2017 Walk Bike Grade Separations: Preliminary Design of Bishop Grandin Greenway Near Pembina Highway

Preliminary Design Report
Executive Summary

Prepared for:
City of Winnipeg
Public Works Department

July 4, 2017

EXECUTIVE SUMMARY

The City of Winnipeg (the City) has identified the current at grade crossing for the Bishop Grandin Greenway as a key point of restriction and safety concern. To address this concern the City engaged Stantec Consulting Ltd. to complete the functional and preliminary design of a grade separated crossing for the Bishop Grandin Greenway. The crossing is to provide an uninterrupted connection across Pembina Highway.

Feasibility Study Review

Stantec conducted a review of a feasibility study completed in 2010 by MMM Group. The study reviewed two options: Option 1, a switch back geometry to go under the existing bridge along Pembina Highway; and, Option 2, a bridge crossing over Pembina Highway. Option 1 better addressed Crime Prevention through Environmental Design (CPTED) guidelines, however Option 2 provided a preferred path geometry. However this option included the use of a pier within the median of Pembina Highway where existing BellMTS ducts are located.

Design Briefs

Design briefs for each discipline were developed prior to commencing the functional design phase. The design briefs outlined the codes, materials, guidelines, design limits, and other items that would be utilized to complete the project.

Functional Design Phase

The functional design included the development of three alignment alternatives. Within the three alignment alternatives, variations were developed for a total of seven options. The seven options were functionally designed and presented to the public at a public workshop. Using the information gathered at the workshop, Stantec worked with the City's project steering committee to finalize the scoring of a decision matrix which resulted in choosing one option to proceed to preliminary design.

Truss bridges were considered for the bridge spans. Two style of trusses were considered: Pratt and bowstring. The bowstring truss was considered for larger clear span options, and the Pratt truss was considered for the smaller bridge spans.

Alignment 1

Alignment 1 has two configurations, Alignments 1A and 1B. Both Alignments 1A and 1B cross over Pembina Highway just to the south of the Pembina Highway and University Crescent intersection. This alignment, Alignment 1A is less direct and utilizes shorter bridge spans. Alignment 1B is a more direct route, however it requires longer bridge spans. For costing purposes, an Alignment 1C was developed to compare the use of the mid-point egress as bridge spans instead of a path on fill that was used for both Alignment 1A and 1B.

The Class 4 opinion of probable construction costs for Alignment 1 during the conceptual phase ranged from $13.7 - $14.7 million.

Figure 1 - Alignment 1

Alignment 2

Alignment 2 has three configurations. Alignment 2 crosses over Pembina Highway just to north of the Pembina Highway and University Crescent intersection. Alignment 2A includes a pier in the median of Pembina Highway using path on fill material for the mid-point egress. Alignment 2B is the removal of the pier within the median and providing a clear span over Pembina Highway using bridge spans within the southwest loop. Alignment 2C was developed to compare the use of bridge spans or path on fill material through the southwest loop area of the interchange for Alignments 2A and 2B as applicable.

The Class 4 opinion of probable construction costs for Alignment 2 during the conceptual phase ranged from $11.4 - $13.0 million.

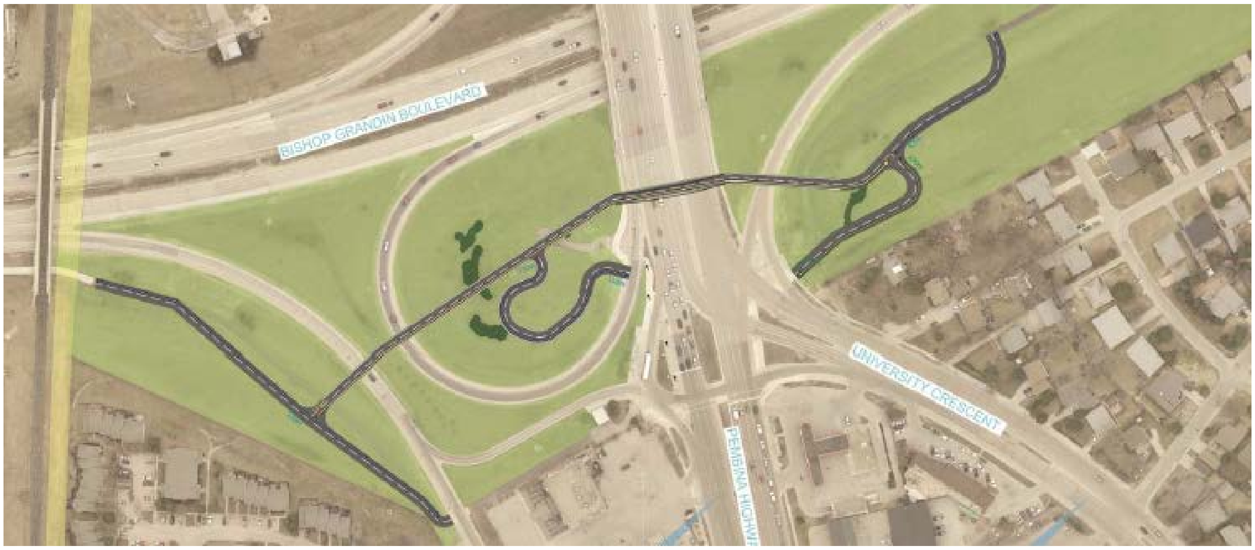

Figure 2 - Alignment 2

Alignment 3

Alignment 3 was developed to explore an alternative to overhead considerations, using space available under the Pembina Highway bridge. The grades are generally in conformance to the design requirements. The alignment does not provide direct connection to the southbound Pembina Highway sidewalk, however it makes the connection to University Crescent more direct. If this option is chosen, a connection could be developed to connect to the Pembina Highway sidewalk. It still leaves mobility users a long and indirect path to access University Crescent. The use of tunnels under the ramps makes achieving CPTED guidelines more difficult as users may question their security. To address this, the tunnels below the ramps were proposed to be bridges to provide an open and bright experience for users.

The Class 4 opinion of probable construction costs for Alignment 3 during the conceptual phase was $11.5 million.

Figure 3 - Alignment 3

Contractor Meetings

The project was discussed with three contractors, to gain their insights on construction schedule, general constructability, and construction costs. Highlights from the meetings are provided below.

- The bowstring truss is likely 10% more expensive than the equivalent pratt truss. The shaping of larger diameter pipe must be completed out of province and adds to the cost and schedule.
- Do not make the truss higher than 6m (20') as the truss would be delivered by truck on their sides to the site.
- The 30m long pratt truss' can be shipped fully fabricated, even with an estimated 6m width.
- An erection scheme is to close southbound Pembina Highway and detour traffic for 24 hours, setup the crane as close to the mid-span as possible and move the 60m bridge span from the laydown area and place longitudinally in the southbound lanes of Pembina Highway. From this position, the crane could lift the span and place it on the substructure. Full closure of Pembina Highway would be required for approximately 2 hours. Motorized dolly's could be used to drive the spans into place. The spans would be constructed on cribbing and then jacked up and lowered on to the dolly or a crane would be required to put the span on the dolly.

- Possibly launch the 60m truss span by building it inline, or almost inline, with its final position and push the truss into place.
- Consider pulling the bridge across Pembina Highway and then using two cranes, for a double pick, to place the truss, rather than one larger crane.
- The spans over the various ramps would require a 2 hour closure to get the crane in position and drive the bridge spans up next to the crane and place bridge on the substructure. If the crane must be prepared at the bridge location, a 12 hour closure will be required.
- Closures of the ramps could be completed at night. There is a premium to be paid in labour and for cranes for overnight work; however, the disruption to the public would be minimized.
- The use of circular piers of a standard size, such that prefabricated steel forms can be used, is recommended as being the most effective pier type.
- Expanded-Polystyrene (EPS) blocks are approximately 1/3 of the cost of cellular concrete; however, if significant onsite alterations are required to the EPS blocks, the efficiencies drop, and costs will increase.

Public Workshop

A public workshop was held on May 11, 2017. The highlights of the feedback received from the workshop were as noted below:

- Participants preferred Alignment 2 as it is a straighter route, has better sightlines and is shorter.
- Participants least preferred Alignment 3 due to perceived higher costs, potential for spring flooding, greater traffic interruptions, lessened user experience, and perceived security concerns.

Recommended Functional Design Option

A decision matrix was completed and finalized with the project steering committee to determine the recommended option. The chosen alignment is Alignment 2C, which provides bridge crossings over the off ramp from northbound Pembina Highway to eastbound Bishop Grandin, Pembina Highway, the southwest loop of the interchange and the off ramp from eastbound Bishop Grandin to Pembina Highway. The grade in the southwest loop is proposed to be raised by the use of lightweight fill to match the required path grades of the various bridge spans. A mid-point egress is provided within the southwest loop. This option uses the bowstring truss to clear span Pembina Highway, avoiding the median curb where BellMTS ducts would likely make the placement of a bridge foundation difficult. As well, the public preferred this bridge type. The smaller spans over the various ramps are Pratt trusses. The Bowstring truss is approximately 60m and the Pratt trusses are approximately 30m.

The vertical and horizontal grades were designed to meet the accessibility requirements with the minimum and maximum proposed grades of 0% and 4.5% respectively. The grades along the main path alignment are approximately 3.5% and lower. The 4.5% grades were utilized for the mid-point egress as this path is geometrically restrained by the proposed path and existing southwest loop geometry. Landing areas along the main path alignment were placed based on the slopes and segment lengths using engineering judgement, rooted in the design requirements for accessibility. The landing areas along the mid-point egress ramp were placed every 30m.

Preliminary Design

Alignment 2C was further developed to a preliminary design level.

Alignment Geometry

The vertical grades for the paths and bridge crossings range from 0% to a maximum of 4.8% (for a short distance). Generally, the maximum path grades are approximately 4.3%.

A minimum radius of 25m was used for the path unless constrained, then a 20m radius could be utilized. A 7m radii was used at intersection of the paths in accordance with the Technical Handbook of Bike Way Design Velo Quebec 2nd Edition.

Stopping sight distance was reviewed and confirmed to be 33m, meeting the requirements set forth for this project.

Geotechnical

Slope stability was reviewed and determined not be a concern for this site and proposed geometry and fill materials.

Due to the fill heights, settlements and consolidation are a concern. Conventional granular fill could settle as much as 1300mm. As such the fill material proposed is a combination of cellular concrete and EPS foam blocks to limit the settlements to an estimated range of 150 – 400mm.

Retaining Walls

Retaining walls for this project have been proposed to be mechanically stabilized earth (MSE) walls as these were determined to provide the functional requirements and are a cost effective system.

Bridge

The bridges were preliminarily design in accordance primarily with CHBDC CAN/CSA S6-14. A combination of Pratt and bowstring truss spans were used to complete the preliminary design.

Loads

The bridges were preliminarily designed using a 4 kPa, without reduction, pedestrian live load, wind load, dead load and a maintenance vehicle.

Pratt Truss and Bowstring Truss

The Pratt truss spans were designed with 30m span lengths and an overall height of 1.54m from the center of the top chord to the center of the bottom chord. Rectangular hollow structural steel (HSS) section are proposed for all truss members.

The bowstring truss span was designed for a span length of 60m, to clear span over Pembina Highway. The top chord attains geometry of a parabolic vertical curve. The maximum height of the truss is proposed to be 4.5 m between centers of top and bottom chords at mid-span. Round hollow structural steel (HSS) section are proposed for all members of the structure except for floor beams which are proposed to be rolled W shape steel beams

The dead load deflections were limited to 1/400 of the span length.

The maximum live load deflection was limited to a maximum of 1/350 of the span length.

The dead load of the truss is such that the vertical and lateral fundamental frequencies of Section 6 - Vibration of the “LRFD Guide Specifications for the Design of Pedestrian Bridges” were satisfied.

Abutments

The abutments are cast-in-place concrete founded on drilled concrete caissons (piles), 3-760 mm diameter for the Pratt spans and 3-1067mm diameter, for the bowstring span.

Piers

The piers are proposed to be cast-in-place concrete. The bearing seat area is geometrically designed to accommodate the horizontal alignment of the bridges. The shaft of the pier is proposed to be a single column. The column is 1067 mm or 1219 mm in diameter, depending on its location. The piers with the 1067 mm diameter column are founded on a cast-in-place concrete pile cap supported by 4-760mm diameter drilled concrete piles. The piers with the 1219 mm diameter column are founded on a cast-in-place concrete pile cap supported by 4-1067mm diameter drilled concrete piles.

Protective Fence and Railings

Guardrails are proposed to be composed of standard City aluminum rails, pickets, and posts. Where required, the guardrail will include an 89 mm diameter circular bicycle rail at 1370 mm height, to the top of the rail.

Over the roadways, the protective fence is proposed to be comprised of a stainless steel mesh, offering improved aesthetics over chain-link, supported by typical City rectangular aluminum posts that extend up from the railing.

Deck

A corrugated steel composite concrete deck with a total depth of 190 mm above the top of floor beam is proposed reinforced by stainless steel reinforcing steel.

Bearings

Laminated elastomeric bearings are proposed for all bridge spans.

Landscaping

Coniferous tress shall not be utilized, as per the requirements of the City. Deciduous trees and low mow grass have been proposed for this project. The City preferred the use of low mow grass for this project. The City of Winnipeg noted during a site meeting that 4:1 is the steepest slopes that can be utilized for access and maintenance reasons. There is one location were the slopes proposed in the preliminary design are steeper than 4:1. The path geometry is to be slightly altered in the detailed design stage to adhere to the 4:1 or flatter requirement.

Wayfinding and route marking signs are proposed at five decision-making points along the proposed path.

Lighting

Path lighting is proposed to be standard Manitoba Hydro 4.6m tall pedestrian level lighting spaced at approximately 30m.

For the bridges, LED lights are proposed. Pathway illumination on the bridges will be provided with the use of linear luminaires integrated into handrail support posts. In areas where the bridge is supported by above deck arches, LED linear fixtures will be installed on the bridge deck and aimed up at the arches. Light reflected off the arches will contribute to the pathway illumination and will highlight the uniqueness and elegance of the support structure. The luminaires will have color changing capability, which will allow to light arches in theme colors for special events and program a color changing sequence during regular time. This concept of lighting arches from the deck up will result in the use of more economical luminaires while allowing easy access to the luminaires for maintenance purposes.

A lighting simulation is required in the detailed design phase to fine tune the proposed lighting scheme.

CPTED

CPTED was addressed by:

- Creating thresholds and clear territorial markers for the structure (i.e., City signage, gateposts)
- Structure designed for durability and ease of maintenance. Selection of materials and design details enable graffiti removal, provide proper clearances for snow removal, and avoid details and finishes that are vulnerable to rust, accidental damage, or vandalism. Typical materials have been selected, such as galvanized or metalized steel and concrete.
- Consideration of lighting.
- Consideration of sight lines.
- Consideration of accessibility and safety.

Preliminary Project Schedule

A project schedule for next phases is proposed below with the assumption that Detailed Design will initiate in November 2017. However, if the project is delayed, the scheduled will have to be adjusted accordingly.

Item	**Timeframe**	
	Start	Finish
Detailed Design		
Steel	November 2017	January 2018
General Construction	December 2018	February 2018
Steel Fabrication Tender	January 2018	February 2018
Steel Fabrication	February 2018	August 2018
Bowstring Arch	February 2018	May 2018
Pratt Truss	February 2018	August 2018
General Construction Tender	February 2018	February 2018
General Construction	March 2018	November 2018

Opinion of Probable Project Costs

Total project cost is approximately $15 million. This is a Class 3 estimate (accurate within +30% to -20% of the final construction cost) developed during preliminary phase. Estimated costs will be refined to a higher level of detail as part of the detailed design process.