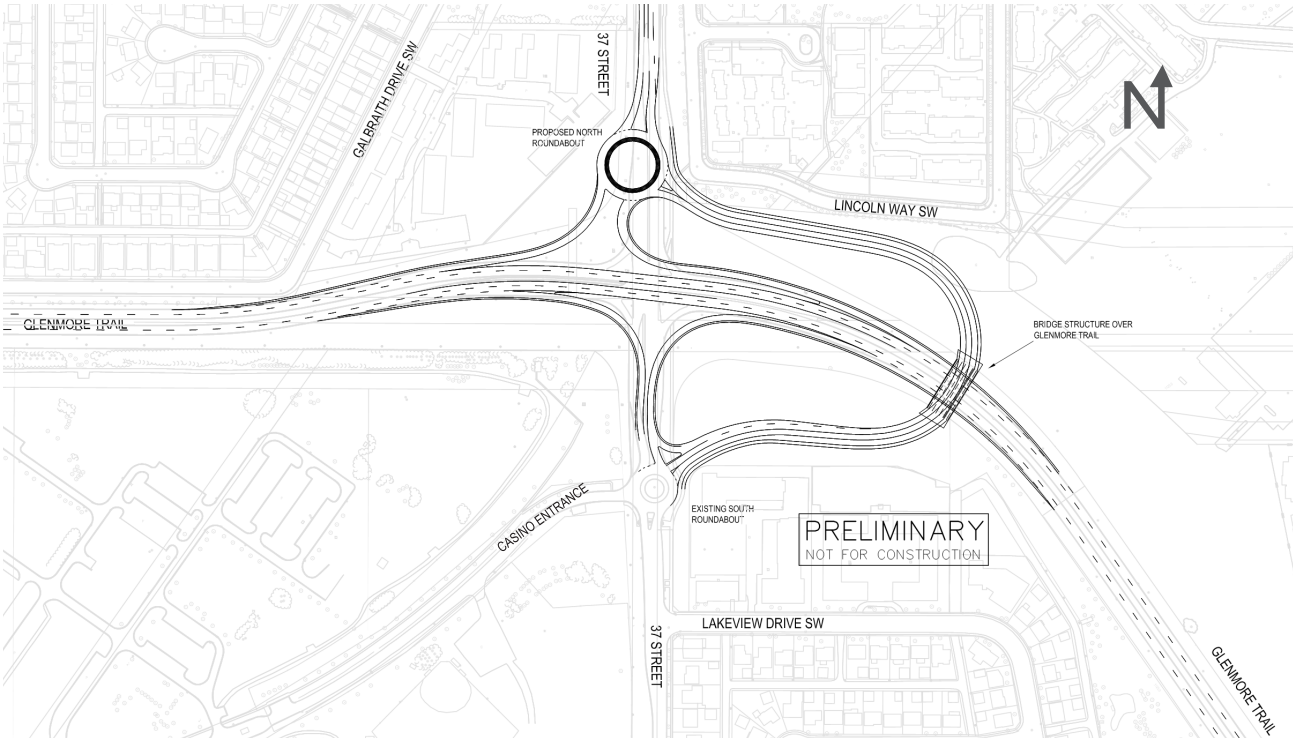
CHANGING THE PROJECT'S DIRECTION

Following the Tsuu T'ina Nation's rejection of proposed plans for Alberta Transportation's Southwest Ring Road (SWRR) and subsequent to the City's call for design proposals on G37, the Province concurrently initiated a new Functional Planning Study for the SWRR. In the interim the City and Province had agreed to cooperate in developing a new plan, so the City's existing approved interchange concept had to be modified so that it did not significantly limit the Province's choice of potential alignments. Ensuring that the City's interchange would not restrict the Province's choices for the SWRR became the primary focus of the transportation planning effort. ISL and CH2M HILL first adapted the existing council approved configuration to accommodate the Provincial concepts. While Alberta Transportation agreed that their initial concepts were accommodated, they pointed out that their concepts were far from finalized and other conflicting plans could evolve that would cause the interchange to be considered a "throw-away," a condition neither the Province nor the City desired.

After lengthy deliberations, and essentially reaching an impasse between the municipal and provincial visions in late January 2010, ISL and CH2M HILL responded with a plan to construct a temporary, low cost interchange as far away from the critical area of the ultimate SWRR as possible, and which could serve as the detour for the eventual SWRR construction. The new plan was the essence of simplicity, with two roundabout ramp terminals, one on each side of Glenmore Trail, that provide access to a two-lane fly-over situated to the east. In mid-February, the City and Province agreed that the configuration was viable, so that functional plans for the "Glenmore Trail / 37 Street SW Interchange - Stage 1 Detour" could be prepared for circulation. Plans were circulated within the City Departments and comments received during March, and, by April 1, a new functional plan for the completely revised temporary Stage 1 Detour interchange configuration was approved.



Original Interchange Approved by City Council, September 2009



Glenmore Trail / 37 Street SW Interchange – Stage 1 Detour Approved by City Council, April 2010

The start of detailed design was substantially delayed by this process. Without a workable alternate delivery strategy, the schedule would have been lost. Every project management challenge presents opportunity and the project team could see at least two such opportunities. First, the detour interchange was temporary in nature and thus open to innovative approaches to design and construction in a way that would not be available for permanent infrastructure; and second, City Council had not relinquished their desire to complete the interchange during 2010. Therefore, the City Administration would support expedited review and acceptance of project innovation, within a framework that ensured fiscal responsibility and best value for money spent.

"The new interchange at Glenmore Trail and 37th Street S.W. is a prime example of how limited projects can bring huge benefits. The addition of a roundabout and overpass on 37th Street for left-turning traffic onto Glenmore and the corresponding removal of traffic lights has wrought an amazing change on traffic flow, reducing stops and starts and shortening commute times through the area. Construction was brief, minimally disruptive and did not put landholders' noses out of joint. In other words, the interchange is an exemplary piece of work which should serve as a model for further improvements citywide."

— Calgary Herald Editorial, October 6, 2010, Copyright © The Calgary Herald

BUILDING THE TEAM

From the outset, the project team had been preparing an Expression of Interest request for the purpose of pre-qualifying three contractors who would then submit unit-price proposals for construction. The City Buyers received six responses on January 7 and three pre-qualified proponents were short-listed. On March 10, 2010 (based on the circulating functional plans received by each pre-qualified contractor,) a Request for Proposals was issued with an evaluated competition that weighed equally price and the proponent's plan of execution. Unit price proposals were received April 1 and the two lowest prices were separated by less than 1%. It was clearly the evaluation committee's assessment of the plan of execution and the proponent's ability to document and communicate their plans that would make the selection.

PCL Construction Management differentiated themselves by specifically addressing each important element and including plans for traffic accommodations on Glenmore Trail in their proposal. PCL also described up front in detail how each major activity would be accomplished so that, as the design evolved, there was a sound basis for negotiating changes that could not be accommodated within the unit price schedule. It was noted during evaluations that PCL identified nine specific innovations they would bring to the project team for consideration. PCL clearly understood the nature of the project. They were awarded the proposal, and on April 20, the first project team meeting was held with PCL in order for the project team's design engineers to start incorporating the construction contractor's input into their design. Thus, a Contractor was on-board and ready to build less than three weeks after the new functional plan was approved.

According to Jerry Guerra of The JAGG Group, "Integrated Practice/Integrated Project Delivery (IP/IPD) leverages early contributions of knowledge and expertise through the utilization of new technologies, allowing all team members to better realize their highest potentials while expanding the value they provide throughout the project life cycle. Through an integrated project delivery method, owners, designers, and builders can move toward unified models and improved design, construction, and operations processes." He lists the characteristics of IPD as the Early Involvement of Participants, Shared Risk and Reward, Multiparty Contract, Collaborative Decision-Making, Liability Waivers and Jointly Developed Goals. The G37 project had each of these to the extent possible within City of Calgary procurement policy.

Each participant, such as City departments, utilities, vendors and contractors, was involved at first opportunity. For example, ENMAX had a transmission line that, under the first design scenario, needed simply to be raised. When plans changed to the detour scheme, the line now had to be completely relocated. With Enmax on the team, the impacts of re-aligning the transmission line, including public notification and regulatory processes, were well communicated and understood by all stakeholders. Shared risk and reward was put in place by having all participants commit to the project schedule established by City Council. Contract terms provided schedule extensions for excusable delay but explicitly stated no price adjustment would be made for delay of any kind. While City policy disallowed multi-party contracts, strong mandatory partnering facilitated the effect of a multi-party contract and the collaborative decision-making that it encouraged. The project's guiding light came from the underlying commitment to do what is right for the project and acceptance of the overall goal to open the interchange prior to freeze-up in 2010. Interim milestone dates were jointly developed and goals agreed to within this framework. The owner, designers, and builders all worked together to improve design and construction.

Source: http://blog.i-designs.ca/Portals/14836/images/ipd.png

PROJECT DELIVERY

As the project was temporary, some new approaches to construction were permitted, such as full-depth, full-width precast bridge deck panels. The three R'-s of sustainability - Reduce, Re-use and Recycle - were adopted as a measure for the suitability of both design and materials. Re-usable pre-stressed girders, surplus to another project, were sourced and incorporated. Spread footing bridge abutments were founded on Mechanically Stabilized Embankments (MSE) (without piles), avoiding future abandonment of pile foundations. The fly-over bridge was designed so that it could be taken apart and re-used in its entirety, as were the MSE Wall Panels. Surface routing of drainage was employed wherever possible to maximize ground infiltration and minimize underground piping. Drainage was configured to take advantage of the existing underground pipe network wherever possible.

The interchange geometry was optimized to minimize both the cost and quantity of materials used. Modern roundabouts were used as ramp terminals, instead of signals, to reduce maintenance and idling costs. Road and sidewalk materials can all be re-cycled when the temporary interchange is replaced by the ultimate roadwork. Major materials were sourced locally, with the import of fill minimized by designing for on-site earth balance. Thinking about the project in these terms also helped reduce cost.

The schedule was challenging when the project was first conceived, planned and approved as a tight split-diamond interchange. The expiration of time to arrive at the phase 1 Detour Plan intensified the challenge and meant the detailed design and construction would be literally concurrent. This was turned to advantage by introducing IPD and using all the project participants' knowledge. With detailed design beginning in early April and the interchange to be opened in early September the same year, the goal was set to bring the interchange from concept to completion in five months, record time for an interchange in Calgary.

The construction sequence is readily revealed in the following aerial photographs. PCL mobilized in early May and, by the third week, had their Environmental Construction Operations (ECO) Plan submitted and had installed Erosion and Sediment Control measures according to the plan prepared by project design team. Stripping and grading could begin soon after as the project had been designed to occupy what was vacant land in three corners of the intersection. For obvious reasons, no access or intrusion onto First Nation land in the southwest corner was allowed.

Glenmore Trail / 37 Street SW Interchange – Stage 1 Detour, May 21, 2010 (Looking Southeast)

By August, the MSE Wall and Bridge Abutments were taking shape and portions of the new roadways were completed.

Glenmore Trail / 37 Street SW Interchange – Stage 1 Detour, August 9, 2010 (Looking Southeast)

By the end of August, the bridge deck was in place and paving was ready to be completed on the exit and entrance ramps connecting 37 Street to Glenmore Trail.

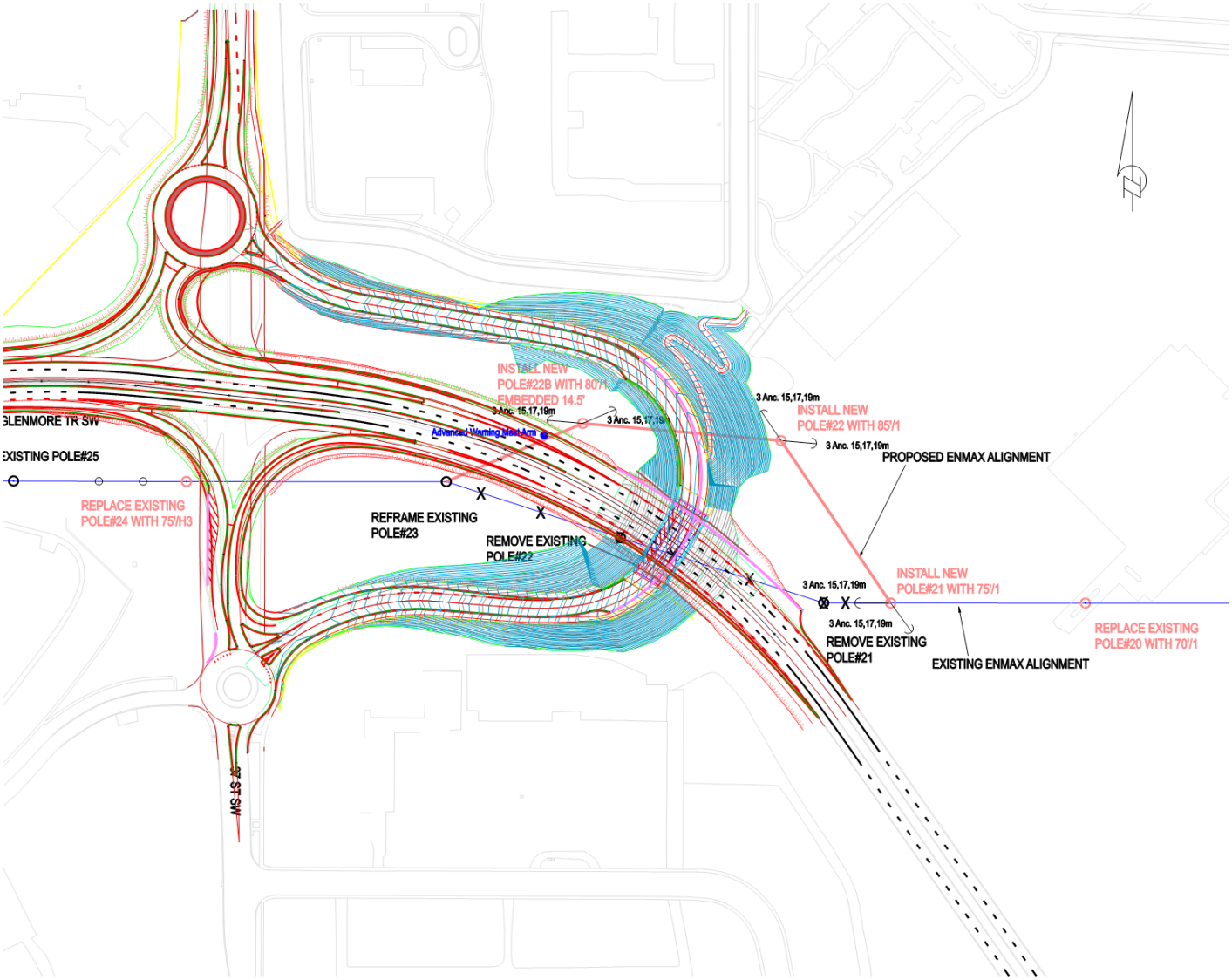
Glenmore Trail / 37 Street SW Interchange – Stage 1 Detour, September 4, 2010 (Looking Southeast)

Following a week of concentrated activity that saw rapid construction of all surface improvements, 37 Street north of Glenmore Trail was closed at 7:00 PM, September 10 so that existing intersection features that conflicted with the new interchange, including the traffic signals, could be permanently removed . A leveling course of pavement was placed where needed for final roadway tie-ins, while line painting and signing proceeded through the night. The new interchange opened to traffic at 7:00 AM, September 11.

Glenmore Trail / 37 Street SW Interchange – Stage 1 Detour, Open to Traffic, September 11, 2010 (Looking Southeast)

A series of overnight closures of 37 Street north of Glenmore Trail followed for ten nights until all on-road features of the ramp and roundabout were in place, with final finishing touches to the roadway completed by 6:00 AM, September 21. The remaining work in the median of Glenmore Trail then proceeded, with completion by early October.

Glenmore Trail / 37 Street SW Interchange – Stage 1 Detour, September 21, 2010 (Looking Southeast)



Glenmore Trail / 37 Street SW Interchange – Stage 1 Detour, ENMAX Transmission Line Relocation Plan

PROJECT PARTNERING

Partnering was a mandatory component of the project and K-3 Project Management Ltd. (Dr. George Jergas) was named as the facilitator. George's method of using the endorsement of the important project goals, then recognizing and addressing major risks, followed up with regular health checks as a basis for establishing and maintaining a trusting environment, was a contract requirement.

Partnering provided the basis for extending the Integrated Project Delivery (IPD) approach to include the builders soon after PCL's proposal was selected, with PCL and their team of subcontractors joining the team. IPD ensured the greatest pool of knowledge was available, from the start, to work towards the overall project goals. Tapping this pool was initially a challenge to the Client and Consultants who were most used to working in the design/bid/build environment where risks were determined then allocated by contract and agency authority. In design/bid/build the risks are more completely defined, and then bidders are paid to assume certain risks, and are responsible for managing them how they best see fit, either by direct control and execution, subcontracting and/or buying insurance. With IPD, the risk takers become involved very early in the project, when the ability to manage any individual risk is limited. While some risks are described and allocated, it is the overall project goals that are better defined and the focus is on achieving the agreed project goals by working creatively and cooperatively, managing all risks together within the contractual framework. While project goals can be definitely described early in a project, it is impossible or at least very time consuming to list and abate every risk early in a project. Hence within IPD any given risk needs to be shared and solved by the project team as a whole, with each member sharing up and downside potential. The risk sharing approach decreases any individual team members ability to utilize or manipulate project risks to their advantage.

This requires a trusting, communicative environment in which each member of the project team feels empowered to contribute their specialized knowledge. The project team recognized this early, and started to have regular meetings that included each discipline on the project team. Examples abound, such as when all members of the project team recognized Enmax's limited ability to provide a definitive timetable for public process and working together toward the shortest duration. The actual timetable for receiving Utility Board approval to relocate the high voltage transmission line was not known when construction proposals were called. This risk was shared by the whole project team, with the construction contract providing for time extension without costs in case the Alberta Utilities Board did not approve the Transmission Line 69-10.60L re-alignment application.

Partnering provided the foundation on which a trusting collaborative approach could be built.

"This team did an outstanding job of documenting how it developed and applied best practices in project management strategies and processes to successfully meet the complex challenges and timelines. A text book example of how such projects should be done!"

Judge's Comment, 2011 Showcase Awards, *Alberta Innovators*, Spring 2011, Consulting Engineers of Alberta. The G37 Interchange – Stage 1 Detour project received an Award of Excellence (1st place) for Project Management.

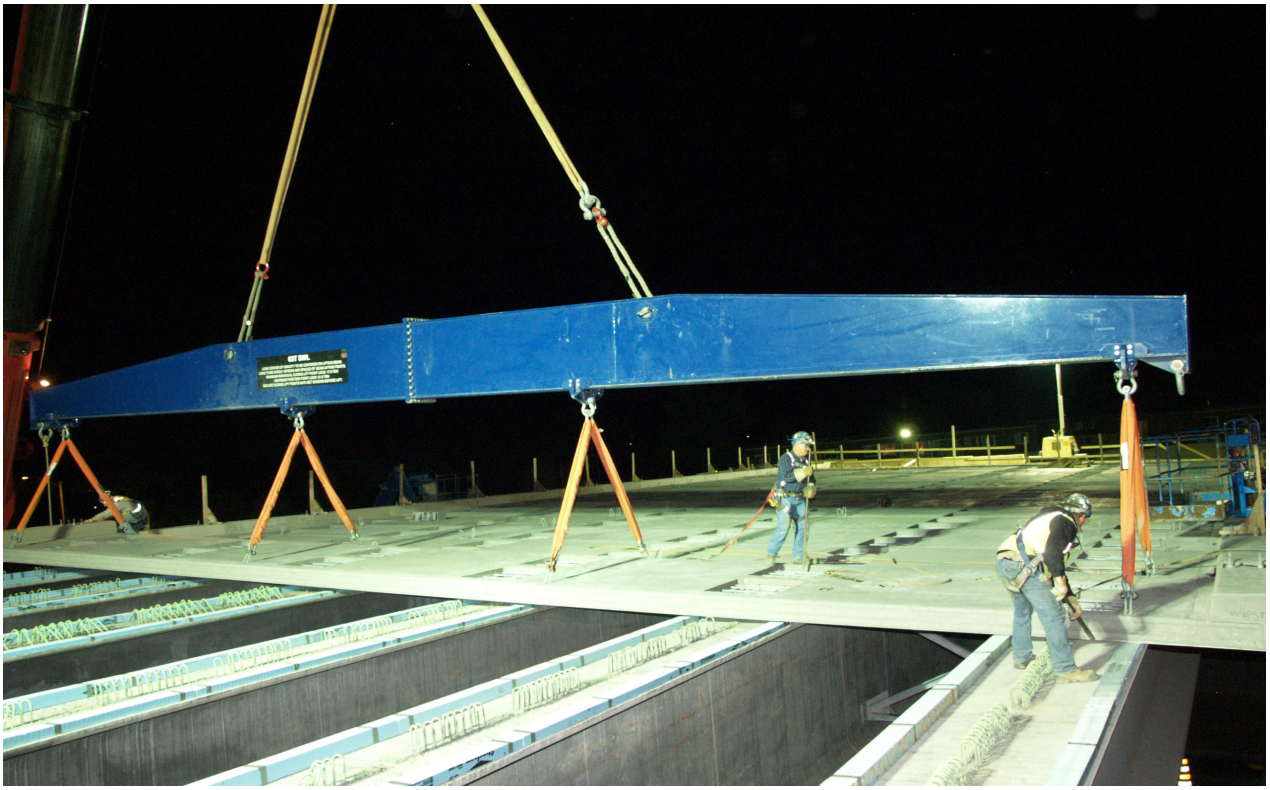
INNOVATIVE BRIDGE DESIGN

When the City recognized the temporary nature of the interchange, the project team was empowered to include innovative approaches in bridge building for the interchange. The first of these innovations was to found the bridge on spread footings resting on Mechanically Stabilized Earth (MSE) embankments. With reasonable soils in most places, Alberta bridges are founded on piles or caissons. This can result in both MSE Walls being constructed and piles being installed. To save time and effort, the project team proposed, and successfully employed, MSE bridge abutments without pile foundations.

The second innovation was in sourcing the bridge girders. The critical path in most bridge building is usually purchasing, detailing, reviewing, fabricating and delivering the girders. The project team was aware of suitable pre-cast girders that, for reasons of durability, were surplus to another project and readily available. Recognizing the design lifespan of the temporary interchange bridge was one half to one quarter or less of a typical design, the opportunity for time and cost savings was seen. Investigations found that, with minor remedial work, the girders would be well suited to a temporary interchange. The roadway was configured to make the span useful in situ. Design that used girders that were ready to set in place shortened the schedule by at least three months.

The third major bridge innovation was the use of full-depth, full-width precast concrete deck panels. The origin of the idea came from a desire to make the bridge wholly re-useable. While partial-depth panels had been used on previous projects to span between individual girders, so far as the project team found, panels spanning the entire width of a multi-lane six-girder bridge had never been used. A design was developed on this basis and, prior to issuing the RFP, thoroughly checked with the local manufacturer for constructability, again employing IPD early in the project.

Glenmore Trail / 37 Street SW Interchange – Stage 1 Detour, Setting First Precast Girder, August 19 10:35 PM



Glenmore Trail / 37 Street SW Interchange – Stage 1 Detour, Setting Precast Deck Panels, August 24 10:18 PM

By using these three major innovations, and many other smaller thought-out details, and careful engineering for the remainder of the bridge to suit rapid erection, PCL (with support from the project team) were able to begin construction of the superstructure on August 19 and complete it by September 10, a total duration of just 23 days.

As noted previously, the whole bridge was designed to be re-cycled and, via controlled demolition, can actually be re-used at another suitable site in the future. This reduces both the life-cycle costs of this bridge and future project costs at another location.

"Impressed with collaborative project delivery system. This eliminated the historical 'line in the sand mentality' between consultant team and contractor. Difficult site logistics were pre-planned prior to actual commencement of site activities, resulting in quick completion."

Judge's Comment, 2011 Showcase Awards, *Alberta Innovators*, Spring 2011, Consulting Engineers of Alberta. The G37 Interchange – Stage 1 Detour project received an Award of Excellence for Project Management.

SOLVING THE PROBLEM TOGETHER

The goal of opening Glenmore Trail to free flow traffic and the removal of commuter congestion for approximately 70,000 vehicles per day had been a defined and stated objective of the City of Calgary for well over a decade. Delivery of this promise had been repeatedly delayed and frustrated by the complexities involved in planning the Province's Southwest Ring Road. Perhaps the true measure of the value added by the entire project team can best be understood by recognizing that, by employing Integrated Project Delivery from the start, a long-standing, seemingly intractable problem was solved, and the resulting solution constructed, in record time for interchanges in Calgary - only five months.

G37 INTERCHANGE AT A GLANCE

Complexity	• Tight timeline – approved functional plan in April, with construction then completed by September. • Potential stakeholder issues were identified, risks were shared, and strategies to abate issues were employed early in the process. • Major scope change included redesign from the approved interchange plan to a temporary interchange. The project team saw this as an opportunity for innovation.
Meeting and Exceeding Client's Needs	• Project solved a decades old client problem through Integrated Project Delivery within the existing procurement framework. • Solution and resulting construction was done in record time for an interchange in Calgary, just five months • Project team purposefully designed the G37 Interchange to be used as a road detour when Calgary's Southwest Ring Road is built. • Uniform public and media praise for the project.
Environmental Impact	• MSE bridge abutments were used without pile foundations, which would have been left in the ground when the bridge was deconstructed. • Project team re-used existing bridge girders. • Bridge was designed to be recycled and can be re-used at another suitable future site. • Interchange removed all traffic signals and solved traffic gridlock, decreasing emissions from idling of over 70,000 cars.
Innovation	• Integrated project team agreed on, set goals and built their contracts around those goals. All team members, had a stake in project success and committed to its' success. • The approved plan was the essence of simplicity and the first roundabout of its kind (ramp terminals) in The City of Calgary. • Bridge was founded on spread footings resting on Mechanically Stabilized Earth embankments to save time, effort and cost. • Sourcing surplus precast bridge girders shortened schedule by at least three months. • Using full-depth, full-width precast concrete deck panels decreased construction time, cost and limited closure of Glenmore Trail.
Social and Economic Impact	• The interchange decreased commute times by an average of 7 minutes for 70,000 users each day. • Team provided access to the Grey Eagle Casino at all times, successfully accommodating the neighbouring Tsuu T'ina Nation. • Reusable design will save money on future projects. • Project was completed with minimal impact and enhanced environment.

G37 Interchange — Stage 1 Detour

2 PAGE SUMMARY

The Project: G37 Interchange

The goal of opening Glenmore Trail to free flow traffic and the removal of commuter congestion for approximately 70,000 vehicles per day had been a defined and stated objective of the City of Calgary for well over a decade.

On November 6, 2009, ISL Engineering and Land Services Ltd. and CH2M HILL Canada Ltd. were selected by The City of Calgary to provide engineering consulting services for the planning, design and construction administration of the grade separation of Glenmore Trail at 37 Street SW (the G37 Project). At that time, the scope of the project was to refine the opening day functional plan (previously developed by ISL), followed with design of detailed plans and construction.

Tight timelines set this project apart from the beginning, with The City of Calgary's objective of opening the finished interchange in fall 2010.

The project was further complicated by its proximity to lands allocated to a proposed Southwest Ring Road (SWRR) around the perimeter of Calgary. Alberta Transportation and the City of Calgary had agreed to work together on a Functional Planning Study for the SWRR. Ensuring that the City's interchange would not restrict the Province's options for the SWRR became a primary focus of the planning effort and the approved design for the G37 interchange needed by be adapted to accommodate the different options. The design team adapted the configuration to accommodate the Provincial concepts, but Alberta Transportation was far from a finalized plan for the SWRR and pointed out other conflicting plans that would cause a conflict. At this point, The City of Calgary; and Alberta Transportation were concerned about the possibility the G37 interchange would be a 'throw-away'. A complete new functional plan that accommodated both the City and Province's aspirations was needed.

Complex Design Challenges Breed Innovation

The project team responded to the challenge by recommending a temporary, low cost interchange as far away from the critical area of the potential ultimate SWRR as possible. This interchange, the first of its kind for Calgary, would even serve as a detour for the time when the SWRR was eventually constructed.

The new functional plan was approved April 1, 2011 and the G37 Interchange – Stage 1 Detour was ready for construction, leaving only five months to complete the interchange.

Temporary Bridge Allowed for Innovative Design

The temporary nature of the interchange allowed the design team to be innovative with design, materials and construction.

The design itself was the essence of simplicity, with two roundabout ramp terminals, one on each side of Glenmore Trail, that provide access to a two-lane fly-over situated to the east.

The bridge itself was designed to be completely re-usable and the team employed the use of full-depth, full-width precast concrete deck panels to meet this goal and save construction time. In an effort to shorten the construction schedule further, surplus pre-cast girders from another project were re-used. Then the bridge itself was founded on spread footings resting on mechanically stabilized earth embankments, without the need for pile foundations. The project team also looked for ways to utilize existing infrastructure; drainage was configured to take advantage of the existing underground pipe network; major materials were sourced locally; and the import of fill material was minimized by designing for on-site earth balance.

The innovations to save time and money also decreased the project's environmental impacts by employing the three R's – Reduce, Re-use and Recycle.

Proactive Response to Stakeholder Issues

The project team identified potential stakeholder issues early in the planning process and were proactively dealt with potential issues before they created any delays in the process.

Access to the neighbouring Grey Eagle Casino was identified as a potential issue and when the Tsuu T'ina Nation (Casino Owner) was informed the project would provide access to the casino at all times, they expressed no objection to the City's plans.

Another potential external stakeholder issue centred around utilities. Both ENMAX (transmission and distribution of electricity) and ATCO Gas were engaged early in the project to negotiate and design temporary relocations for utilities.

Integrated Team Approach to Project Delivery

An integrated project delivery (IPD) approach was employed by the project management team. IPD is a system of early involvement by participants, agreeing on project goals and sharing the risk and rewards, which ensures the greatest pool of knowledge is available and utilized from project onset.

Through this process, the overall project goals are better defined and the focus is on achieving the agreed project goals by working creatively and cooperatively, while managing all risks together within the contractual framework.

When building the team, the proposals received from contractors were evaluated based equally on price and their plan of execution. With relatively equal prices from all bidders, it was clear to the evaluation committee that the proponent's ability to document and communicate their plans would be the deciding factor. The project team expected the contractor to bring innovations to the table in order to meet the deadlines and project scope. One contractor, PCL Construction Management, stood out from the rest based on their innovative approach and was on board and ready to build less than three weeks after the new functional plan was approved on April 1, 2010.

Working collectively, the team delivered the interchange project in record construction time of five months, opening the new facility to traffic on September 11, 2010.

Partnering

Partnering provided the basis for extending the IPD approach to include the builders soon as the contractor and their subcontractors joined the team. IPD ensured the greatest pool of knowledge was available from the start to work towards the overall project goals. With IPD, all risk takers become involved early in the project, when the ability to manage any specific risk is limited. While some risks are described and allocated, it is the overall project goals that are better defined and the focus is on achieving the agreed project goals by working creatively and cooperatively, managing all risks together within the contractual framework. Project goals can be definitely described early in a project, when it is impossible or at least too time consuming to list and abate every risk. Project challenges are shared and solved by the whole team with each member sharing up and downside.

Exceeding Client Expectations

The G37 project demonstrated the exceptional project management skills of ISL Engineering and Land Services Ltd. and CH2M Hill Canada Ltd.

Using innovative methods of team building, design and project delivery, the team was able to meet client expectations under very tight deadlines and, in record time, effectively solved an intractable traffic issue that had persisted for more than a decade.