A Case Study in Innovation – 26 Avenue Roundabout

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ABSTRACT: Governments, consulting engineers, and the development community have a shared responsibility to set attainable goals and work together to understand the opportunities and challenges of sustainable design. Through a collaborative effort that included many stakeholders, the Calgary Municipal Land Corporation (CMLC) led the development of a unique and innovative roundabout solution as part of their off-site East Village works in downtown Calgary. Working within numerous constraints and the boundaries defined by the project objectives, a multi-lane roundabout design was developed that included 2 lines of heavy rail through the centre of the circulatory roadway. To our knowledge, this is the first roundabout in North America that includes multiple heavy rail lines through the central island and circulatory roadway.

The project need originated from the relocation of over 12,000 feet of rail siding in order to facilitate the construction of an underpass crossing of the Canadian Pacific Railway in downtown Calgary. The relocated siding yard was moved to an industrial area of Calgary called Manchester. The Manchester area is adjacent to an established community and the connecting roadways and intersection where the roundabout was built provide a direct and well used transportation linkage between Blackfoot Trail, a major arterial roadway, and the downtown core.

Designed and constructed in an extremely tight timeframe, this paper describes some of the challenges and opportunities unique to the development of this innovative project. It describes accounting methodologies that were considered in evaluating baseline and design alternatives in terms of sustainability. The project needed to satisfy the traditional criteria expected of transportation facilities including maintaining safety for all road users, enhancing mobility, respecting development patterns and plans for adjacent properties, and engaging local communities through a public information session.

The 26 Avenue roundabout project demonstrates the creativity of consulting engineers and the progressive philosophies of the CMLC, CP Rail, and City of Calgary which all collaborated to consider and develop innovative solutions that challenged conventional thinking. Leveraging the experience, skill, and input of the team, this project resulted in increased value for the CMLC, CP Rail, and City of Calgary, and improved sustainability through reduced impacts on the environment compared to other conventional intersection alternatives.

1. INTRODUCTION

Governments, consulting engineers, and the development community have a shared responsibility to set attainable goals and work together to understand the opportunities and challenges of sustainable design. With an emphasis on partnerships, collaboration between communities, government agencies, consulting engineers, contractors and other stakeholders is becoming commonplace in the design and delivery of transportation infrastructure projects.

The evolution of inter-disciplinary design philosophies and project innovation bring along a certain amount of risk. Transportation agencies are continually searching for ways to incorporate community values, safety, and efficiency into the projects they deliver for the movement of goods and people while following advice documented in proven design, construction, maintenance, and operations guidelines. Design innovation and implementation often challenge the very nature of standard guidelines and requires practitioners and stakeholders to accept a certain amount of 'risk'. This is because in many cases there is an uncertainty on how the particular innovation will function and if the actual outcome will match the initial expectations.

Context sensitive design or context sensitive solutions are gaining ground in terms of providing stakeholders with a framework for achieving extraordinary performance through innovation in a manner that outlines the risk process as well as provides an environment for learning and improvement and for ultimately delivering innovative projects.

This paper describes some of the challenges and opportunities the Calgary Municipal Land Corporation (CMLC) faced in the development of a unique and innovative roundabout solution as part of their off-site East Village works in downtown Calgary. It describes the site constraints and explains the need for enhancing the existing intersection and the accounting methodologies that were used in evaluating baseline and design alternatives for the site.

2. BACKGROUND

2.1 Innovation Defined

In the transportation context, innovation is the successful exploitation of new ideas[1]. This simplistic definition is intrinsically tied to modifying novel ideas and knowledge into new, high value-added pieces of infrastructure. Roundabouts are no longer novel to North America and their design is not overly difficult, however this particular roundabout is the first on the North American continent to our knowledge which incorporates two lines of heavy rail through the circulatory roadway.

There was significant leadership demonstrated by the CMLC, the City of Calgary and CP Rail in looking for innovative solutions for a highly constrained location. The risk management approach taken, although informal, was extremely effective in terms of managing expectations for stakeholder, extracting the full potential of the project in terms of derived value, and vetting and dismissing extremely remote or unrealistic perceived negative outcomes.

2.2 Project Description

East Village in Calgary is adjacent to historic Fort Calgary and is located in the heart of downtown. This community, once best known for its rampant crime and vacant lots, has now become one of the busiest construction sites in the city.

As the CMLC focus on revitalizing East Village, one of the many key infrastructure projects that link East Village to areas south of the downtown core is the Fourth Street underpass project.

The Fourth SE Underpass crosses through a CP Rail siding yard. The siding yard is instrumental to the customer service operations for CP Rail; therefore the construction of the underpass was predicated on finding a suitable replacement location for the siding yard close by on CP land. The CMLC worked with CP Rail and the City of Calgary to find a suitable location. The Manchester Yard was selected as the preferred site for the replacement siding yard.

Surrounding the proposed new Manchester Yard are a few key intersections which serve commuter traffic and the adjacent industrial developments. CP Rail operates a pair of tracks in their right-of-way at this location running north-south between 26 Avenue SE and 30 Avenue SE.

Figure 1 – Site Location

To accommodate the 12,000 feet of siding tracks, several parallel lengths of track required installation in CP right-of-way between Dartmouth Road and Highfield Road. The siding tracks are used to assemble trains and are also used as storage areas for rail cars depending on CP client demands and needs. In order for the sidings to be functional and serve their purpose, the closure of 30 Avenue SE was required. 30 Avenue SE provided an east – west connection across the existing tracks linking traffic from Blackfoot Trail to 25 Ave SE, one of the direct connections to the south end of Calgary’s downtown core.

As a result of this closure, traffic would be directed approximately 800m to the north and cross the tracks at the 26 Avenue location. The existing 26 Avenue / Highfield Road / Dartmouth Road Intersection was not formalized and without enhancements or improvements, would not adequately serve the additional traffic as a result of the 30 Avenue SE closure.

2.3 Design Alternatives

Several intersection alternatives were considered before the mutli-lane roundabout was selected as the preferred solution. These included using all way stop controls, installation of a single traffic signal and development of dual intersections with signals on either side of the tracks. It was quickly determined that installation of stop signs would not provide the desired performance or satisfy traffic demands so that alternative wasn't considered further.

The geometry of the intersection as well as the required off-set distances from the rail tracks would have made installation of a traffic signal awkward in terms of layout as depicted in Figure 2.

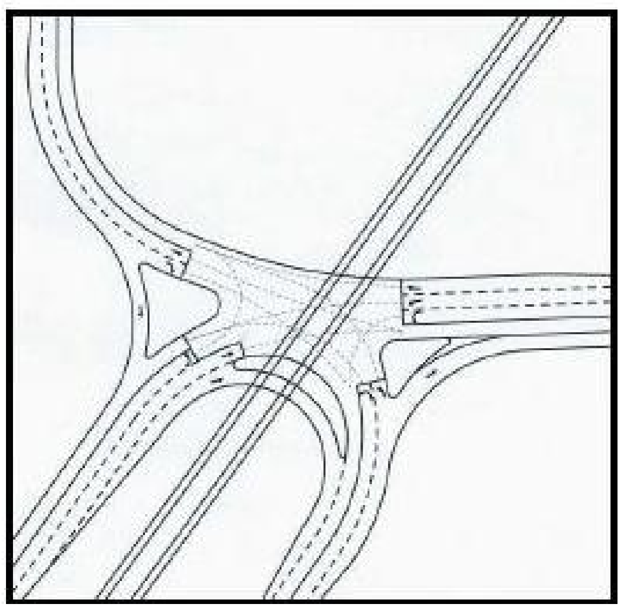

Figure 2 – Potential Signalized Intersection Layout

A single signalized intersection would result in a very large footprint for the intersection. There were concerns that the crossing gate arms would not be able to span such distances. Sight distances were not optimal and while a signalized intersection could easily be graded to accommodate the relatively flat longitudinal grades along the tracks, there were poor pedestrian and cyclist connections and long crossing distances involved in navigating through the intersection.

To address some of the challenges imposed by a single signal, offset signalized intersections were considered. Figure 3 illustrates the dual intersection concept.

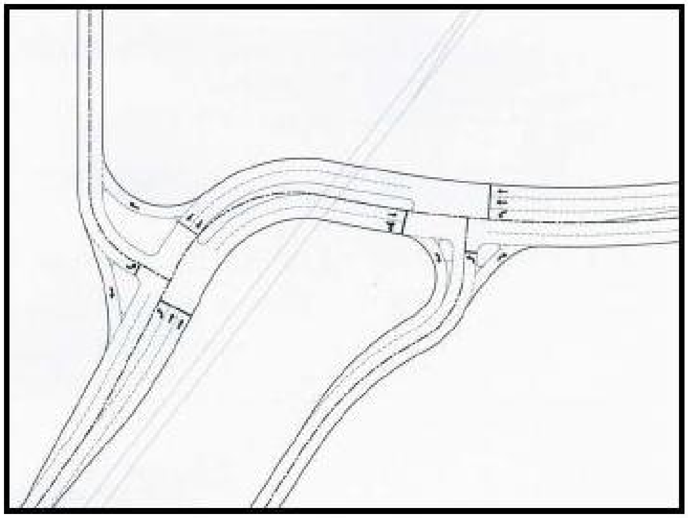

Figure 3 – Potential Signalized Intersection Layout

This configuration too was awkward with a fairly constrained horizontal alignment and less than optimal sight distances to the intersection locations as well as to the rail crossing signals. This option also required property acquisition which would have been cost prohibitive and a detriment to the project schedule.

A roundabout configuration was also considered for the intersection. Figure 4 illustrates the concept.

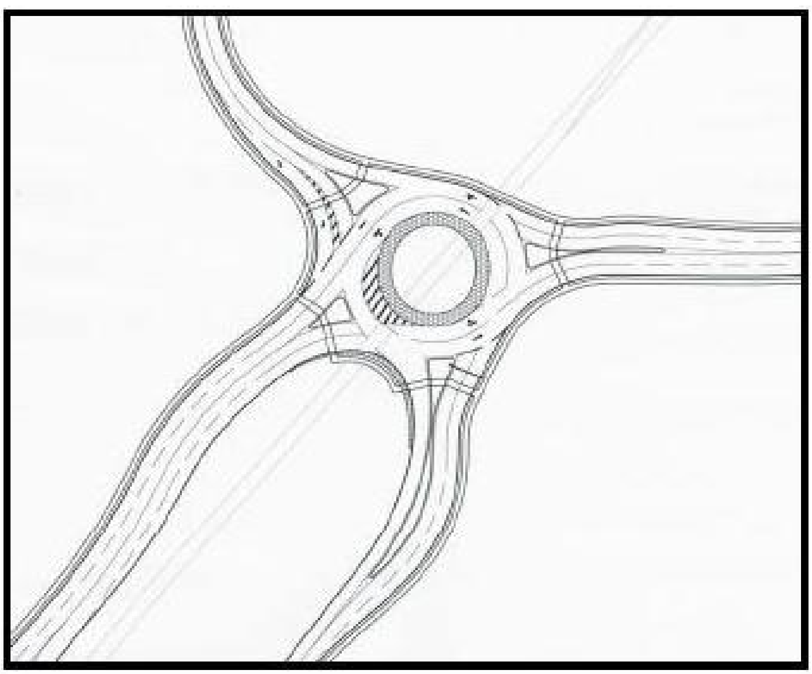

Figure 3 – Potential Roundabout Layout

The roundabout configuration addressed the unusual geometry of the intersecting roadways reasonably well and because of the central island, there was adequate space for the installation railway crossing arms which could easily span across the 2 lane circulatory roadway.

3. Traffic Analysis

Traffic analysis for the alternatives was required to evaluate the longer term performance of the intersection. This in itself was complicated since there were development applications for adjacent industrial lands that will see the conversion to higher density residential forms. The projected traffic generated by these developments significantly influenced the performance of the intersection.

A Level of Service Analysis was used to measure the intersection performance. Synchro 7 and Sidra Intersection analysis software was used to determine level of service. The City of Calgary did extensive work reassigning traffic in the area as their existing models did not contemplate closure of the 30 Avenue SE roadway.

The traffic analysis was further complicated by the two sets of active rail tracks that bisect all of the proposed intersection alternatives. CP Rail noted that the particular rail lines could be used for up to 10 trains per day with no set arrival times. In addition, the longest train that could potentially use the crossing would take about 5 ½ minutes to clear the roadway based on their typical operating speeds through urban areas.

Using Highway Capacity Manual methodologies, the level of service for each leg of the intersection and each alternative under consideration was estimated. Table 1 reveals the level of service analysis for the 2026 horizon. This horizon was selected to coincide with the operational failure of the intersection with one of the alternatives under consideration. This would allow a comparison of performance to the other alternatives and help with the evaluation and selection of a preferred alternative.

As shown in Table 1, the signalized intersection had an overall level of service rating of E for both AM and PM Peak Hours. Overall delay was over 70 seconds per vehicle in the AM Peak Hour and over 60 seconds per vehicle in the PM Peak Hour.

The dual signalized intersections performed much better than the single signal with an overall intersection level of service of C during the PM Peak Hour and a rating of D for the AM Peak Hour. Level of service for the approach legs ranged from B to D ratings and compared to the single signal alternative, the delay per vehicle was nearly cut in half.

The roundabout performed the best from a traffic operations perspective with an overall intersection level of service rating of B for both AM and PM Peak Hours. The delay in seconds per vehicle was approximately half of that calculated for the dual signalized intersections and approximately a quarter of that for the single signalized intersection. It should be noted that none of the level of service analysis explicitly factored the delay caused by train crossings into the calculations but a VISSIM model was developed to enhance site understanding of the intersection and the implications of the train crossing on the operational characteristics of the intersection.

The Synchro and Sidra analysis provided a good indication of intersection alternative operational performance and allowed efforts to be focused on developing a more

Table 1 – Summary of Alternative Level of Service

		Signalized Intersection				
		EastBound Approach	Westbound Approach	Northbound Approach (Dartmouth)	Nortbound Approach (Highfield)	Overall
AM Peak Hour	Delay (sec/veh)	66.2	96.8	43	71.8	**71.5**
	LOS	E	F	D	E	**E**
PM Peak Hour	Delay (sec/veh)	58.6	68.3	54.2	68.1	**61.6**
	LOS	E	E	D	E	**E**
		Dual Signalized Intersections				
		EastBound Approach	Westbound Approach	Northbound Approach (Dartmouth)	Nortbound Approach (Highfield)	Overall
AM Peak Hour	Delay (sec/veh)	51.6	42.9	4.5	21	**36.6**
	LOS	D	D	A	C	**D**
PM Peak Hour	Delay (sec/veh)	39.3	34.4	10.1	18	**29.1**
	LOS	D	C	B	B	**C**
		Roundabout				
		EastBound Approach	Westbound Approach	Northbound Approach (Dartmouth)	Nortbound Approach (Highfield)	Overall
AM Peak Hour	Delay (sec/veh)	25.4	18.3	7.4	21.8	**16.4**
	LOS	C	B	A	C	**B**
PM Peak Hour	Delay (sec/veh)	18.6	11.5	9.6	20.4	**12.7**
	LOS	B	B	A	C	**B**

sophisticated model that would include the effect of the trains and allow an assessment of the queue dissipation characteristics of the alternative. Determining appropriate modeling techniques that would adequately represent all the site conditions and constraints was difficult. The Microsimulation VISIM model allowed better visualization of the queuing at the intersection and the capability of the alternatives to handle dissipation following the clearing of a train.

3.1 Project Appraisal

Following completion of the traffic analysis the project team consulted with the CMLC, the City of Calgary and CP rail to receive their input. The team had also conducted site inspections to document issues and objectives for the intersection. The construction of the siding yard was on the critical path as the Fourth Street Underpass project could not begin until the sidings were relocated and operational. By extension, an upgrade to the existing 26 Avenue / Highfield Road / Dartmouth Road intersection needed to be completed in order to accommodate the additional traffic demands that would be placed on the infrastructure following the requisite closing of 30 Avenue SE.

Based on these numerous factors and constraints of the site that were best mitigated by the roundabout alternative, the team prepared the roundabout concept as the preferred functional plan for the intersection and held a public information session to inform the local community about the project and receive feedback. In general, the vast majority of community residents were informed that localized improvements were being considered for the ad-hoc industrial intersection.

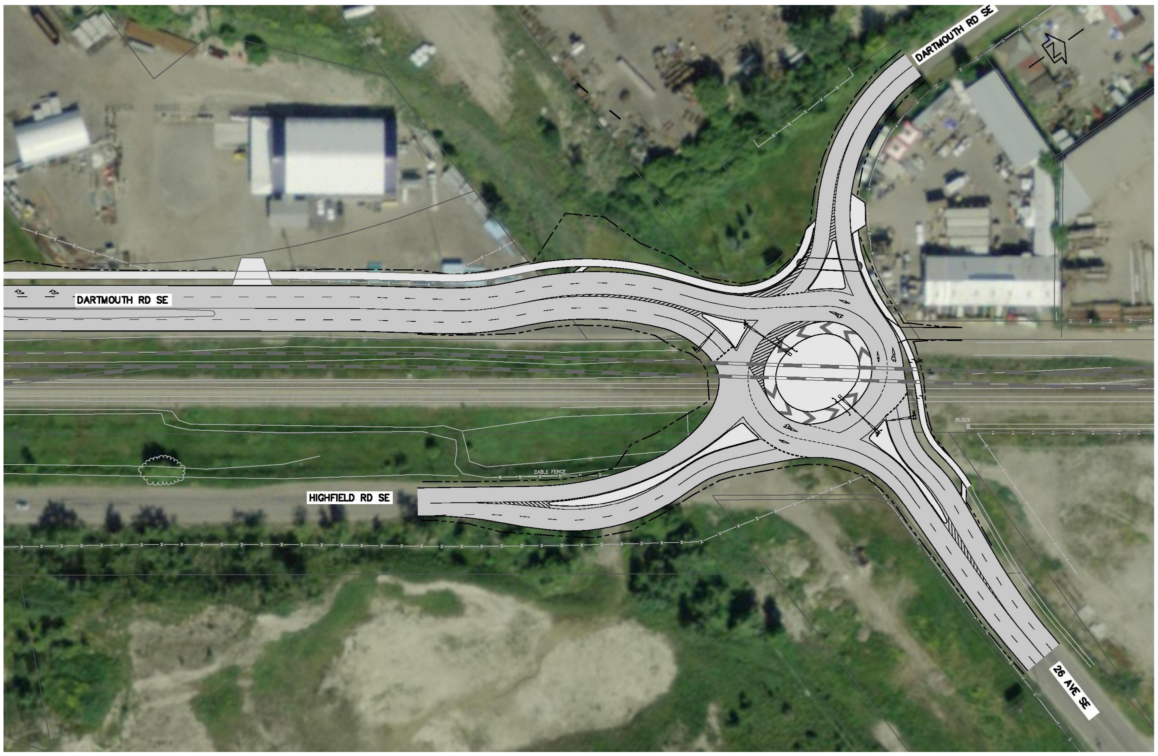

Figure 4 – Roundabout Concept Advanced as Preferred Alternative

3.2 Design Constraints

Good design begins with good planning. In order for the project team to focus on design activities, their initial efforts needed to be explicitly directed at thoroughly understanding the site constraints and issues before attempting to solve them. An integrated approach was used to mature the concept into a constructible design. Weekly meetings were held by the project team, CMLC, and City of Calgary and each party equally contributed to advancing the work as quickly and efficiently as possible in order to meet the construction schedule. Bi-weekly meetings were also held with CP Rail. CP Rail was extremely helpful in communicating their requirements with respect to track safety and was keen on advancing this innovative crossing. Design work did not begin until late June 2009.

Although designing roundabouts is not overly difficult the adoption of national standards through the Transportation Association of Canada has not yet occurred. Local variations and design techniques are still relatively prevalent and integration of roundabouts with CP Rail standards such as AREMA is nonexistent.

The property constraints also influenced the seating of the roundabout. The aggressive schedule did not allow for any property acquisition so the iterative process typically used in layout for roundabouts was further complicated. The property constraints also impacted

Figure 5 – Aerial Photography Showing Roundabout in Construction

the extent of salvage and therefore project costs. There were several businesses along the north side of the intersection which required continual access. Construction staging required consideration of business access and accommodation of active rail lines.

Figure 5 showing the roundabout under construction provides context to the surroundings. Courtesy of the CMLC who commission aerial photography of their infrastructure projects, these images provided the design team and other stakeholders with an appreciation of progress from a different perspective.

Figure 6 - Aerial Photography Showing Roundabout in Construction

Figure 6 demonstrates many aspects of the roundabout design in a larger scale including the CP Rail design constraint, the ultimate geometry of the roundabout, the railway stop signals, some utility locations, and access management issues with adjacent land among others.

SUMMARY:

An innovative and collaborative design approach was embraced by project stakeholders in a highly constrained area to develop a unique multi-modal transportation solution for a challenging project site. Through regular communication and a team work approach, the project moved through preliminary design, detailed design and approvals and to construction in approximately 8 months.

The 26 Avenue roundabout project demonstrates the creativity of consulting engineers and the progressive philosophies of the CMLC, CP Rail, and City of Calgary which all collaborated to consider and develop innovative solutions that challenged conventional thinking. Leveraging the experience, skill, and input of the team, the end project result increased value for the CMLC, CP Rail, and City of Calgary, and improved sustainability through reduced impacts on the environment compared to other conventional intersection alternatives.

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