CPR Yards Functional Design Crossing Study

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ABSTRACT

CPR Yards Functional Design Crossing Study

Stantec was retained by the City of Winnipeg to complete a Functional Design Crossing Study over the CPR Yards located in North West Winnipeg. The Yards were constructed in the late 1800s at the outer limits of the City. Over one hundred years later, the Yards seem to divide the North End community of Winnipeg. There are three existing crossings over the 5km long and 1km wide Yards, located along McPhillips, Arlington and Salter Streets.

Purpose of the Study

The existing 37 span Arlington Street Bridge, constructed in 1912, is at the end of its functional life and is proposed to be decommissioned in approximately 5 years. The intent of the study was to develop a cost effective functional transportation plan for the removal of the existing Arlington Street Bridge and a preliminary decommissioning plan for the existing Bridge. Considering vehicular and active modes of transportation the transportation plan determined if and where a new crossing would be optimally located. The study addressed railway yard operations and coordination for the proposed decommissioning and new crossing construction. The transportation plan considered current and estimated traffic volumes in 2031.

CPR was involved in the development of the decommissioning plan, which consisted of the removal of the spans in 6 - 10 hour track blocks via SPMT methods, as well as the new crossing concepts.

The paper will discuss the plan in detail and how we addressed transportation and CPR requirements.

INTRODUCTION

The City, in its 2013 Capital Budget provided funding for a Functional Route Study for the Crossing of the CPR Yards between McPhillips Street and Salter Street, after determining the existing Arlington Bridge requires decommissioning in approximately 2020. Rehabilitation of the century old structure is not seen as a viable alternative as the existing structure is weight and clearance restricted and the steep approach span grades are seen as a deterrent to some users. Due to these constraints, transit and truck traffic cannot use the existing bridge.

The study area for this project has been identified as the area bounded by the Slaw Rebchuk Bridge to the east, McPhillips Street Underpass to the west, William Avenue to the south, and Selkirk Avenue to the north; the intersection of Inkster Boulevard and McPhillips Street and, by default, the McPhillips Street corridor, are also included. The City of Winnipeg initially identified four basic alternatives for study consideration:

- A new vehicle crossing on the Arlington street alignment
- A cycling /pedestrian crossing on the Arlington Street alignment
- Expand the McPhillips Underpass
- Investigate the Sherbrook to McGregor crossing

The Project Team through this assignment undertook a unique collaborative and integrated brainstorming session to identify many ideas, options and constraints and filter these to the options that best achieve 'success' and meet the project objectives.

The project and its scope of work included identifying and documenting risks associated with the developed options as well as costs and implications of alternatives. Determining the schedule and financial requirements to mitigate impacts of the alternatives will allow the City to prepare for a well thought out process for the eventual decommissioning of the Arlington Bridge. Mitigating those impacts was a primary objective of this study.

PROJECT SCOPE

The City of Winnipeg stated that rehabilitating the existing structure is not considered feasible and therefore not part of this project. The Arlington Street Bridge is nearing the end of its service life and a plan for how transportation will cross the CPR Yards, post removal of the Arlington Bridge, needs to be developed. This assignment focuses on a plan for the next phase of transportation over the CPR Yards targeting the year 2020 for Arlington Bridge Decommissioning. The traffic management planning was to investigate current traffic volumes and patterns, post Arlington Bridge Decommissioning and projected volumes in the year 2031.

This study is to develop a new crossing plan and location, or expansion of an existing crossing to satisfy traffic needs now and in the future. The solution could be a single crossing or combination of new and rehabilitated existing crossings or multiple new crossings. The recommended solution must satisfy the project goals as best as possible and consider the community and local needs. Social and economic conditions and potential growth will be included during the comparison of crossing options within this project. Bridges function as a transportation link between neighbourhoods for pedestrians, cyclists, transit, freight movement, vehicles and the location of a crossing can greatly impact social connections, the ability for businesses to grow and the ability for vulnerable users to make direct connections between their origins and destinations.

At the McPhillips Street Underpass, an existing pumping station is in service to drain the underpass during rainfall events. In the event the recommended solution consists of replacement of the underpass and a new pumping station, the new pumping station will be identified with a proposed location which may not be within City of Winnipeg right of way.

The Arlington Bridge, after providing a critical community connection between the residential areas north of the CPR Yards and the employment areas to the south for over 100 years, may soon reach the end of its structural and functional life. With the City of Winnipeg continuing to grow, providing additional traffic capacity across the yards is becoming a priority.

HISTORY

Prior to the construction of the Arlington Street Bridge, there were limited options for crossing the CPR Yard and Main line tracks: an underpass on Main Street and a timber bridge at Salter Street. In the early 1900s, there was only an at grade crossing on McPhillips Street. As the population of Winnipeg grew, new solutions were needed for movement across the CPR Yards. The idea of an overpass at Brown Street (in the North End) and Brant Street (in the south) was proposed in 1906. Brown and Brant Street are now known as Arlington Street.

Similar to todays' needs, in 1906, the need for an additional crossing was necessary however the Brown and Brant Street Bridge was controversial as some felt that replacing the existing Salter Street Bridge was the best option. Others felt that the Brown Street/Brant Street connection was too far away from the desired movement to downtown.

The Arlington Bridge was originally proposed to include street car traffic and therefore was supported as it would provide a second streetcar link to the North End, Main Street being the other streetcar line. The Salter Street Bridge was deemed not structurally adequate to be retrofitted for streetcar service. Streetcar service on Arlington was expected to reduce traffic on Main Street which was viewed as a nightmare at that time.

In 1906 the Brown and Brant Street bridge project (Arlington Street Bridge) was debated by the City committee, however made it through council vote and became part of the official City of Winnipeg / CPR improvements negotiations for the next year, 1907. In 1907, through federal rule of the Railway Commission of Ottawa, it was determined that the project would move forward, but CPR had no financial responsibility for the proposed bridge connecting then Brown and Brant Street.

A money by-law was drawn up to be voted on in June 1909 which included $240,000 for a new Brown and Brant Street Bridge (Arlington Street Bridge).

In May 1910, the City called for tenders for the new bridge. It was divided into two parts:

- Construction of concrete piers to be completed on or before the fifteenth day of November, 1910
- Erection of steel superstructure and floors, with two lines of street railway tracks, to be completed on or before the first day of June. 1911.

On July 5, 1910 the City announced the successful bidders. William Newman and Company was awarded a $54,720 construction assignment for the construction of the piers. The Cleveland Bridge and Engineering Company of Darlington, England was awarded $205,160 for the superstructure.

In August 1910 council changed the name of Brown and Brant Streets to Arlington Street. It wasn't a 'new' name as that stretch of road was already called Arlington from its starting point at the Assiniboine River in Wolseley to Notre Dame Avenue.

It appears that the project stayed on budget but not on time. In November 1911 the project was still unfinished but it was expected that the final piece of steel would be swung into place on time and that the bridge would be open for Christmas. The new bridge wasn't opened until February 5, 1912.

COMMUNITY

The Community around the CPR Yards includes some of the oldest areas of Winnipeg, with development beginning shortly after the city's incorporation in 1874. Initial development west of the downtown was initiated as a natural extension of the built-up area that concentrated along Main Street and Notre Dame Avenue. Likely the most important factor in how the area has developed was the arrival of the Canadian Pacific Railway in the early-1880s. The decision to extend the railway line across the Red River along with the subsequent construction of the CPR Winnipeg Yards, left the area north of the CPR developments isolated from the downtown and other parts of Winnipeg. This isolation resulted in very different histories for the neighbourhoods north and south of the CPR Yards—culturally, economically, and physically.

The area immediately south of the CPR Yards and west of Downtown Winnipeg's then emerging wholesaling district includes the Logan-CPR, Centennial, and West Alexander neighbourhoods. Early development was primarily low-density residential developed along avenues oriented east-west, including Logan, William, Bannaytne, and McDermot. With the growing wholesaling district nearby, this area gradually evolved into a handy residential location for district workers.

By the first decade of the 20th century, further railway development in the area—this time, the Midland Railway line and freight shed built to connect the downtown wholesaling area to another warehouse area near McPhillips Street, between Pacific and Ross avenues—resulted in a much more diverse community, but also led to a disruption of the area's physical continuity. West of Sherbrook Street, the Winnipeg General Hospital was constructed in the mid-1880s.The gradual expansion and consolidation of medical facilities at this location—including the University of Manitoba's Faculty of Medicine—continues to shape development in its vicinity.

Population decline and physical deterioration of the area's housing stock was evident as early as 1946. Since then, a series of government interventions have targeted these neighbourhoods. Each of these interventions emphasized community participatory methods and focused on capital improvements, such as: park upgrades, subsidized housing infill, street and sidewalk renewals, home improvements, railway and new health, daycare, and education facilities.

The area immediately north of the CPR Yards includes the Dufferin Industrial, Dufferin, William Whyte, and Lord Selkirk Park neighbourhoods. Initially connected to the rest of Winnipeg via level crossings, grade-separated crossings were soon necessary to ensure unimpeded railway operations and safe pedestrian and vehicle travel. By 1912, four crossings were in place: the Main Street underpass (c.1904), the Salter Street Bridge (c.1898), the Arlington Street Bridge (c.1912), and the McPhillips Road

underpass (c.1912). Even with these crossings, the CPR Yards remained a substantial barrier cutting-off the North End from the downtown and neighbourhoods south of the Yards.

A collaborative planning and public engagement process was implemented for this study to ensure the community was involved. The process created opportunities for stakeholders and the broader public to participate in and assist with developing a recommended conceptual (functional) transportation plan for a CPR railway yards crossing. The goal for public engagement in the study was to recommend a plan that is technically sound, cost-effective and environmentally responsible, and which reflects the needs of the community and city in general and is generally understood and accepted by most of those affected. These were the five key tenets by which this was to be accomplished:

- Identifying public concerns/values/aspirations/priorities;
- Maintaining an open, honest and flexible forum for public input;
- Conveying information to and collecting information from the public using simple, fun and effective engagement tools;
- Designing and implementing a meaningful collaborative process; and
- Integrating public input in final recommendations

The public engagement process was customized with multiple participation goals including consultation, involvement and collaboration, with each supported by public communication materials (IAP2 Spectrum of Public Participation). This allowed for agile public engagement that could match the best input methodology to the needs and interests of the stakeholders, community members and broader public. At the same time, the public engagement was designed to align with the technical study, so the collaborative planning process and public engagement would inform and advance the technical study and similarly, technical information and analysis would inform the planning.

The study continued with options developed from the Public Advisory Committee vetted through the technical team and vise versa. Together, with guidance from the project goals, the options developed further within this assignment had input and acceptance from the public and technical team.

TRAFFIC ANALYSIS

Three significant employment zones influence traffic through the study area south of the CPR Yards; St. James Industrial, Health Science Centre and downtown. The traffic patterns at the intersections south of the yards show marked preferences for these destinations. Southbound traffic on the Slaw Rebchuk Bridge shows a strong preference in downtown and Health Science Centre destinations. Southbound Arlington, because of turning restrictions, shows a strong preference to St. James Industrial and possibly downtown, but using cross roads south of Notre Dame Avenue. McPhillips Street shows an almost even split between St. James industrial and downtown destinations with a significant amount to the Health Science Centre.

A significant portion of traffic passes through the study area, going to other destination areas. Turning movements to and from the cross streets to the routes crossing the CPR Yards (Selkirk, Dufferin, Logan, William and Notre Dame Avenues) in the study area create high turning movements that appear to be under served. This results in potential congestion locations. These movements include the Logan Avenue eastbound left turn to McPhillips Street in the PM peak (242 vehicles), and the Logan Avenue eastbound left turn onto Slaw Rebchuk Bridge (330 vehicles).

Traffic Growth

The 10 year traffic counts provided by the City of Winnipeg on the four (4) links that cross the CPR Yards form the basis for one method of determining a reasonable growth rate for future projections of traffic demand. Traffic growth can also be predicted based on anticipated development impacting traffic flow within and through the study area. Both of these methods provide a means to verify and assist in calibrating traffic growth and volume projections developed from the City's transportation model.

The various methods for calculating traffic growth in the study area are summarized as follows:

- AM Peak Hour traffic growth rate based on historic traffic count data = 0.99% per year
- AM Peak Hour traffic growth rate based on anticipated area development = 1.2% per year
- AM Peak Hour traffic growth rate based on City of Winnipeg transportation model = 0.84% per year

Based on the analysis results, a 1.0% per year traffic growth rate was assumed to be applicable to the study area during the AM and PM Peak Hours over the design years under consideration. This rate is in keeping with similar recent planning studies developed for other areas in the City of Winnipeg.

Route Capacity Summary

The new residential growth areas influencing traffic across the CPR Yards are at the north limits of the City of Winnipeg and within West St. Paul, bounded by Pipeline Road and Main Street. Routing options for these new areas include Main Street, McPhillips Street and a probable connection across the proposed Chief Peguis Trail at Ferrier Street/McGregor Street. Distribution of this traffic to routes servicing the CPR Yard crossings requires further analysis based on the capacity accommodation of the options developed.

Traffic distribution over the yards indicated that McPhillips and Arlington were not attracting new traffic due to possible capacity issues and ease of access to desired destinations. McPhillips Street terminates at Notre Dame Avenue and Arlington Street has turning restrictions during peak hours, while Salter Street/Slaw Rebchuk bridge accommodates turning movements on dedicated lanes south of Selkirk Avenue. Analysis of existing traffic shows a significant movement from eastbound Dufferin Avenue to southbound Slaw Rebchuk, indicating a potential desire for more direct routing to the City Centre and points south, compared to McPhillips or Arlington as route options.

Except for Main Street, the predicted traffic flows for each of the routes crossing the CPR Yards are reaching or expected to exceed their nominal capacity by the 2031 design year. Intersection capacity analysis is needed to determine the operating capacity of governing intersections in the study area, but the growth analysis indicates that additional route capacity improvements should be considered when developing options.

Based on the results of the nominal route capacity analysis, the following conclusions can be made:

- The existing CPR Yard crossings are inadequate to accommodate the projected traffic demand for the 2031 design year;

- As a minimum, two additional traffic lanes must be provided across the CPR Yards to partially meet the projected traffic demand anticipated due to background traffic growth and continued development in the north portion of the City of Winnipeg and the West St. Paul;
- Ideally four additional traffic lanes should be provided to fully accommodate the anticipated traffic volume increases on routes crossing the CPR Yards.

Increased transit mode share across the northern neighbourhoods would reduce or defer the need to improve roadway capacity through provision of additional traffic lanes across the CPR Yards. Improvement to existing transit service and/or transit service system enhancements should be investigated as a means of reducing the need to improve capacity on study area roadways.

Final Crossing Options

Independent discussion with the Project Steering Committee agreed with the SWOT analysis results. The following options were presented to the PAC as recommended options for further analysis and review:

Arlington Bridge and McPhillips Widening

Build a new Arlington Bridge in conjunction with removal of the old Arlington Bridge in 2020, and build a new crossing on the McPhillips Street alignment in the future. The Arlington Bridge would include improved pedestrian and cycling infrastructure and incorporate other community amenities to be determined in functional design development. The design of the approach roads will be included to maximize walkability, cycling experience, economic development opportunities, and other social aspects that were identified through community discussions.

Arlington Bridge and Sherbrook – McGregor Connection

Build a new Arlington Bridge in conjunction with removal of the old Arlington Bridge in 2020, and build a new crossing on the Sherbrook - McGregor alignment in the future. The Arlington Bridge would include improved pedestrian and cycling infrastructure and incorporate other community amenities to be determined in functional design development. The design of the approach roads will be included to maximize walkability, cycling experience, economic development opportunities and other social aspects that were identified through community discussion.

The Sherbrook – McGregor Connection will be built when capacity requirements determine it is required. The new crossing will consist of four lanes for automobile traffic. A tunnel option was determined to be the most viable and separate pedestrian and cycling facility will be considered.

Conclusions and Recommendations

The development of a reliable traffic model required the application of considerable assumptions related to population growth, route assignment and mode choice. The City of Winnipeg's transportation model provided sufficient direction for the projection of traffic volumes that represent the most likely distribution of peak hour traffic flows.

The provision of additional capacity along McPhillips Street as proposed in Network Option 1 resulted in that capacity being filled by new traffic to the point where projected traffic flow along McPhillips Street

would experience periods of extreme congestion. The retention of transit priority in the form of diamond lanes would result in additional congestion.

The inclusion of the Sherbrook-McGregor link would reduce demand on McPhillips Street to the point where additional capacity is not required within the study period, but at a cost. Congestion along Sherbrook Street near the Health Science Centre will increase as traffic growth makes use of the new link. Turning restrictions and other considerations such as improved transit service have the potential to reduce some of the anticipated congestion on Sherbrook Street.

The consideration for improved cycling accommodation along the Arlington Street Corridor, as a way of meeting OurWinnipeg strategies, requires design compromises influencing vehicle accommodation. Many configurations were developed and the optimal configuration, which strikes a balance between transportation modes, includes a three-lane cross section on the new Arlington Bridge with left turn lanes provided at critical intersections. With this scenario, property requirements are reduced south of Alexander Avenue.

The recommendations resulting from the traffic analysis are:

- Build the Arlington Street Bridge with a three lane cross section with one way cycle lanes on each side of the road;
- Reconstruct Arlington Street as a three lane facility, providing protected left turn lanes at key intersections and protected one way cycle lanes on each side. Provide two lanes northbound through the Logan Avenue intersection and over the Arlington Bridge to Selkirk Avenue. Provide two lanes southbound through the Logan Avenue intersection to William Avenue;
- Proceed with planning the Sherbrook-McGregor link to provide additional capacity across the CPR Yards. The planning should include transit system improvements that link at least five significant market areas: U of M downtown campus, Polo Park, downtown, north end and Health Science Centre;
- Proceed with developing Travel Demand Management strategies to reduce congestion along major corridors and at major attractions such as the downtown and the Health Science Centre;
- Investigate the transit system improvement opportunities that each of the crossing options provides.

WINNIPEG CPR YARD LAYOUT & OPERATIONS

In its current state the Winnipeg Yard connects lines from all directions to form a hub. The main line runs East-West and carries the majority of the volume through the region. Trains are not built at this yard, rather cars are added to or taken away from the trains passing through the yard.

The Winnipeg CPR Yard is bounded by McPhillips Street Underpass on its west end and the Main Street Underpass on its east end. With 7800 feet of track length to spot a train on the main line this presents challenges for CPR since the current average train lengths have grown beyond this length in recent years. To address this issue CPR has created a northern yard bypass line that they can use to route longer trains through the yard without clogging the main line; this track is approximately 10,000 feet in length. The Winnipeg Yard also uses this bypass track to accommodate train refueling and crew transfers.

In the figure below, the red line shows the north main line. The yellow lines show the dual through main line.

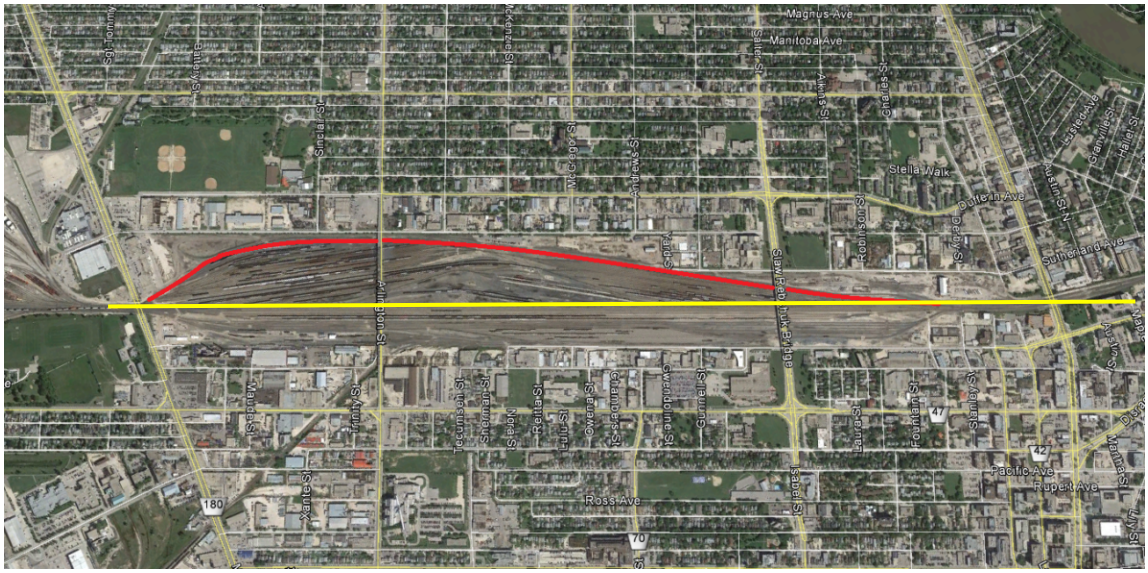

Figure 1 - CPR Yard Layout & Operations

Work Blocks and Track Outages

CPR is aware of the need to remove the Arlington Street Bridge and are willing to work with the City to accomplish this goal. From these discussions we have also learned that the summer months traditionally have lower volumes of traffic through the Yard and as such would be a better time to plan any work blocks and track outages.

Only short outages will be possible for the main line tracks and the main line bypass track and must be planned in advance with CPR. Due to the volume of traffic that uses the main line through the Winnipeg Yard work blocks and track outages will be limited in duration (4-8 hour windows) and frequency.

ARLINGTON BRIDGE REPLACEMENT

Existing Bridge Geometry

The Arlington Street Bridge consists of 37 spans of varying types of superstructures, refer to Figure 2 below. The spans have been divided into Approach Spans (Spans 1 – 13 and 27 – 37), Pratt Truss Spans (Spans 14 – 18), Camelback Truss Spans (Spans 19 – 21) and Beam Spans (Spans 22 – 26). The bridge consists of 38 substructure units (SUs), including 36 piers. Piers SU 13 – 22 are large concrete piers. The remaining piers are steel pile bents.

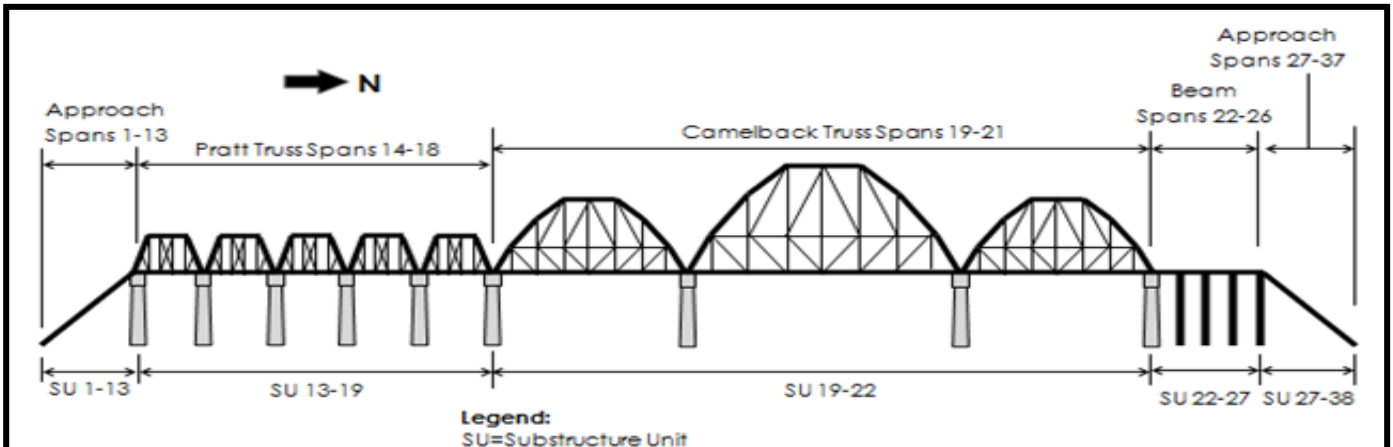

Figure 21 - Arlington Street Bridge Schematic

Rail Constraints

The key rail constraints of the yard at the Arlington Street crossing are the Back Lead, L-Lead line, west bound main line, east bound main line and the skewed classification track configuration on the northern half of the yard. The Back Lead line is the northern most and longest track in the yard. This track can accommodate 3,050 m long trains. The clearance envelope requirement at this track sets the north bridge elevation and the proposed bridge profile must accommodate this clearance requirement.

The L-Lead line is the southerly most track in the yard. The location of this track precluded the construction of a new bridge on a westerly offset to allow the existing bridge to remain in service. At Stantec's recommendation, the City of Winnipeg is working with CP to make improvements elsewhere in their network to allow for the removal of the L-Lead track. CPR Yard Constraints.

CPR vertical clearance requirement from the top of the rail to the underside of the bridge structure is 7.01m.

Proposed Arlington Bridge Geometry

Two potential bridge geometries have been reviewed, an on alignment and offset alignment. The on alignment bridge geometry would replace the existing bridge in approximately its current alignment and the offset alignment proposes to place the new bridge to the west of the existing bridge, to allow the existing bridge to remain open during construction.

Span Arrangement

The conceptually proposed geometry of the various bridges utilizes the existing substructure locations. The span arrangements of the existing bridge have not been necessarily maintained, but where a substructure unit has been proposed, it has been proposed in the same area as the exiting substructure units. This was done so as to limit the track disruptions or yard alterations required to accommodate the proposed wider Arlington Bridge.

Superstructure Concepts

The superstructure concepts evaluated include truss, NU girders, steel trapezoidal box girders, segmentally post-tensioned concrete trapezoidal box girders, steel tied arch, cable stay and suspension bridges. The conceptual superstructure depth was evaluated for each of the structure types. The NU girders lack the structural capacity to span the lengths required for the main spans of the proposed structure. A suspension bridge, though very pleasing in appearance, is not suited for the relatively short spans for the proposed Arlington Bridge crossing. It is therefore not considered to be a viable option for this site.

Table 1 – Conceptual Superstructure Depths

Bridge Type	Main Spans Superstructure Depth (mm)	Maximum Main Span Superstructure Envelope (mm)
Truss	1600	3700
NU Girders	n/a	3700
Trapezoidal Steel Tub Girders	3300	3700
Segmentally Post-Tensioned	2700+	3700
Arch	1600	3700
Cable Stay	1590	3700
Suspension	n/a	3700

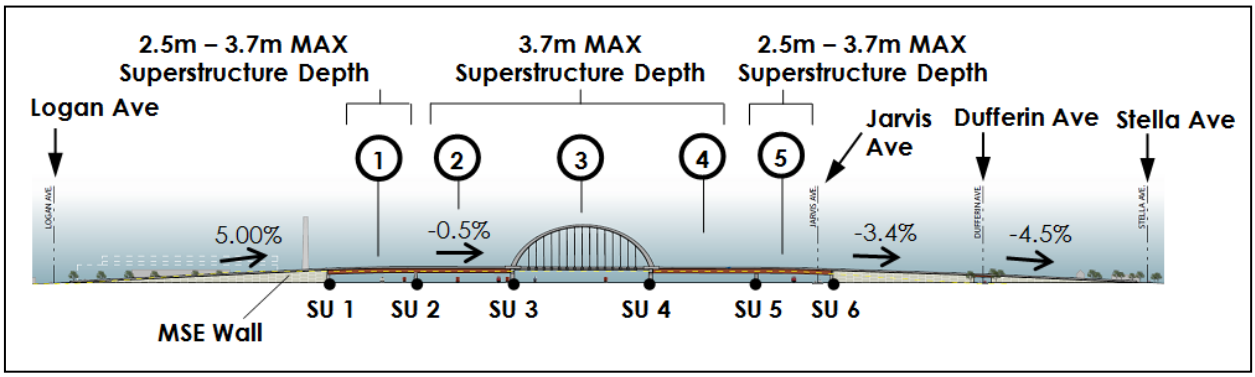

Figure 3 - General Revised Proposed Replacement Arlington Bridge Span Arrangement

McPhillips Street Reconstruction

The McPhillips Street underpass was constructed in approximately 1912. The bridge structure carries seven tracks and a north maintenance road. The bridge is on a slight skew and is approximately 25 metres long by 40 metres wide and 1.15 metres deep from base of rail to underside of the girder. The substructure consists of a concrete wall abutment, and braced steel pile columns with steel cap beams for the piers. The bridge spans two north and two southbound lanes. The existing clearance is posted as 3.9 metres. The existing underpass profile is quite flat at the underpass and has relatively steep grades.

There are many restrictions at this location that increases the complexity of an underpass replacement. On the west of McPhillips Street, south of the tracks, there is the City of Winnipeg Water Distribution buildings and reservoir. The McPhillips Underpass Pumping station is located at the northwest corner of the site. The existing McPhillips Pumping Station is one of the City's three water supply pumping stations and is a critical facility. The Kildonan Feedermain is a major water supply for the north end of the City.

Overhead restrictions are also present on the west side and consist of a 360kV hydro line running from the Manitoba Hydro Converter station just north of Logan Ave. The hydro line runs north on the west side of McPhillips and is supported by tubular steel towers. The line jumps over to the east side of McPhillips at Jarvis Ave.

Underpass Option

The proposed underpass expansion consists of the northbound lanes being realigned to the east to allow two lanes of traffic to operate during construction. The southbound lanes, once the underpass has been reconstructed, are proposed to be realigned to the east as well, on top of the existing northbound lanes. The existing southbound lanes could be used for an Active Transportation passageway under the existing rail lines to link the north AT pathways to the proposed south AT network.

Rail Detour

To accommodate rail traffic during construction, the concept consists of diverting 3 tracks north of the existing underpass structure on a new bridge. The remaining 2 or 3 tracks would be rerouted to the south of the existing underpass structure. Based on the amount of track work to detour the main line and yard track, one option is to leave the north track detour in place and therefore would be a permanent relocation. The south track detours, due to the unsatisfactory track geometry, would be only temporary until the existing structure has been replaced.

Underpass Structures

The proposed new structures are three spans, skewed to suit the track alignment geometry. The proposed span lengths are approximately 35, 20, 35m for the new permanent north structure and similar span lengths for the replacement structure. The spans have been determined based on the east abutment offset from the existing retaining wall to bridge the existing utilities.

The north structure anticipated to be a TPG structure with ballasted deck and steel deck plates. A two track TPG could be accommodated with two girders, however a 3rd track is likely to require a common girder, due to restrictive geometric constraints of the underpass. Another bridge option for the north bridge would be a multi girder superstructure, which is similar to the existing McPhillips Underpass bridge. Typically this type of bridge is not as economical as a TPG for a small number of tracks, but could be utilized to avoid a common girder(s) that may be required for the TPG option.

For the main replacement structure, viable superstructure options are multi-steel girders or prestressed precast concrete box girders laterally post tensioned as the bridge types provide a flat and wide bridge deck ideal for multiple tracks and varied track centres. The multi-steel girder bridge better suits the vertical profile geometry as it is slimmer than a box girder structure.

For the temporary detour structure, steel multi-girders appears to be the best option as they would provide the slimmest structure depth and the easiest structure to construct and remove at the end of construction, as compared to the laterally post tensioned concrete box girders.

Construction Staging

The proposed south temporary structure would further reduce vertical clearance from the already substandard posted clearance of 3.9m. With a temporary structure in place further up the vertical curve, the vertical clearance to the existing McPhillips Street south grade could be as low as just over 3 metres. CPR recommends 5.8 metres (or TAC clearance), the City of Winnipeg's typical minimum clearance for new structures is 5.3m and the TAC minimum clearance is 5.0m (with consideration of an additional 0.1 – 0.2m for future overlays of the roadway). A clearance of just over 3 metres is not safe for rail or vehicular use.

McPhillips Street is categorized as a Truck Route at 3.9 metre vertical clearance. However, at a clearance of 3.5 metres or less, McPhillips Street would need to be declassified as a Truck Route during construction. Emergency response, fire trucks, city transit, school buses, RV and trailers would not be permitted on McPhillips during construction. At that time, the Arlington Street bridge would be fully operational and therefore could be used as an alternate route for height restricted vehicles across the CPR Yards.

Due to the reduced clearance the City should consider temporary closure until partial or full operation of the reconstructed underpass has been completed. CPR may also not accept a reduced clearance due to risk of structure collision and rail operation interruptions. Protection beams could be installed to protect the temporary bridge and provide users with advance notice that their vehicle is overheight.

The other option is to consider is going over the existing CPR tracks on McPhillips, rather than reinstating the underpass.

MCGREGOR SHERBROOK CONNECTION

The proposed tunnel has been conceptually designed to accommodate 4 travel lanes (2 northbound, and 2 southbound), with a central structural support/dividing structure in the middle as well as two emergency lanes/shoulders in either direction. The tunnel is proposed to be approximately 370 metres long. A single tunnel, for both travel directions, is approximately 28 meters wide. The 28 metres is comprised of 4 - 3.7 metre lanes, 2 - 3 metre emergency lanes, a 900 mm centre divider between directions of traffic and 0.9m shy distances. The tunnel walls, depending on structure type range from 0.6 to 0.9 metres. Tunneling options requiring two tunnels would be approximately 13.1 metres wide each. The 13.1 metres would be comprised of 2 - 3.7 metre lanes, 1 - 3 metre emergency lane, 0.9m shy distance and 0.9m walls. For emergency purposes, cross passage access is required between the two directions of traffic, if separate tunnels are provided for each direction of travel. The height of the tunnels ranges from 7.8 m to 9.6 m depending on the structure type. The tunnel height was determined based on 5.3 m clearance, plus 1.2 m additional clearance for ventilation and the required roadway and structure thickness. The proposed tunnel will traverse below approximately 33 existing rail lines. The conceptual tunnel profile requires minor to no grade changes at Dufferin Avenue (north side), and Logan Avenue (south side).

Tunnel Construction Options

Cut-and-cover is a conventional method for shallow tunnel construction, in which a trench is first excavated, the tunnel structure is then built inside the trench, and the trench is backfilled to restore the surface facilities. The top-down cut and cover tunneling may be considered as an option, in which secant pile walls will be first drilled from ground level to provide central and side support, and then the tunnel roof will be constructed using the support of the secant pile wall. The surface will then be restored. This allows early reinstatement of railroad services.

Sequential Excavation Method (SEM) Tunneling, the tunnel will be excavated following the designed sequences based on the ground conditions and is typically modified in the field with close communication between the SEM field engineer and the Contractor. The tunnels will consist of 2 - 13.5 metre wide sections. The excavation sequence usually includes top heading, bench, and invert, with side drifts required for large span tunnels. Immediately following each round of excavation (typically 1 to 1.5 metres long), fiber reinforced shotcrete with lattice girders will be applied against the ground to provide initial support. Canopy tubes above tunnel crown and face dowels at the tunnel face will be needed to

reduce the surface settlement and provide additional ground support. Ground improvements such as soil freezing/jet grout may be needed in some areas for stability. After the entire tunnel is excavated, a final CIP concrete lining is typically constructed as the permanent tunnel structure.

Microtunneling requires a series of approximately 750 mm diameter, interlocking steel pipes would be jacked from one end to the tunnel centre using a microtunneling technique to form the canopy around the tunnel roof and side walls. Since the tunnel length is approximately 370 metres, a rectangular intermediate shaft in the middle of the tunnel length of the tracks, would be required to reduce the pipe driving distance. However, the feasibility of an intermediate shaft will depend on the available free space for the shaft and, if necessary, any additional costs from shutting down rail lines to accommodate the intermediate shaft. If an intermediate shaft cannot be constructed, a 370 metre horizontal pipe roof can be constructed with larger diameter steel pipes, as a larger machine is capable of delivering the required thrust forces needed to jack the pipe over a distance of 370 metres. However, a microtunnel drive of 370 metres would present increased risks over the shorter drives that would be possible if an intermediate shaft can be constructed.

The pipes would be jacked from the portals toward the shaft. After the pipe roof is in place, a length of 1 to 2 metres of material will be removed from the face, and steel support frames will be immediately erected against the pipes after each round of excavation. After the entire tunnel is excavated, a final precast/CIP concrete lining would be constructed as the permanent tunnel structure, and a connection piece built at the centre-shaft to connect the two drives. The remainder of the shaft would then be backfilled, followed by rail replacement at the centre-shaft.

Jacked box tunneling requires the tunnel structure to be cast as a box segment on a jacking base at each portal, adjacent to the railroad. A tunnel shield is attached at the tunnel leading end, and the thrust jacks provided at its trailing end, against the jacking base. An anti-drag system (ADS) would be installed at the top and bottom tunnel surface to prevent the ground from moving with the tunnel. Ground improvement such as ground freezing/grouting is typically at the portals. An intermediate, rectangular, shaft would be required at the centre of the tunnel length. The tunnel structures would be jacked from the portals toward the centre-shaft in a straight alignment without horizontal or vertical curvature. As the tunnel box structure is being jacked forward, the ground is excavated inside the tunnel. The centre-shaft is then backfilled and the surface rails replaced. The tunnel box structure becomes the permanent structure.

OPINION OF PROBABLE COST

The Opinion of Probable costs were compiled according to the recommended crossing options and phased construction. The Functional Design option costs are a Class D category cost estimate, which is +50%, -30%. The costs are typically high level costs with very little quantities determined. For the Preliminary Design of the Arlington Street Bridge Decommissioning study, the cost estimate is a category C, +35%, -25%. All costs have been included to each option; utility relocations, property acquisition, rail detours and track modifications, bridge structures, retaining walls, drainage structures, etc.

The total option cost is one component of the decision criteria and is a high level cost that can gauge the magnitude of the proposed functional level solutions. The scale of the proposed crossings will attract international construction firms. The end result is an Opinion of Probable Cost that is based on market conditions, Canadian dollar value, current industry rates for materials and installation, costs for recently constructed projects, and estimated costs provided by the construction industry based on our

consultations. The limits of the proposed works as shown on the drawings have been used for the construction cost estimate.

Factors were applied for inflation for the targeted year for construction, engineering and contingency. For property assessments, the costs included are for 2016, since property acquisition was to commence in this year.

For rail work, it was assumed that all track work would be completed by a rail contractor, however all signal designs and communications would be designed and installed by CPR forces. An allowance has been included for CPR flagging during construction.

Details of the cost calculation are provided in Appendix B. Note that a Contingency of 25% and Professional Services fee of 10% has been included.

The Opinion of Probable Costs per option were based on the following:

- 2016 Market value material costs
- Property assessment for 2016
- Canadian dollar at 75 cents US (±5¢)
- Cost of financing not included
- CPR operation impact costs not included
- GST not included
- RST not included

A summary of the crossing options opinion of probable costs are shown in Table 2 below.

Table 2 – Opinion of Probable Cost

Crossing Option	Opinion of Probable Cost
Phase 1	
Option 1A – Arlington Bridge On Alignment	$182,600,000
Option 1B – Arlington Bridge Off Alignment	$184,000,000
Phase 2	
Option A – McPhillips Underpass	$147,500,000
Option B – Sherbrook McGregor Tunnel	$212,000,000

PROJECT SCHEDULE

The driving force for this project schedule has always been the decommissioning of the existing Arlington Street Bridge. The City of Winnipeg established a target bridge closure date of 2020-2025.

Shown below in Table 3 is a tabular form of the Phase 1 schedule. The major tasks in the timeline are discussed in the subsequent sections below. The proposed timeline was based on completion of the Functional Design Report in 2016 and Arlington Bridge decommissioning in 2023. The schedule discussion below is with respect to the recommended off alignment concept for the new Arlington Street Bridge crossing.

Table 3 – Phase 1 – Arlington Bridge Replacement Tentative Schedule

Project Tasks	Start	Finish
CPR Yards Crossing Functional Design Study	July 2014	May 2016
Detailed Design L-Lead Removal	November 2016	March 2017
Preliminary Design New Crossing	November 2016	October 2017
Property Acquisition	October 2017	August 2019
Bid Opportunity L-Lead Removal	January 2018	February 2018
Detailed Design Arlington Bridge Decommissioning	February 2018	January 2019
Detailed Design New Crossing	Mar 2018	July 2020
Construction L-Lead Removal	May 2018	October 2018
Bid Opportunities New Crossing Works	June 2019	April 2021
Construction New Crossing Works	September 2019	July 2024
Bid Opportunities Arlington Bridge Decommissioning	January 2021	April 2021
Decommission Arlington Bridge	April 2023	November 2023
New Crossing Open to Traffic	October 2023	-
Site Redevelopment	April 2024	-

Decision Matrix Overview

The three sections of Financial, Social and Environment are given a point maximum value to recognize the significance of that section. The current Decision Matrix uses the following, a Financial section, Social section and an Environmental section. The Financial Section was weighted to be 40% of the total score. The Social implications section was assigned 35% of the total score. The remaining 25% is dedicated to the Environmental section.

The Sections are scored out of 100 with the sub criteria assigned an individual weight. Each sub criteria is scored between 1 and 10. The options are scored on how they best satisfy that specific sub criteria. All options may score high or low depending on the level of satisfaction for that sub criteria.

The Decision Matrix was developed to address the most significant issues within the scope of work as understood through this study.

Financial Section

The Financial Section addresses the cost of the various options. Criteria identified under this section include; Capital Cost, Life Cycle Costs and phased or Staged Construction Cost.

Since the cost of the new crossing will be significant the Financial section was assigned 40% over the overall weight with capital cost the most important contributor.

Social Criteria Section

The Social Criteria Section deals with the impacts and quality of life improvements for the community such as aspects of the area that maybe enhanced or industries that maybe affected during construction and/or the completed and potentially staged solution.

Social Criteria viewed to be nearly as important as costs, this section was weighted 35% of the total score evaluation. Social Criteria has 10 sub levels for evaluation.

Environmental Criteria

The Environmental Criteria addresses the aesthetics, health benefits, environmental factors and impacts on wild life.

For conceptual design, the landscaping and aesthetics will not be fully developed. For this reason, the Environmental Criteria section has a 25% weight for option evaluation.

Option Assessment Results

The Decision Matrix criteria were scored to determine the overall best option for Phase 1 and Phase 2 that meet the project requirements and goals.

Table 4 – Option Evaluation Score Results

Crossing Option	Evaluation Score	Pass / Fail
Phase 1		
Option 1A – Arlington Bridge On Alignment	78.9	Pass
Option 1B – Arlington Bridge Off Alignment	84.8	Pass
Phase 2		
Option A – McPhillips Underpass	64.5	**Fail**
Option B – Sherbrook McGregor Tunnel	38.1	Pass

CONCLUSIONS AND RECOMMENDATIONS

The scope of this project was wide although the intent was to determine the best location for a new crossing upon decommissioning of the existing Arlington Bridge and to determine if warranted now and in 2031. Our traffic analysis supported the need for the Arlington Bridge link to maintain existing traffic

volumes, however, this connection was not sufficient for future projected volumes. Our solution was twofold and consisted of a crossing constructed now (Phase 1, 2022) to maintain existing transportation for the community and a second crossing (Phase 2) in 2031 (approximately) to address increased traffic volumes beyond the capacity of Arlington Street. Two options were developed for Phase 2, Option A - Reconstruction of McPhillips Underpass, Option 2B – McGregor Sherbrook Tunnel Connection.

Phase 1 Summary

From this Collaborative process of this wide scope project, we determined the following for Phase 1 – Arlington Bridge Replacement:

- The Arlington Street Bridge is required today for vehicular traffic
- The Arlington Bridge link over the yards is needed for the community for local access via all modes of transportation
- The new crossing could support Transit service, an improvement for connectivity of the community
- 3 lanes of traffic are required for today's vehicular needs, 2 North, 1 South (expandable to 4)
- The public favoured separate one way protected bike lanes which are included from Selkirk to William Avenue.
- Property conflicts identified for Arlington Bridge Decommissioning and proposed crossing.
- Off alignment preferred by the community and less intrusive to CPR than the On Alignment
- CPR preferred the cable stayed structure as it provides the least amount of yard conflicts
- The Public seem to support the Arch span options
- Five structure types were determined to be viable, conditioned on CPR L-Lead Line
- CPR L-Lead line (south spur) could be removed
- Decommissioning PD determined removal of the bridge via SPMT methods the most efficient approach, CPR agreed.
- Public raised support for yard relocation, not addressed for Phase 1
- Estimated FD Cost is $184,000,000.
- Estimated Bridge Opening date, Fall 2023

Phase 1 Recommendation

Stantec recommends further developing the "Off Alignment" Arlington Bridge crossing and recommends removal of the existing Arlington Bridge with SPMTs. Stantec also recommends moving forward immediately with the removal of CPR L-Lead Line as this is required for the "Off Alignment" and provides greater flexibility for the "On Alignment" if pursued.

Phase 2 Summary

McPhillips Underpass Reconstruction

From this Collaborative process of this wide scope project, we determined the following for Phase 2 – Option A – McPhillips Underpass Reconstruction:

- Proposed alignment is to the east to allow for offset construction
- The proposed new underpass would consist of 3 lanes in each direction
- Sidewalks would be provided on both sides of the structure
- AT could be accommodated on the existing southbound lane footprint
- Substantial utility relocations required
- Substantial rail detours required including a temporary structure
- Three railway bridges are required, 2 permanent and one temporary structure for construction
- The existing pump station needs to be in service until the new pumping station is complete and traffic is operational on the northbound new alignment
- Property conflicts identified
- Vertical clearance of 5.3 or greater provided upon completion
- Three span permanent bridge required.
- West bridge span needs to extend beyond the existing west abutment/retaining wall and utilities behind the wall
- Clearance during construction questionable, approximate 3.1 to 3.4 metres
- McPhillips Underpass expansion does not satisfy 2031 traffic volumes as Transit bus lanes occupy the new lanes during peaks hours.
- Not fully supported by public, just over 50%
- Estimated FD Cost is $147,500,000
- Overpass option investigated and was determined to be less expensive and construction friendly.

McGregor Sherbrook Link

From this Collaborative process of this wide scope project, we determined the following for Phase 2 – Option B – McGregor Sherbrook Tunnel:

- Proposed alignment is on a skew to the CPR Yards and is approximately 370 metres long
- Tie-in points are Logan and Dufferrin Avenue
- The proposed Tunnel would consist of 2 lanes in each direction with an emergency lane
- Sidewalk and AT paths not recommended in the tunnel

- Cut and Cover construction method deemed most economical and geometrically beneficial, however has great impact on CPR.
- CPR does not support the tunnel construction at this point in time
- Substantial utility relocations required
- Substantial rail detours required
- Lengthy construction timeframe due to rail accommodations
- Property conflicts identified
- Vertical clearance of 5.3 plus ventilation clearance provided
- McGregor Sherbrook connection provides the best traffic capacity and is the only Phase 2 option that meets the RFP identified traffic requirements.
- Potential diamond/BRT lane within the emergency lane
- Not fully supported by public, less than 50%
- Public concern was not AT/Pedestrian accommodation
- AT bridge proposed at Slaw Rebchuk, not fully supported by public
- Estimated FD Cost is $212,000,000
- Overpass option investigated on tunnel alignment and deemed not viable.
- Overpass bridge option investigated on alternate alignment and was deemed viable, however has greater property impact.

Phase 2 Recommendation

Phase 2 is required in approximately 20 years from the study year, 2014. McPhillips underpass is an aging structure and will need to be replaced most likely prior to the implementation of Phase 2 of this study. However, McPhillips Underpass expansion does not solve the project goals identified for traffic capacity and therefore cannot be recommended further. When McPhillips Underpass is to be replaced, issues and ideas identified herein this report should be developed further.

The McGregor Sherbrook Tunnel was more difficult than anticipated, more expensive than other options and not fully supported by the public and CPR. For this reason, the tunnel is not recommended, but the connection is. Stantec recommends upon completion of Phase 1, the traffic analysis and project be recompleted and updated to reconfirm the need for the new connection. At that point in time, the CPR Yards may be reduced, mainlines only or completely relocated thereby alleviating a lot of issues identified herein this report. The overpass option on the alternate McGregor Sherbrook alignment should be further investigated as it is more economical, provides amenities that the community was requesting at this location and is less intrusive to CPR. The issue with this option is property conflicts and therefore over the next few decades, properties around this potential crossing should be monitored for availability and acquired if possible. The ability to acquire property and mitigate the sudden impact to the community could be the key to moving this option forward and developing a significant north south transportation route with BRT potential in North West Winnipeg.