

Issues and Challenges of “Complete Streets” Implementation on a Bridge Structure
and Its Approaches

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Abstract

A 370m long bridge structure spanning a major provincial highway, a cold-water creek and its associated valley lands needed to be replaced. This 100 year old high-level bridge, a key link in the city's transportation network, connects the city centre with the adjacent residential areas. The planning and design of the replacement bridge was particularly challenging. Considering the critical location of this bridge, traffic flow needs to be maintained at all times, even during construction. In addition, other issues and challenges were encountered related to approach roads at either end of the proposed bridge in terms of their approach curves, sightlines and grades. Traffic management during construction was also a major issue due to limited creek and highway crossing options within the roadway network.

This paper/presentation focuses on the issues and challenges faced in accommodating all modes of transportation on the bridge structure and its approaches, along with an extensive stakeholder, technical agency and public consultation that was undertaken to develop a consensus between all parties involved. Also included in this paper/presentation is an explanation of the innovative approach taken in determining the bridge alignment (staged construction) that was utilized to minimize property impacts, maintain traffic flows at all times (even during construction), and improve the alignment of the approach roads (approach curves, sightlines and grades), all with a net positive effect to the environment. Lastly, a complex traffic management plan that was developed to accommodate traffic flows during various types of bridge and highway closure scenarios is also included in the paper/presentation.

Background

Complete Streets is a relatively new terminology, even though the concept has been in place for a long time. Traditionally, transportation planning focused on catering to automobiles. *Complete Streets* policies promote planning, engineering and transportation policies that provide a safer road network for all users. The National Complete Streets Coalition (NCSC) defines it as, "A Street that works for motorists, bus riders, cyclists and pedestrians, including those with disabilities." The focus of this approach is to move away from "automobile-centric" approach to a "multi-modal" approach which not only provides infrastructure for automobiles but also improved infrastructure for other modes as well including pedestrians, cyclists and transit. Key benefits for this approach are efficient use of the transportation network, improved user safety, better health for individuals using other modes and improved environment resulting from less pollution due to reduced automobiles on the network.

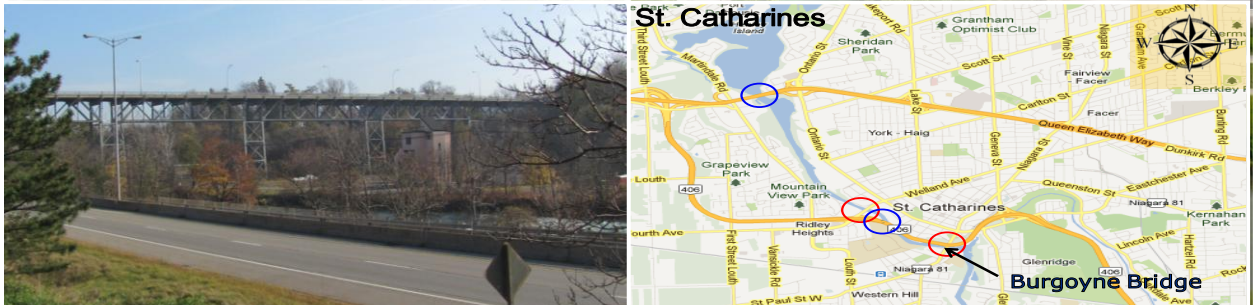
Niagara Region has adopted this *Complete Streets* concept and strives to incorporate it in their projects, where applicable. This paper presents a case study for the replacement of a high level, long span 100-year old bridge structure where the Region, along with their consultant, Delcan (a Parsons company) has successfully incorporated this concept despite numerous issues and challenges related to design, property acquisition, construction staging and overall cost. This project demonstrates how a commitment to a vision was achieved by aligning the goals of various stakeholder groups/agencies and setting a stage for these stakeholders to consider innovative / customized approaches, strategies and design solutions, which allowed for the vision to be achieved.

The need for replacement of this structure stemmed from the finding of a 2010 structural assessment of the bridge. This study recommended to the Region that the structure was approaching the end of its useable life, with only 5 to 7 years remaining and load restriction along with repairs to some of the critical structural elements needed to be undertaken in the interim. These works were implemented shortly after the recommendations were made. Based on the findings of this report the Region initiated an environmental assessment (EA) study to assess the best course of action. This EA study addressed the following:

- Rehabilitation vs. replacement of existing structure;
- How to address complete streets concepts/multi-modal accommodation?
- Sensitivity toward natural, socio-economic and heritage/cultural environment;
- Corridor/Bridge Aesthetic; and
- Utility accommodation across the valley.

Environs

The existing Burgoyne Bridge is a steel truss structure built in 1915 spanning the Twelve Mile Creek and Highway 406 at high level (about 26m). It is 370m long and it includes multiple steel truss spans supported on steel truss towers together with steel girder spans flanking the main structure. The bridge includes 2 travel lanes with sidewalks on both sides and carries Regional Road 81 (St. Paul Street West) over the valley in the City of St. Catharines.



The Official Plan of the City of St. Catharines recognizes the Twelve Mile Creek corridor as a "Regional Natural Heritage Corridor". Additionally, the Ontario Ministry of Natural Resources (OMNR) courses and the Niagara Peninsula Conservation Authority (NPCA) has a keen interest in preservation of this area given the existence of provincially significant wetlands (PSWs) and the presence of species at risk. Within the valley, the creek itself is designated as a navigable waterway, regulated by Transport Canada (TC). Also, this creek is utilized by the Ontario Power Generation (OPG) to generate electricity through their Heywood Generating Station and as such they control and adjust the water flow through the project study area. As such, there are many agencies ranging from municipal to

federal that have jurisdictional interests in what is planned in the valley and the potential impacts of these plans.

This natural feature also contains a recreational trail and a provincial transportation corridor within the valley area. The Merritt Trail is an 11 km pathway for both pedestrians and cyclists which crosses under the Burgoyne Bridge and connects to the St. Paul Street West corridor on the north side of the structure. The provincial highway (Highway 406) was introduced in mid-1980s to connect the southern Niagara municipalities to downtown St. Catharines and to the Queen Elizabeth Way (QEW). Unfortunately, the valley and the highway corridor create a significant barrier to mobility within the city of St. Catharines. These features bisect the city creating an east and a west segment. As with all natural barriers there are limited crossing opportunities within the transportation system. Within the downtown area there are only two bridge crossings of which Burgoyne Bridge is one. A recent transportation study for the west St. Catharines area concluded that additional creek crossing capacity will be required in the future.

St. Paul Street West is the key commuter route serving as a gateway to the downtown and a significant link of the Niagara Wine route. The crossing is also a significant transit (local, Regional and inter-city) and pedestrian linkage (trails, school trips, and others) providing continuity to and from the downtown area. Additionally, it serves as a primary response route for all emergency services and most recently with the opening of a Regional hospital in west St. Catharines the travel demands have increased and travel time reliability along the crossing has become even more important. In short, the St. Paul Street West crossing is an integral link in the Regional and City transportation network. As such, significant capacity reductions at these crossings for the replacement of Burgoyne Bridge would create severe hardship to all corridor users.

The EA Process and Recommended Solution

This project was completed under the EA Act in accordance with the *Municipal Class Environmental Assessment, October 2000, as amended in 2007* and classified as a Schedule "C" Study, which have the potential for significant environmental affects and must proceed under the full planning and documentation procedures specified under the Class EA document. The key objectives of this EA study were to achieve the following:

- *Accommodation of all modes – "Complete Streets"*
- *Bridge Structure – "Made in Niagara Solution"*
- *Bridge Approaches – "Realign to improve roadway geometrics"*
- *User Safety – Overall bridge and approach design to improve user safety*
- *Aesthetics – Need for an aesthetically pleasing bridge*

- *Traffic Impacts – Need to maintain traffic flow during construction*

There are two main components of an EA process: Consultation and Technical Analyses. For a successful outcome of any EA study these two processes go hand in hand in developing a preferred solution.

Consultation

Consultation is a key feature of environmental assessment planning. One of the principal aims of the consultation process is to achieve resolution of differing points of view, thus reducing or avoiding controversy. If concerns are raised during the consultation process that are related to anticipated negative environmental impacts and the concerns cannot be resolved via discussion, then the party raising the concern may request from the Ontario Ministry of the Environment (MOE) that the project undergo part two of the EA Act (i.e. upgrade to an individual environmental assessment, requiring significant additional consultation and analyses, as required).

Extensive consultation was undertaken throughout the study with various stakeholder groups, agencies and the members of the public. Three public information centres were conducted where project information was presented to the public and their input was obtained. Additionally, three meetings with each identified stakeholder group (BIA representatives, City and Regional cycling groups, etc.) and technical agencies (MTO, NPCA, EMS, St. Catharines Fire, etc.) were held. The groups/agencies were used as a *sounding board* prior to going to the public due to their extensive knowledge of the area. A number of one-on-one meetings with potentially affected individuals, property owners, business owners, emergency services personals, heritage groups and other concerned area residents were also conducted. The purpose of these meetings were two fold, one to obtain inputs from stakeholder groups, technical agencies and the members of the public and the other to present the study findings as the study progressed. Various comments received during or after these meeting were utilized in developing a preferred solution. The consultation not only assisted the project team in understanding their viewpoint but also helped in developing a vision for the area and ultimately achieving that vision by building consensus.

Technical Studies

Considering the number of constraints within the study area and in order to evaluate the various alternative solutions, a number of technical studies were undertaken by the project team members. These studies assisted in analysing and assessing the impacts to the environment as defined in the EA Act (i.e. natural,

socio-economic, technical and cost). This assessment was carried forward into the alternative evaluation and utilized in the selection of the preferred solution. The various technical studies undertaken included the assessment of the following:

- Bridge
- Transportation
- Geotechnical
- Cultural Heritage
- Archaeological
- Noise
- Natural Environment

Recommended Solution

Based on the technical studies and the extensive consultation that was undertaken, a comprehensive evaluation of alternative solutions was completed.

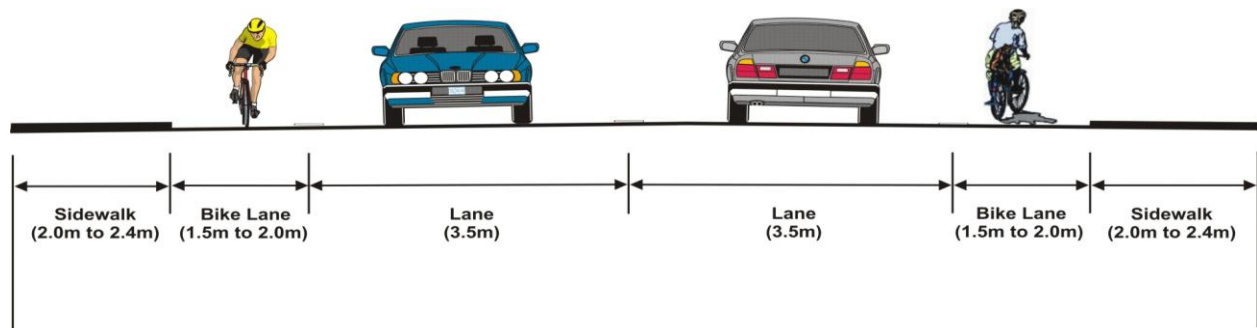
Rehabilitation vs Replacement

It was determined that the bridge needed to be replaced rather than rehabilitated. The key reasons for this were:

1. Extensive cost of rehabilitation (equivalent to the cost of replacement)
2. Limited useful life if rehabilitated
3. Replacement provided opportunities to implement complete streets concept on bridge structure and its approaches.

Design Element – Cross Section

The proposed cross section included the complete streets concept. A preliminary cross section was developed that not only accommodated automobiles but also gave equal importance to other modes, including active transportation.



As the approach roads are only two lanes wide, the bridge structure included two travel lanes with bike lanes and sidewalk on either side, however in the future, should the approach roads require widening to four lanes, the bridge could be

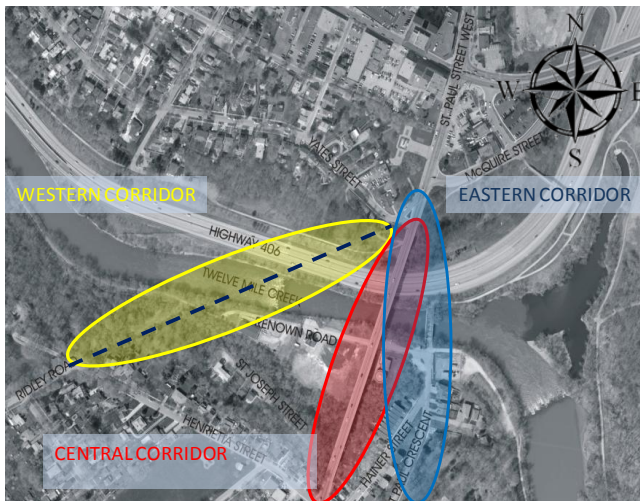
reconfigured to four travel lanes, with the segregation of pedestrians and cyclists on a separate parallel structure.

Design Element – Profile

Two possible profiles were evaluated, which included the existing high level profile and a new lower level profile. Changing the profile would have resulted in introducing substantial grades at either end which could provide several challenges with respect to user safety. As such, considering the climate, the multi-modal aspect and accessibility accommodation, it was recommended that the existing high level profile be maintained.

Design Element – Corridor

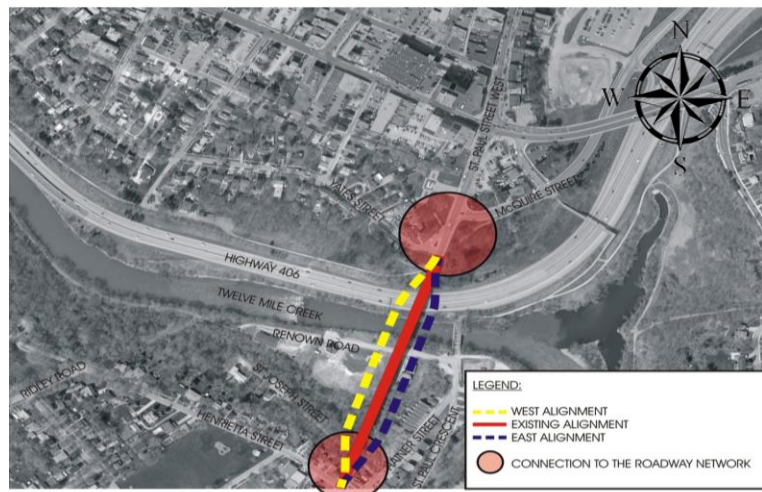
Three key corridors were considered, including a western and eastern corridor along with the original central corridor.



The western and eastern corridors presented various challenges pertaining to not only travel patterns, but also to the natural environment (within the Twelve Mile Creek Valley land) and socio-economic environment (severe property impacts). The central corridor best serviced the travel patterns for all modes and had the least amount of impacts to the natural and socio-economic environment. Based on the comparative evaluation of these corridors it was recommended to carry forward the central corridor.

Design Element – Alignment

Within the central corridor two alignments other than the existing were considered, one to the west of the existing alignment and another to the east.



A summary of the evaluation of each of the alternative alignments is presented below:

West Alignment

The west alignment presents challenges in terms of the geometrics of the approach roads at each end. The existing horizontal curves on the south end are substandard and with this alignment, the horizontal curves would be even less desirable (even with a reduced posted speed and introduction of super elevation). Additionally, significant property (both residential and commercial) would need to be acquired.



East Alignment

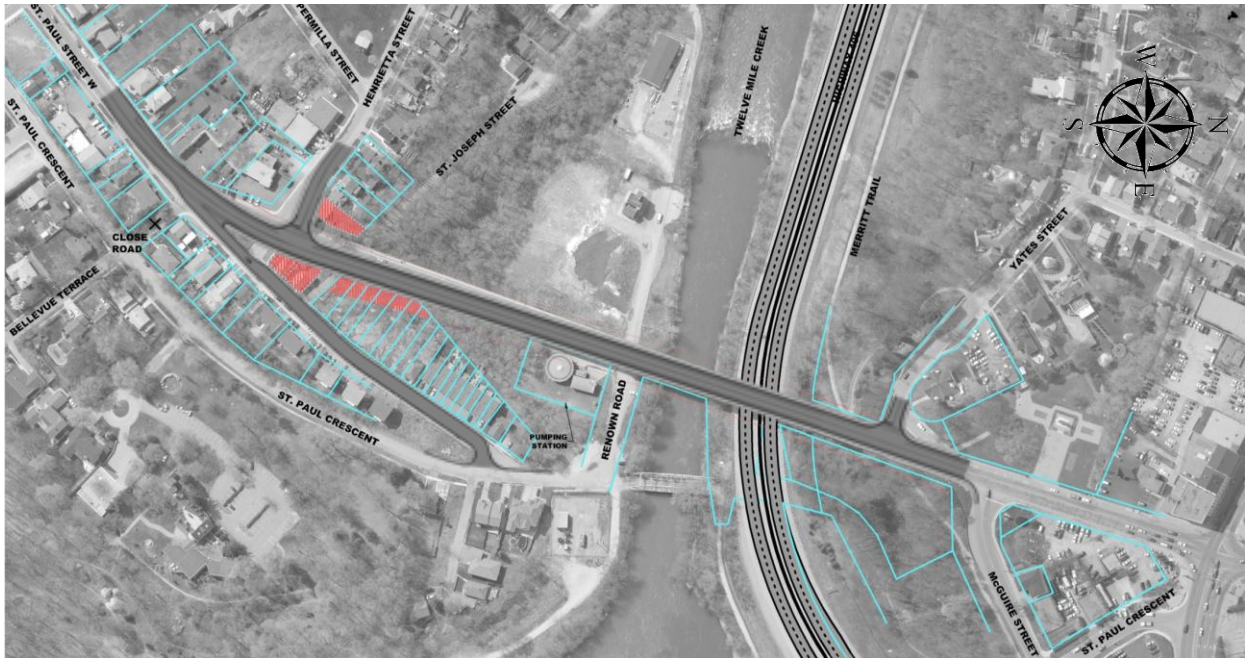
The east alignment allows for introduction of a proper horizontal curve on the south approach, thus correcting the existing safety concerns related to restricted sightlines and substandard approach curve. However, it would require considerable property acquisition to implement. The connection at the north approach would require the introduction of back to back horizontal curves, a less than desirable geometric solution. Additionally, the north approach alignment would impact existing public lands which contain graves.



Central Alignment

The central alignment (replacing the bridge at its current location) provides the least property impacts, while providing the opportunity to correct the substandard horizontal curve on the south approach while maintaining the existing desirable geometry on the north approach. This is achieved by shifting the south approach to the east and maintaining the alignment of the north approach. The main challenge

to this alignment is the existing bridge occupies this alignment, and traditionally would need to be removed prior to the construction of the new bridge.



A comparative evaluation of these three alignments was undertaken and the central alignment was selected, due to its minimal property impacts as well as the opportunity it provides to improve the roadway geometrics at the south approach.

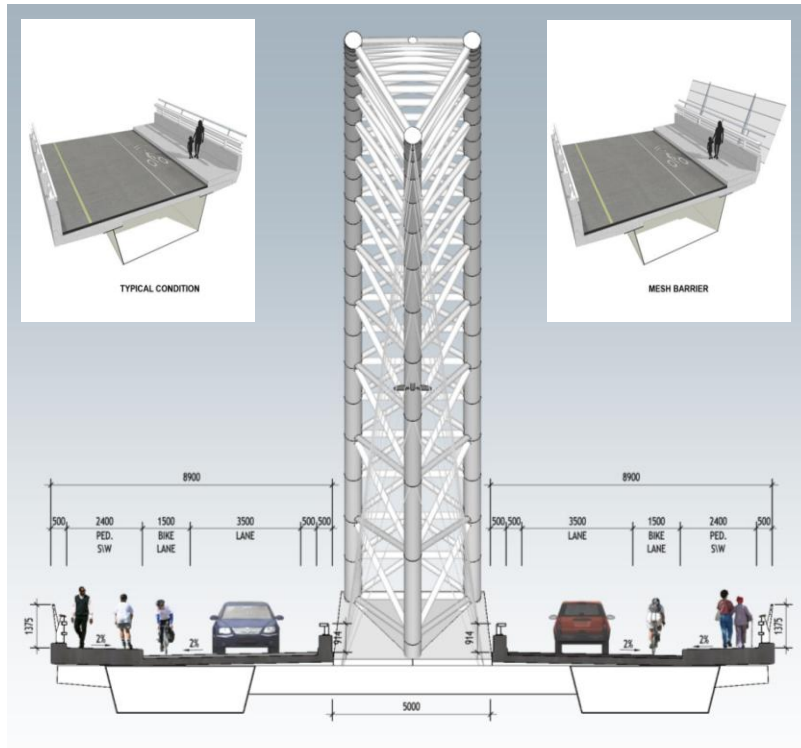
Design Element – Bridge Type

As identified earlier, the existing bridge is a key link in the City’s transportation network and should remain open even during construction of the new structure. Constructing a new bridge on the existing alignment without removing the existing bridge certainly posed a challenge and required a non-traditional innovative solution. In selecting an appropriate bridge type, consideration was given to:

- Bridge engineering
- Bridge architecture
- Stakeholder and Public Input
- Technical Agency Reviews
- Environmental considerations
- History and Heritage
- Budget
- Constructability

The unique design for the new Burgoyne Bridge was envisioned to celebrate the past and to serve the future, while ensuring the least disturbance to residents and the social, natural and cultural environments. The project team





delved deeply into the heritage features of the project location for the inspiration to create an environmentally responsible structure with landmark and iconic characteristics. Only a few bridges around the world comprise the forebears of the new Burgoyne Bridge, which is a multi-span structural steel box girder bridge with a long span steel arch that includes elements of the old cable-stayed swing bridge which once crossed the river at this site.

Design Element – Constructability

Initially, a concept was developed to construct the new bridge west of the existing bridge (along with temporary approaches) while maintaining traffic on the existing bridge. Once the new bridge was constructed, the traffic would be diverted onto the new bridge to allow for the removal of the existing bridge and the construction of new support columns. When completed, the new bridge could be slid onto the new support columns at the existing alignment. The project team members have in the past successfully implemented this construction staging. Geotechnical assessment results obtained later in the study identified that the soil conditions, including the presence of artesian water, would make this construction methodology non feasible.

Subsequently, a new non-traditional construction staging concept was developed that would allow for maintaining traffic during the construction of the new bridge structure. This included constructing the bridge in stages while keeping the bridge

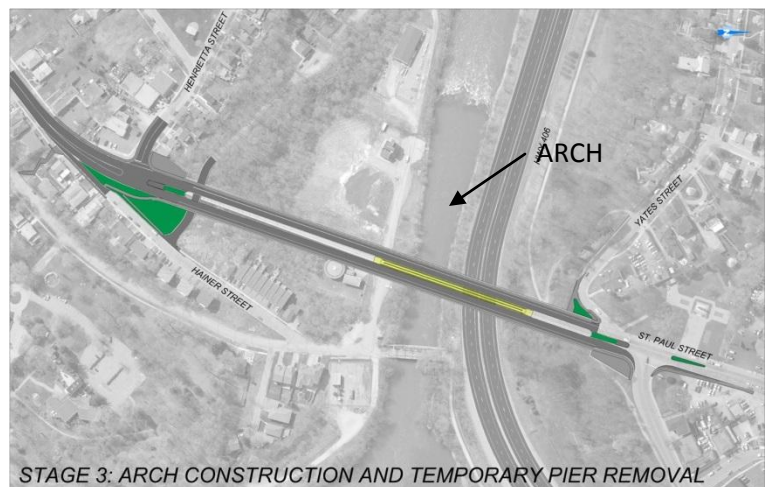
open to all modes throughout the construction. This would be achieved through the following construction staging:

Stage 1 – Construct temporary piers and east portion of bridge, including approaches.



Stage 2 – Divert traffic to the east portion of the new bridge and remove existing bridge. Construct west portion of the bridge.

Stage 3 – Construct Arch and remove temporary piers. Define pedestrian and cycling areas. Open west portion of new bridge to southbound traffic, pedestrians and cyclists.



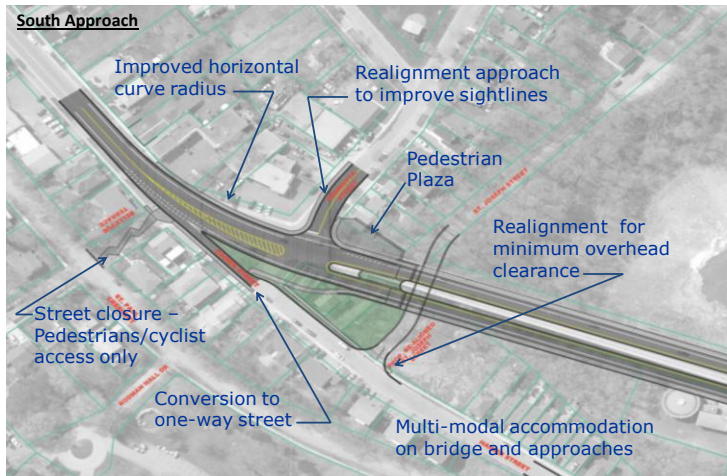
Roadway Modifications

The existing approach roads had a number of issues that required improvements. These included:

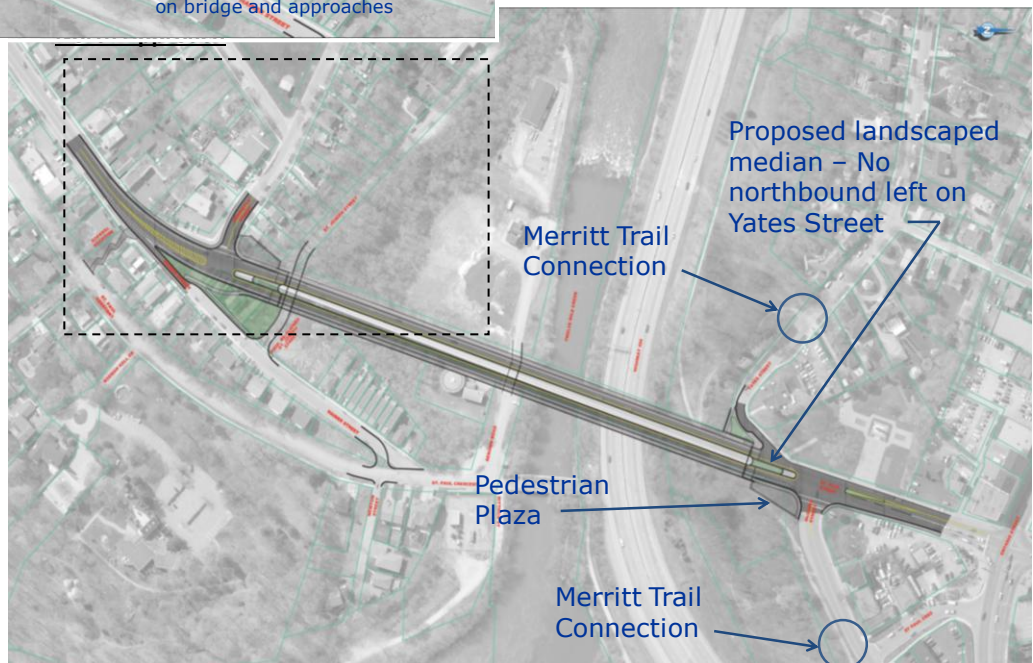
- Substandard horizontal curves at south approach road
- Sightline issues at intersecting street
- Vertical grade issues

Any improvements needed to be undertaken within the constraints of the built-up area and considering the fact that the bridge must remain open at all times.

The approaches were designed considering the complete streets concept. This included providing pedestrian and cyclist enhancements at both the north and south approach roads (including viewing platforms). Connection at the north end to Merritt Trail was also provided.



At the south approach road, various geometric modifications were made to improve the issues identified previously. This included modifying the horizontal curve radius, improving the sightlines, accommodation of multi-modal facilities within the constraints of the built up environment and area topography, thereby improving the safety of all roadway users.



Traffic Management During Construction

The goal of any traffic management is to facilitate efficient implementation of the infrastructure being constructed while minimizing disruptions and providing travel time reliability for commuters, commercial vehicles, residents, businesses, and emergency services during construction. This accommodation must consider and make provision for all modes of travel affected by the construction.

For the Burgoyne Bridge the multi-stage implementation plan requires the partial or full closure of both St. Paul Street West, intersecting adjacent municipal roadways at each bridge approach and the provincial highway, which runs beneath the bridge.

These roadways service a variety of modes (pedestrian, cyclist, transit, school bus, etc.) and serve as key response routes for the various emergency services. Considering these requirements the traffic management plan was developed in conjunction with these agencies and area stakeholders (residents and businesses). The plan consisted of two primary components:

- Development of the details pertaining to closure types, durations and detours associated with various construction activities during each stage
- Development of a communication strategy for disseminating the information to all users of the impacted corridor(s)

The typical suite of traffic management strategies permitted by various road authorities (Municipal, Regional and Provincial) were reviewed and it was determined that the bridge implementation could not be achieved if restricted to these traditional traffic management strategies. A tailor made solution was developed which was sensitive to the area specific needs and constraints. The solution involved a series of more intrusive traffic management strategies along the provincial highway to allow for the implementation of various construction stages.

Plan Overview

The traffic management plan included:

- Temporary encroachments onto Highway 406 resulting in the form of lane closures, interchange closures and full mainline highway closures
- Temporary closure of St. Paul Street Bridge in the form of single lane closures and night time bridge closures
- Temporary closure/turn restrictions at adjacent municipal roadways at bridge approaches
- Temporary detour of the Merritt Trail under the Burgoyne Bridge

Highway Lane Closures

Given the constraints of the study area and the uniqueness of the high-level bridge non traditional provincial traffic staging/closure scenarios were developed. These scenarios had to provide access from the highway both to the existing structure and to the areas required to construct the footings of the new structures. The time required to construct these footings dictated the duration of the highway lane closure. The average duration of these lane closures was about 30 working days during which time the highway mainline capacity was reduced. Normally, the MTO requires a widening of the roadway platform to allow the shifting of travel lanes around the construction zone for long term closures, thereby maintaining the mainline capacity. However, the site constraints did not permit this and comprehensive traffic analyses were completed to determine the impact of the capacity reduction on highway performance. The analyses indicated that a reduction in travel demand was required in order for the highway to function at an acceptable level of service.

The other significant construction activities which would impact the highway included the demolition of the existing bridge spans over the highway and the erection of the arch on the new bridge. During these activities all highway traffic must be stopped in order to ensure public safety. Traditionally, when activities

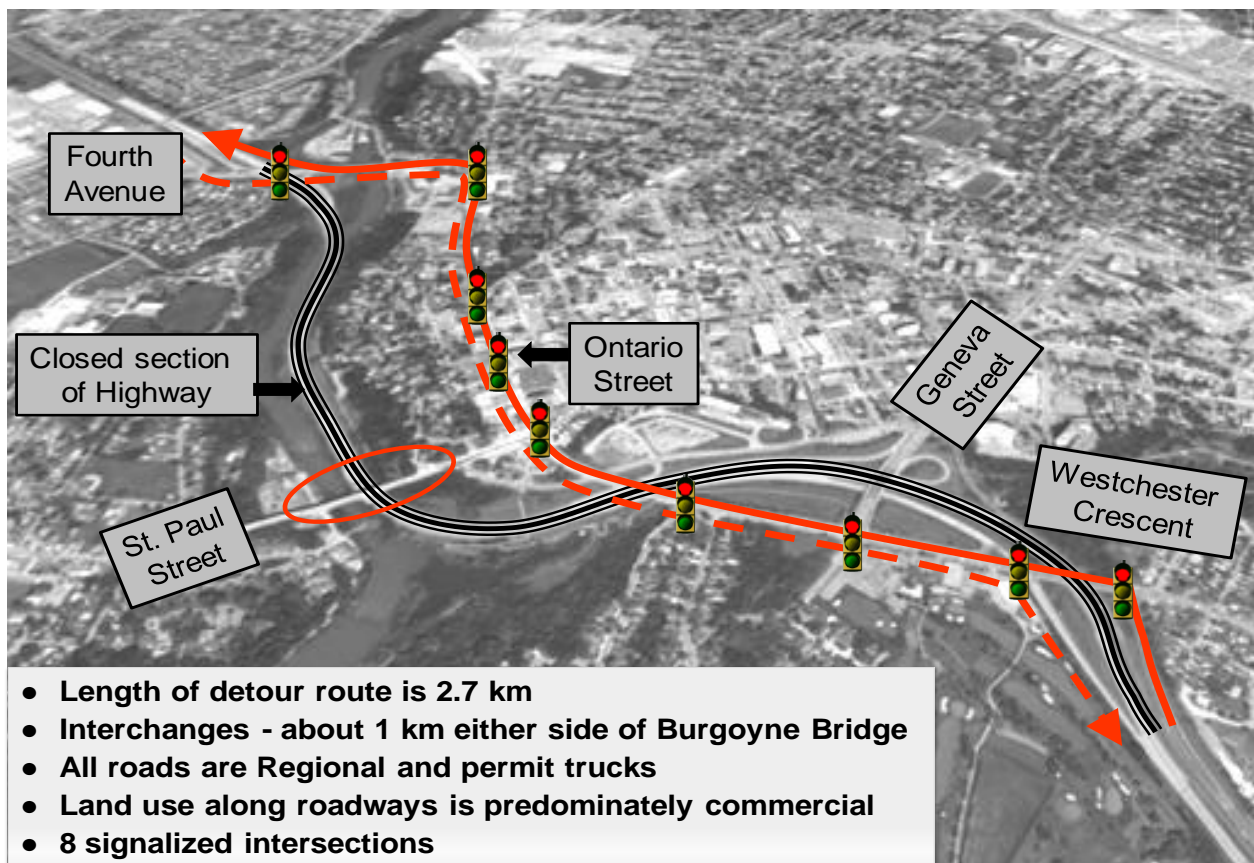
occur over highway lanes the Ministry allows for the use of pace vehicles to create gaps in traffic. These gaps are of short duration and there is risk of end of queue collisions during pace vehicle operations. The nature of construction activities is such that they will require about two to three days to complete and would not be feasible for them to be undertaken in a "stop and go" fashion that the pace vehicle scenario would create. The investigation of full highway closure and traffic diversion to a



parallel arterial roadway during the night time hours was undertaken. A traffic analysis was completed and indicated that the night time highway traffic volumes could be accommodated on the arterial detour route. Utilizing this approach it would take about ten days of consecutive night time closures to complete each of these tasks. This was considered to be very disruptive to the highway users and not cost efficient both from the traffic control and construction perspective. In consultation with the MTO a final scenario was developed which minimized disruption to highway traffic and shortened the construction duration of these activities. The approved traffic staging scenario included the full closure of the

highway between the two adjacent interchanges to the Burgoyne Bridge for a weekend. The closure would commence Friday evening and end early Monday morning.

This scenario would see all highway traffic diverted to a parallel arterial route. A detailed traffic analysis was undertaken to determine the impacts to the city street system and identify any mitigation measures, turn restrictions or traffic control modifications that may be required. The analyses determined that during the hours of 9:00 am to 9:00 pm the detour route would have to be supplemented with point duty police officers at key locations in order to facilitate the efficient movement of detoured traffic and avoid traffic spillback on to the highway. Also, the officers would provide priority to emergency services and city transit. There are eight signalized intersections and numerous unsignalized intersections along the detour route. The proposed daytime hour plan would also require the development of special traffic signal plans and the temporary closure of the minor unsignalized cross roads. During evening hours the detour traffic volumes are substantially lower and can be managed without police officers or side street restrictions. This plan was vetted with the emergency services, city traffic and operations staff, and City council. After some minor adjustments the plan was adopted. It was recognized that if highway traffic could be diverted to other routes prior to reaching the construction zone an improvement in overall network operation would be achieved.



Regional and Municipal Road Closures

The nature and type of construction activities required along the non provincial roadway are more conventional in nature and did not require non-traditional traffic management techniques. However, given the limited Twelve Mile Creek crossing opportunities and the distance between them it is imperative that accurate and timely information is provided to the Bridge users to allow them to make appropriate travel choices to minimize the disruption to their trip. The construction activities throughout the project will have impact to all the various modes currently utilizing the Burgoyne Bridge.

Communication Plan

A comprehensive communication plan was developed to target roadway/highway users both at the origin of their trips and along the approaching roadways at locations where alternative route choices were available to them. This would allow individuals to adjust their travel patterns (timing and route choice) in order to minimize disruption to their trip. This will require the use of a variety of communication methods and media. The following would be implemented for this project:

- Press releases at regular intervals from the Niagara Region's Communication Group. These would be distributed to local radio, newspapers and local cable.
- A project website will established supplying data on construction progress and upcoming traffic closures/detours.
- Static roadway information signs would be erected a minimum of two weeks prior to all traffic closures/detours
- Portable Variable Message Signs (PVMS) along Highway 406 and on St. Paul Street West will be installed. The signs on the provincial highway will be linked to the Ministry's traffic controlled centre.
- An EMS stakeholder group will be created which will include representatives from Ontario Provincial Police, Regional Niagara Police, City Fire and Regional Ambulance services, City transit and school transit. This group will meet at key milestones preceding significant traffic closures/detours in order to ensure they are prepared and contingency plans are in place.

Under the full highway closure scenario where traffic diversion from Highway 406 is desirable and required, an additional level of communication extending beyond that list above was developed. This communication strategy includes signage and driver information being provided at locations which increases the likelihood of an alternative route choice being made. These locations extend to areas which are from ten to twenty kilometres in advance of the construction area on the provincial system and two to five kilometres on the city and Regional roadway system. On

the provincial system the use of MTO's freeway traffic system, highway advisory radio and non-local radio stations provide traffic information.

Incident Management

The success of the traffic management plan and the construction staging is contingent on the safe and efficient movement of vehicles and other modes through the work zones. In order to ensure that this occurs, an incident management plan was developed in order to quickly respond to and clear collisions, disabled vehicles or other incidents. In this plan the contractor will have to provide a 24/7 incidence response team to secure the incident site and expedite the reopening of the impacted area. This response team will be responsible for both the Regional/City streets and the portion of the provincial highway under their control (e.g. within the construction zones).

Summary

The project demonstrates the Niagara Region's commitment to the "Complete Streets" concept in both the final infrastructure solution and during the implementation (construction) phase. Although, it is difficult and costly to do this, especially on such a large structure, the cooperation and cost sharing by Municipal, Regional, Provincial and Federal levels governments made this project viable.

The project team's approach and expertise was paramount in the development of a preferred solution which achieved the objectives set out for this project and could be implemented within this very complex environment.

The willingness of the various roadway authorities to not only consider but support traffic management and staging solutions which are outside the norm of their standard practices, along with their recognition of the unique nature of the study area, allowed the project team to develop a viable staging plan. This staging plan was not only cost effective but sensitive to the need to maintain efficient movement of all travel modes through the various work zones.

