The Corporation of the Town of Milton

Report To:	Council
From:	Barbara Koopmans, Commissioner, Development Services
Date:	May 31, 2021
Report No:	DS-044-21
Subject:	Boyne Active Transportation Link – Environmental Assessment and Preliminary Design Report
Recommendation:	**THAT** Council endorse the preliminary design for the Boyne Active Transportation Link, as included in Appendix 1 of Staff Report DS-044-21

EXECUTIVE SUMMARY

Through the Secondary Plan work completed in support of the Boyne Survey, the need for a link across the CN Rail corridor (between Louis St. Laurent Avenue and Britannia Road) was identified. Originally identified as a road crossing, further study at the Secondary and Tertiary plan stages resulted in the grade-separated link being required to accommodate Active Transportation (namely, pedestrians and cyclists). The Boyne Active Transportation Link is identified as a Schedule C project, as defined in the Municipal Class Environmental Assessment (MCEA) process. Therefore, phases 1 through 5 of the MCEA are required. Phases 1 and 2 were satisfied through the Boyne Secondary Plan work, and Phases 3 and 4 have been addressed through the Class Environmental Assessment (EA) Study, currently nearing completion. Phase 5 is implementation of the recommendations in the EA.

It is proposed to continue to detailed design and ultimate construction of the Boyne Active Transportation Link, with the following characteristics, as outlined in the preferred design included in Figures 5-1 through 5-5 in Appendix 1:

- Located approximately 300 metres south of Louis St. Laurent Avenue, crossing the CN Rail corridor
- S-shaped approach ramp on both the east and west approaches to the crossing
- 6 metres wide pathway on approaches and across the bridge, to safely accommodate pedestrians and cyclists
- Tied Arch Bridge with Hanger Cables for structure spanning the CN Rail corridor
- Rest stops proposed on approaches
- Grading, stormwater, landscaping and lighting design to be coordinated with adjacent development

EXECUTIVE SUMMARY

The draft Environmental Study Report (ESR) as required by Phase 4 of the MCEA for Schedule C projects, is nearing completion and will be submitted to Conservation Halton (CH), the Ministry of Natural Resources and Forestry (MNRF) and the Ministry of Environment Conservation and Parks (MECP) in June. It is anticipated that the final ESR will be filed for the statutory public review period in mid-July. It should be noted that the date of filing is dependent on timing required to address agency comments, so this timing may shift slightly. Detailed design will continue in 2021 and construction tender is currently anticipated for 2022. The purpose of this report is to inform Council of the project status and to obtain Council endorsement for the preliminary design, ahead of filing the final ESR for public review.

REPORT

Background

The Boyne Active Transportation Link is identified in the Boyne Secondary Plan as a required connection across the CN Rail corridor within Block 1 of the Boyne Survey Secondary Plan Area), which is bounded by Louis St. Laurent Avenue to the north, Britannia Road to the south, Bronte Street South to the east, and Tremaine Road to the west. There are a number of residential subdivision applications within Block 1 which are proceeding through the approvals process. Currently, there are no mid-block crossings (between Louis St. Laurent Avenue and Britannia Road) of the CN Rail corridor, and this crossing will ensure connectivity between future neighbourhoods and community amenities on both the east and west sides of the CN Rail corridor. Staff have engaged Wood Environment and Infrastructure (Wood) to complete Phases 3 and 4 of the MCEA for this project. The preferred design, as supported by the EA work completed to-date, includes an S-shaped approached on both sides, a 6m wide pathway to accommodate both pedestrians and cyclists, and a tied arch bridge with hanger cables for the bridge span.

Discussion

Works Completed to Date

Staff engaged Wood, one of the Town's Civil Engineering Roster Consultants, to complete the MCEA for the Boyne Active Transportation Link in April, 2019. Since this time, the following work has been completed:

- Review of available background/planning studies to confirm Phases 1 and 2 of the MCEA were satisfied through the Secondary Plan
- Completion of supporting studies and technical memos to inform the ESR

Discussion

- Preparation and evaluation of design alternatives for both bridge and approaches, and detailing of the preferred design
- Stakeholder consultation (including various Town staff, provincial agencies, Indigenous Communities, Conservation Halton, CN Rail, adjacent landowners)
- Meetings with CN Rail and Conservation Halton
- Public engagement via two online engagement events through Let's Talk Milton – including presenting the preferred preliminary design in March 2021.
- Commencing preparation of the draft ESR for Town and environmental agency review

Evaluated Alternatives (Phase 3 of the MCEA)

As required by Phase 3 of the MCEA, all feasible and reasonable alternative design concepts were considered for evaluation. The first step in identifying various alternative design concepts was, through stakeholder consultation, to identify constraints and requirements that had to be considered in developing the alternatives. These included:

- Bridge width of 6.0 metres to accommodate both pedestrians and cyclists;
- Sufficient bridge span for possible future expansion of railway tracks;
- CN Rail design requirements for bridge structure;
- Protection, safety, and security of both CN's railway operation and the pedestrians and cyclists using the bridge;
- Integration with proposed adjacent land uses, and
- Conservation Halton requirements related to the adjacent Indian Creek Tributary.

With these constraints and requirements in mind, the following approach alternatives were developed and evaluated:

- Approach Option 1 - Spiral
- Approach Option 2 - "S" shaped approach
- Approach Option 3 - Undulating
- Approach Option 4 - Ramp

The approach alternatives were evaluated against the following criteria:

- *Planning* – does it comply with planning policy and address active transportation needs?
- *Structural Design Requirements* – implications on number of structures that would be required;
- *Socio-economic Environment* – compatibility with future development, user experience through vista opportunities, and property taking requirements;

Discussion

- *Natural Environment* – impacts to wildlife and habitat, vegetation and aquatic habitat;
- *Cultural Environment* – impacts to archaeology, and cultural landscape resources;
- *Safety* – safety considerations for users;
- *Cost* – estimated construction and maintenance costs;

There were four structure alternatives considered for the bridge span, as follows:

- Bridge Option 1 – Bowstring Truss Bridge
- Bridge Option 2 – Girder Bridge
- Bridge Option 3 – Tied Arch Bridge with Hanger Cables
- Bridge Option 4 – Full Height Arch Bridge

The approach options and the bridge options were then combined to create 8 alternatives for evaluation for the Bridge Structure (i.e. Bridge Option 1, with Approach Alternative 1, and with Approach Alternative 2, 3, or 4, Bridge Option 2, with Approach Alternative 1, and with Approach Alternative 2, 3, or 4, and so on, as detailed in the Evaluation of Alternatives Memo, included in Appendix 1 of this report).

The Bridge Structure alternatives were evaluated based on the following criteria:

- *Aesthetics* – provides a positive change to the community via aesthetics;
- *Constructability* – construction complexity;
- *Cost* – estimated construction and maintenance costs;
- *Safety* – safety considerations for users and for CN corridor;

The Evaluation of Alternatives Memo, included as Appendix 1 to this report, details the evaluation of the alternatives noted above, considering the above criteria.

Preferred Alternative Design

As a result of the evaluation of the 8 Bridge Structure alternatives, the preferred design is to implement an “S” shaped approach (on both the east and west sides) with a Tied Arch Bridge with Hanger Cables.

The “S” shaped approach was identified as the preferred bridge approach, based on the following:

- Provides a seamless connection to the future walkways and village square on the west side
- Compatible with future adjacent developments. “S” shaped ramp and bridge can function as a unique landmark in the area, visible from immediate adjacent development

Discussion

- The location of rest areas on the east and west approaches will provide the best views into the future park (to the east) and the Niagara Escarpment (to the northwest)
- This option requires the least amount of property taking, the lowest amount of vegetation removal, and there are no impacts anticipated to the channel block of the regulated water course
- Lowest construction cost, compared to the other alternatives

The Tied Arch Bridge with Hanger Cables was identified as the preferred structure alternative, based on the following:

- The structure will provide pleasing, positive and unique aesthetics to the future community. The arch combined with the thin hanger cables and shallow structure under the bridge deck will achieve transparency of the structure
- Lower construction cost, compared to the other alternatives
- Climb-proof guard system and lighting can be easily installed to promote safety of bridge users

The preferred bridge approach and structure can be seen in Appendix 1 of this report. It should be noted that the design is preliminary in nature, and there are several design components that will be finalized during the detailed design stage, including the following:

- Ultimate location of the western terminus of the west ramp, in coordination with adjacent subdivision design
- Grading of ramps in relation to future development
- Location and sizing of rest stops on bridge approaches
- Method and materials to separate pedestrians and cyclists on the bridge and approaches
- Specifications for the railings on the bridge and approaches
- Fencing/noise wall along the mutual property line with CN Rail
- Landscaping options and details for the approach slopes

Land

All lands required for the bridge, on the east and west side of the CN Rail corridor, will be transferred to the Town as a condition of the subdivision approvals for the adjacent development lands. Staff have been coordinating with the adjacent developers throughout the MCEA process, and the land requirements for the west side are reflected in the Fieldgate West Draft Plan of Subdivision, which is scheduled to be presented to Council on May 31, 2021. Land is not required from CN Rail, however a crossing agreement will be entered into with CN Rail, prior to construction tender, which will allow the bridge crossing of the CN corridor.

Discussion

Construction

It is anticipated that detailed design will be completed in 2021, with construction anticipated to start in 2022. In order to facilitate construction and ensure efficiencies with the surrounding development, continued coordination will occur between the Town, Wood, and the adjacent development, with respect to both timing of construction and implementation of the project.

Financial Impact

The nine year capital forecast as presented through the 2021 budget includes construction of the Boyne Active Transportation Link in 2022 at an estimated total amount of $5,182,197, including $4,377,500 for the construction contract. The preliminary, high-level construction estimate for the recommended design alternative, as presented through Appendix 1, identifies a required construction budget of $4,061,242, including non-recoverable HST. Through the 2022 budget process, the project budget will be adjusted to reflect the costs associated with the pre-tender cost estimate, which will be further refined during the detailed design process.

This project will result in ongoing operating impacts including lifecycle contributions for the future replacement of the structure and annual maintenance activities. The operating impacts will be determined through the 2022 budget process and incorporated into the 2022 operating budget.

Respectfully submitted,

Barbara Koopmans, MPA, MCIP, RPP, CMO
Commissioner, Development Services

For questions, please contact:	Diana Jiona, P.Eng. Manager, Infrastructure	Phone: Ext. 2513

Attachments

Appendix 1 – Evaluation of Alternative Memo and Preferred Preliminary Design

CAO Approval
Andrew M. Siltala
Chief Administrative Officer

Wood Environment & Infrastructure Solutions,
a Division of Wood Canada Limited
3450 Harvester Road, Suite 100
Burlington, ON L7N 3W5
Canada
T: 905-335-2353

Memo

To: Diana Jiona, P.Eng., Dave Muraca, CET (Town of Milton)

From: David Sinke, Mir Talpur, Mathew Galloway

Wood File No.: TPB166053

Date: 05 February 2021

Regarding: Development and Evaluation of Alternative Design Concepts and Identification of Preliminary Preferred Design for Boyne Active Transportation Link

1.0 Introduction

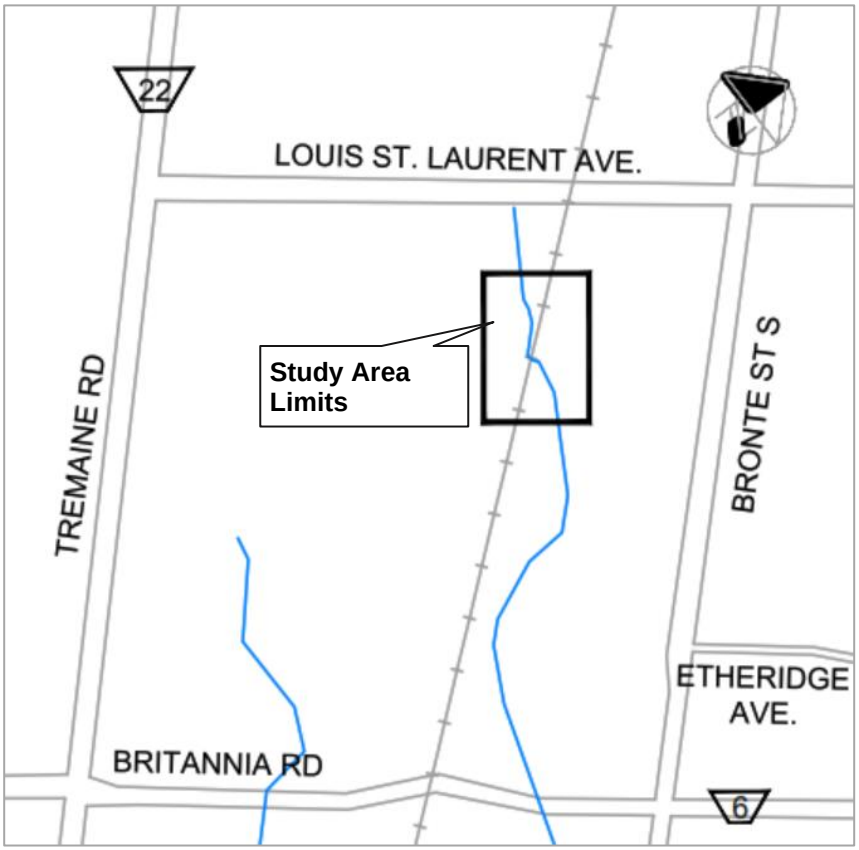
Wood Environment & Infrastructure (Wood) was retained by the Town of Milton to complete a Municipal Class Environmental Assessment Study (Class EA) to develop a new pedestrian and cyclist connection over the Canadian National (CN) Railway Line between Louis St. Laurent Avenue and Britannia Road. This bridge is known as the Boyne Active Transportation Link. The Boyne Active Transportation Link Study (the Project) is following the Schedule 'C' Municipal Class Environmental Assessment process, which is outlined in the Municipal Engineering Association document titled "Municipal Class Environmental Assessment," (October 2000, as amended in 2007, 2011 & 2015).

This study builds on the recommendations of the Boyne Survey Secondary Plan (July 2017) which fulfilled the requirements of Phases 1 and 2 Class EA process for this project. Phases 3 and 4 are being completed as part of the current Study.

Phase 3 of the Municipal Class EA process involves the development and evaluation of alternative design concepts for the Preferred Solution. This memo describes the alternative design concepts that were developed and evaluated and identifies a Preliminary Preferred Alternative for the Project.

Approximate limits of Study Area are shown in **Figure 1-1**.

Figure 1-1: Approximate limits of Study Area



2.0 Development of Alternative Design Concepts

The alternative design concepts developed for this project are based on the recommendation of the Boyne Survey Secondary Plan (i.e., "*a grade-separated Planned Active Transportation Link shall be provided across the CN Rail line*") (Town of Milton, 2017). Alternative design concepts were developed for the bridge approaches and bridge structure by considering a number of constraints and criteria based on the input from key stakeholders (Town of Milton staff, Conservation Halton, Fieldgate Development, and Canadian National Railway). The following constraints and requirements were identified and considered in the development of the alternative design concepts:

- Bridge width of 6.0 m (19.7 feet) to accommodate both pedestrians and cyclists;
- Sufficient bridge span to allow for addition of railway tracks within existing CN Rail right of way;
- CN design requirements for the bridge structure (CN Railway, 2006);

- Protection, safety, and security of both the CN Railway operations and the pedestrians and cyclists using the bridge;
- Integration with proposed adjacent land use per Fieldgate Commercial Draft Plan Context (May 27, 2020); and,
- Conservation Halton's requirements related to Indian Creek Tributary (I-NE-1B-1).

2.1 Alternative Design Concepts for Bridge Approaches

The following four alternatives were identified for the bridge approaches:

Alternative 1: Spiral Approach:

This alternative approach include Spiral ramps on both sides of the CN rail tracks with a 6.0 m wide multi-use path. This alternative is illustrated in **Figure 4-1**.

Alternative 2: "S" Shaped Approach:

This alternative approach include "S" shaped ramps on both sides of the CN rail tracks with a 6.0 m wide multi-use path. This alternative is illustrated in **Figure 4-2**.

Alternative 3: Undulating Approach:

This alternative approach include undulating / "U" shaped ramps on both sides of the CN rail tracks with a 6.0 m wide multi-use path. This alternative is illustrated in **Figure 4-3**.

Alternative 4: Ramp Approach:

This alternative approach include linear ramp on the east side and "U" shaped ramp on the west side of the CN rail tracks with a 6.0 m wide multi-use path. This alternative is illustrated in **Figure 4-4**.

2.2 Alternative Design Concepts for Bridge Structure

The following four design alternatives were identified for the bridge structure:

Alternative A: Bowstring Truss Bridge:

The bowstring arch truss bridge option includes two main arch trusses. The trusses are similar to tied arches whereby the load of the deck puts the top chord of the truss into compression and the bottom chord into tension, however the bowstring trusses also include diagonal load bearing members. There is one truss on either side of the concrete bridge deck. Transverse steel members span between the trusses to carry the bridge deck from below, however the tops of the trusses are not connected, with the vertical and diagonal members of the trusses providing the lateral support for the trusses.

Based on the configurations of Alternative Bridge Approaches, this alternative design for the bridge structure was subdivided into the following two categories:

- Alternative A1: Bowstring Truss Bridge with Approach Alternative 1
- Alternative A2: Bowstring Truss Bridge with Approach Alternative 2, 3 or 4

Bridge Structure Alternatives A1 and A2 are illustrated in **Figure 4-5** and **Figure 4-6**, respectively.

Alternative B: Girder Bridge:

The steel girder bridge option consists of two I-girders which support the bridge through shear and bending in the girders. The concrete bridge deck then spans between the two girders.

Based on the configurations of Alternative Bridge Approaches, this alternative design for the bridge structure was subdivided into the following two categories:

- Alternative B1: Girder Bridge with Approach Alternative 1
- Alternative B2: Girder Bridge with Approach Alternative 2, 3, or 4

Bridge Structure Alternatives B1 and B2 are illustrated in **Figure 4-7** and **Figure 4-8**, respectively.

Alternative C: Tied Arch Bridge with Hanger Cables:

The tied arch bridge with hanger cables option includes an arch rib on each side of the concrete bridge deck. Vertical ties connected to the arches support the deck from above. The force of the load of the deck tries to flatten the arch and push its tips outward. Resistance of this thrust puts the arch into compression. The thrust is resisted by tie beams at deck level. Transverse steel members span between the cable hangers to support the bridge deck from below, and the tops of the arches are connected to provide lateral support.

Based on the configurations of Alternative Bridge Approaches, this alternative design for the bridge structure was subdivided into the following two categories:

- Alternative C1: Tied Arch Bridge with Hanger Cables with Approach Alternative 1
- Alternative C2: Tied Arch Bridge with Hanger Cables with Approach Alternative 2, 3 or 4

Bridge Structure Alternatives C1 and C2 are illustrated in **Figure 4-9** and **Figure 4-10**, respectively.

Alternative D: Full Height Arch Bridge with Hanger Cables

The arch bridge with hanger cables option includes an arch rib on each side of the concrete bridge deck. Vertical ties connected to the arches support the deck from above. The force of the load of the deck tries to flatten the arch and push its tips outward. Resistance of this thrust puts the arch into compression. The thrust is resisted by the foundations. Transverse steel members span between the cable hangers to support the bridge deck from below, and

the tops of the arches are connected to provide lateral support. For ramp options 2, 3 and 4, the abutments are set further back than the other bridge options in order to accommodate the full height arch in front.

Based on the configurations of Alternative Bridge Approaches, this alternative design for the bridge structure was subdivided into the following two categories:

- Alternative D1: Full Height Arch Bridge with Hanger Cables with Alternative Option 1
- Alternative D2: Full Height Arch Bridge with Hanger Cables with Alternative Option 2, 3 or 4

Bridge Structure Alternatives D1 and D2 are illustrated in **Figure 4-11** and **Figure 4-12**, respectively.

3.0 Criteria for Evaluating Alternative Design Concepts

To identify the impacts and advantages of each alternative design concept, evaluation criteria were identified. These criteria were chosen based on their ability to identify potential effects of each alternative design and distinguish the advantages and disadvantages between them.

3.1 Criteria for Evaluating Alternative Design Concepts for Bridge Approaches

Following evaluation criteria were developed to evaluate alternative design concepts for bridge approaches:

- **Planning:** Complies with planning policy and addresses active transportation needs.
- **Structural Design Requirements:** Implications on number of structures.
- **Socio-economic Environment:** Compatibility with future development, user experience through vista opportunities, and property taking.
- **Natural Environment:** Impacts to wildlife and wildlife habitat, vegetation, and aquatic habitat.
- **Cultural Environment**: Impacts to archaeology, built heritage and cultural landscape resources.
- **Safety:** Safety issues.
- **Cost Considerations**: Estimated construction and maintenance costs.

3.2 Criteria for Evaluating Alternative Design Concepts for Bridge Structure

Following evaluation criteria were developed to evaluate alternative design concepts for bridge structure:

- **Aesthetics:** Provides positive change to the community via aesthetics.
- **Constructability:** Construction complexity.
- **Cost:** Estimated construction and maintenance costs.
- **Safety:** Allows incorporation of features to address safety issues.

4.0 Evaluation of Alternative Design Concepts

The alternative design concepts described in Section 2.0 (Development of Alternative Design Concepts), were evaluated using the evaluation criteria outlined in Section 3.0 (Criteria for Evaluating Alternative Design Concepts). Evaluation of Alternative Design Concepts for Bridge Approaches is provided in **Table 4-1**. Evaluation of Alternative Design Concepts for Bridge Structure is provided in **Table 4-2**.

Figure 4-1: Bridge Approach Alternative 1 - Spiral Approach

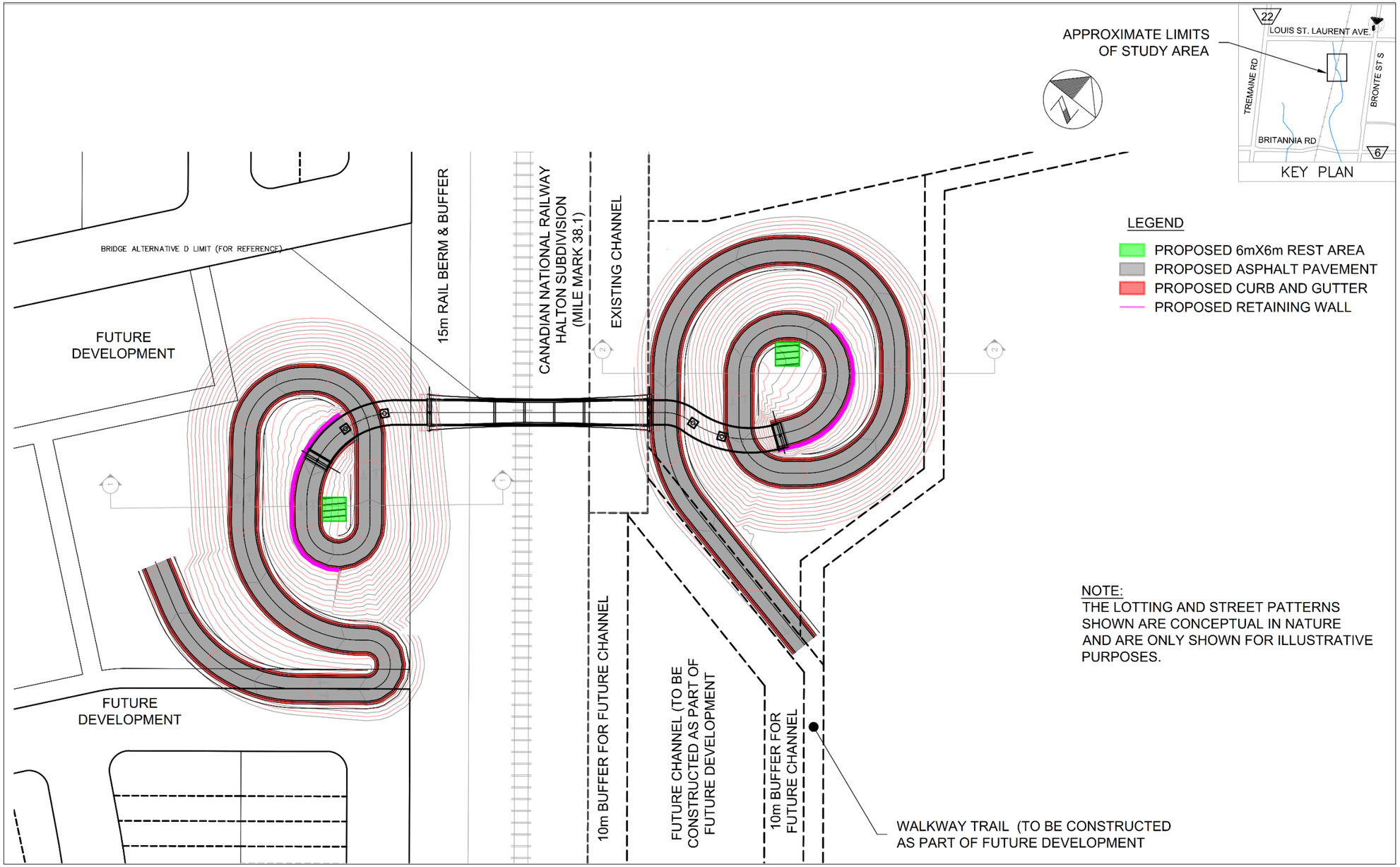


Figure 4-2: Bridge Approach Alternative 2 - "S" Shaped Approach

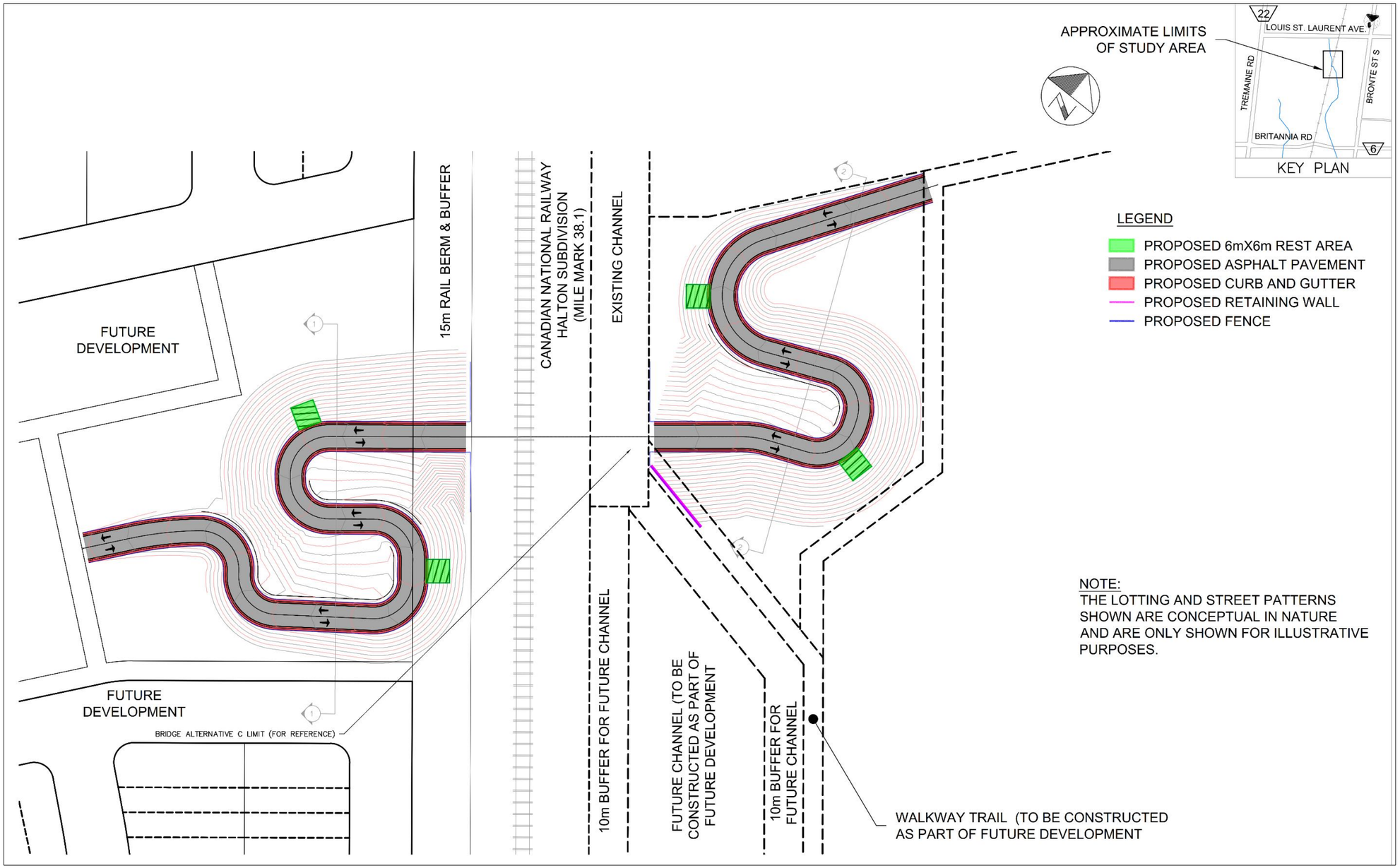


Figure 4-3: Bridge Approach Alternative 3 - Undulating Approach

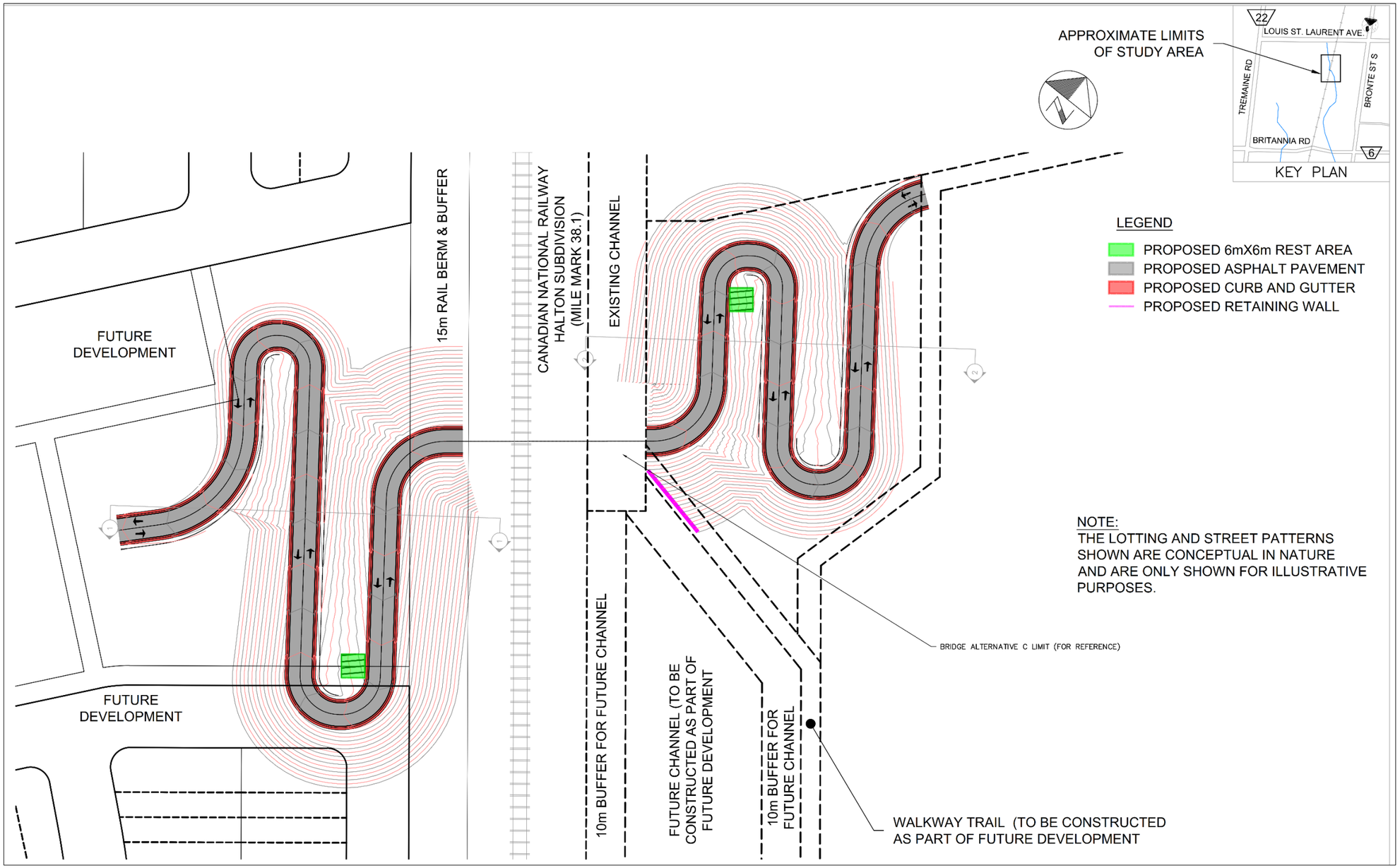


Figure 4-4: Bridge Approach Alternative 4 - Ramp Approach

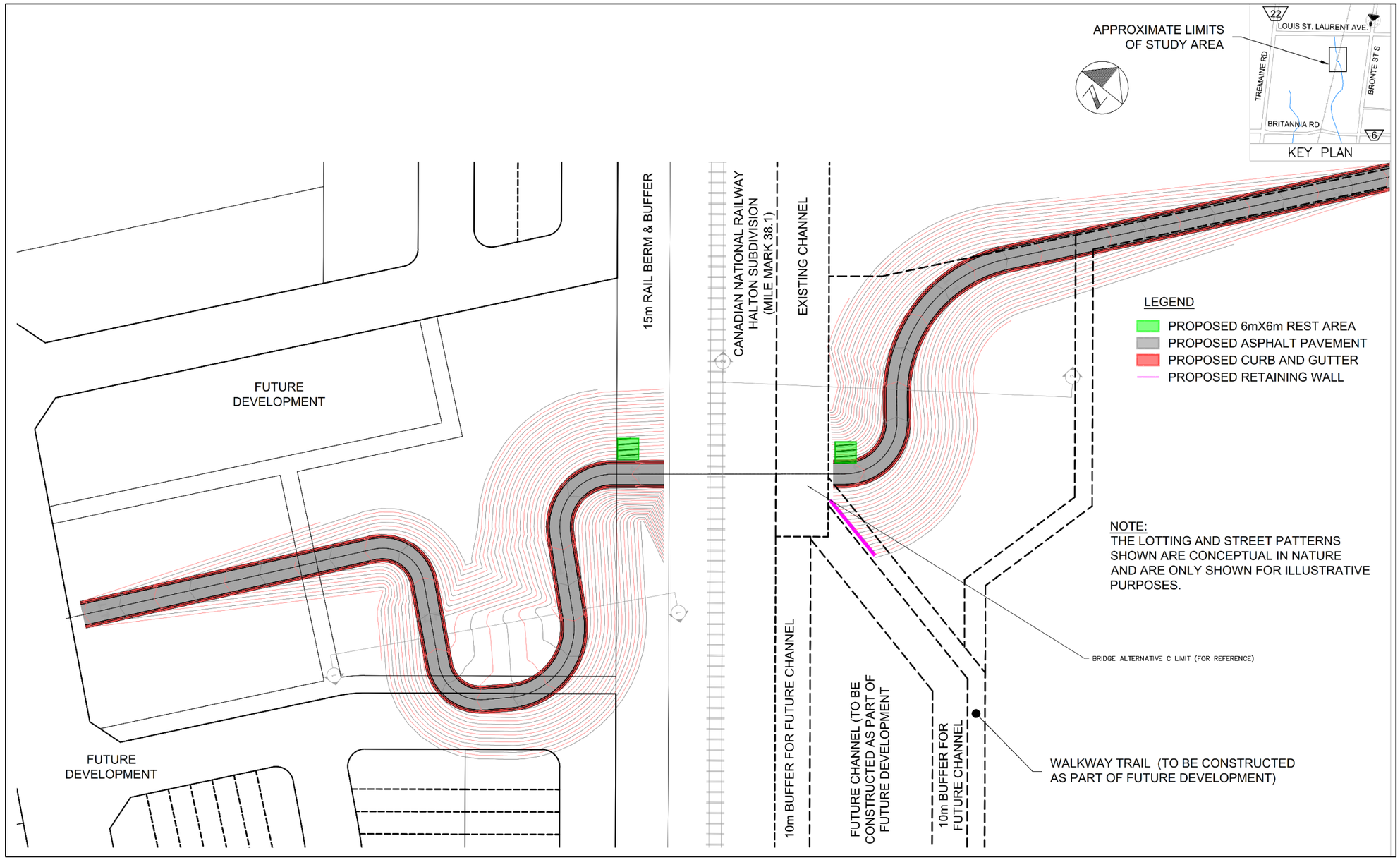


Figure 4-5: Bridge Structure Alternative A1: Bowstring Truss Bridge with Approach Alternative 1

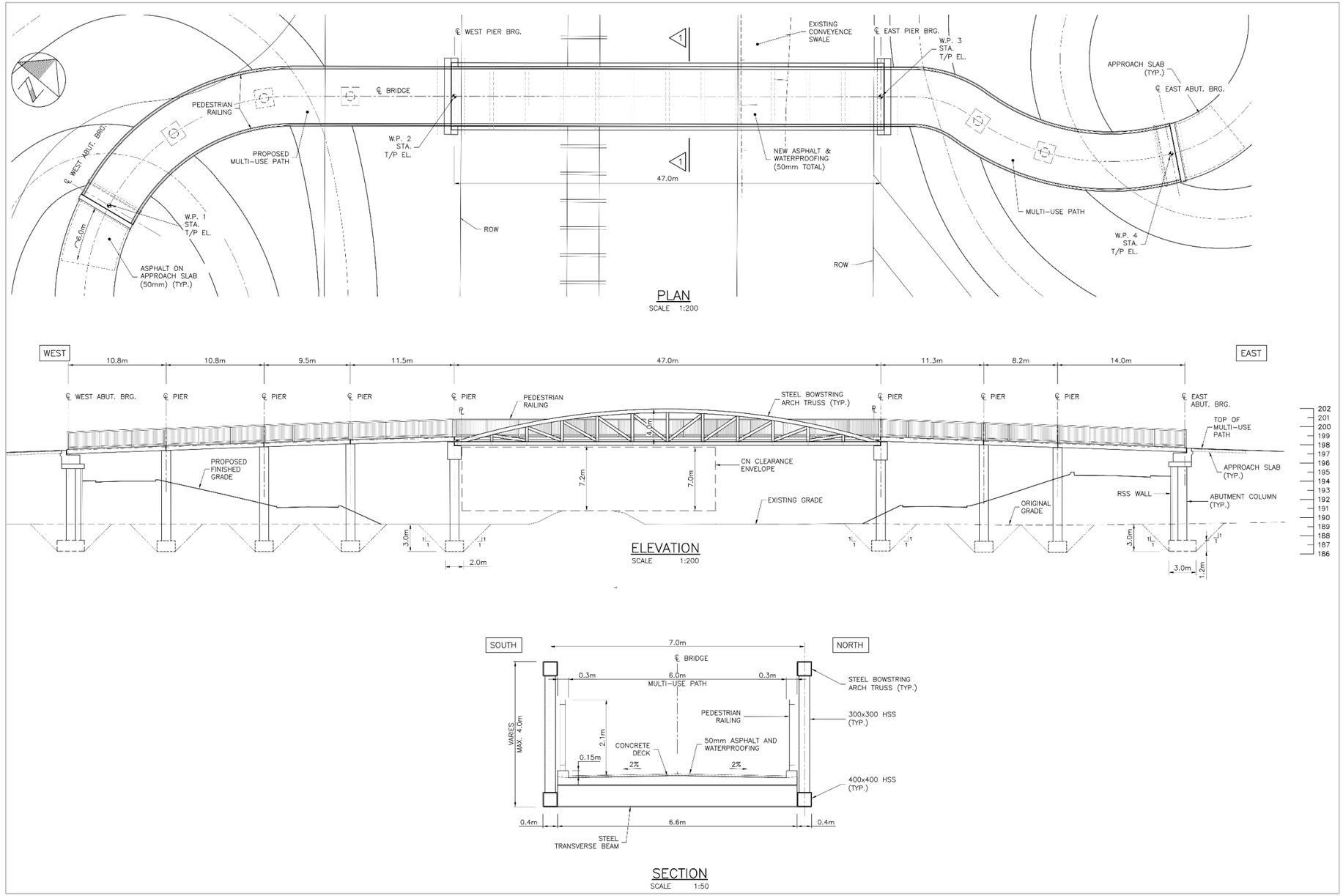


Figure 4-6: Bridge Structure Alternative A2: Bowstring Truss Bridge with Approach Alternative 2, 3 or 4

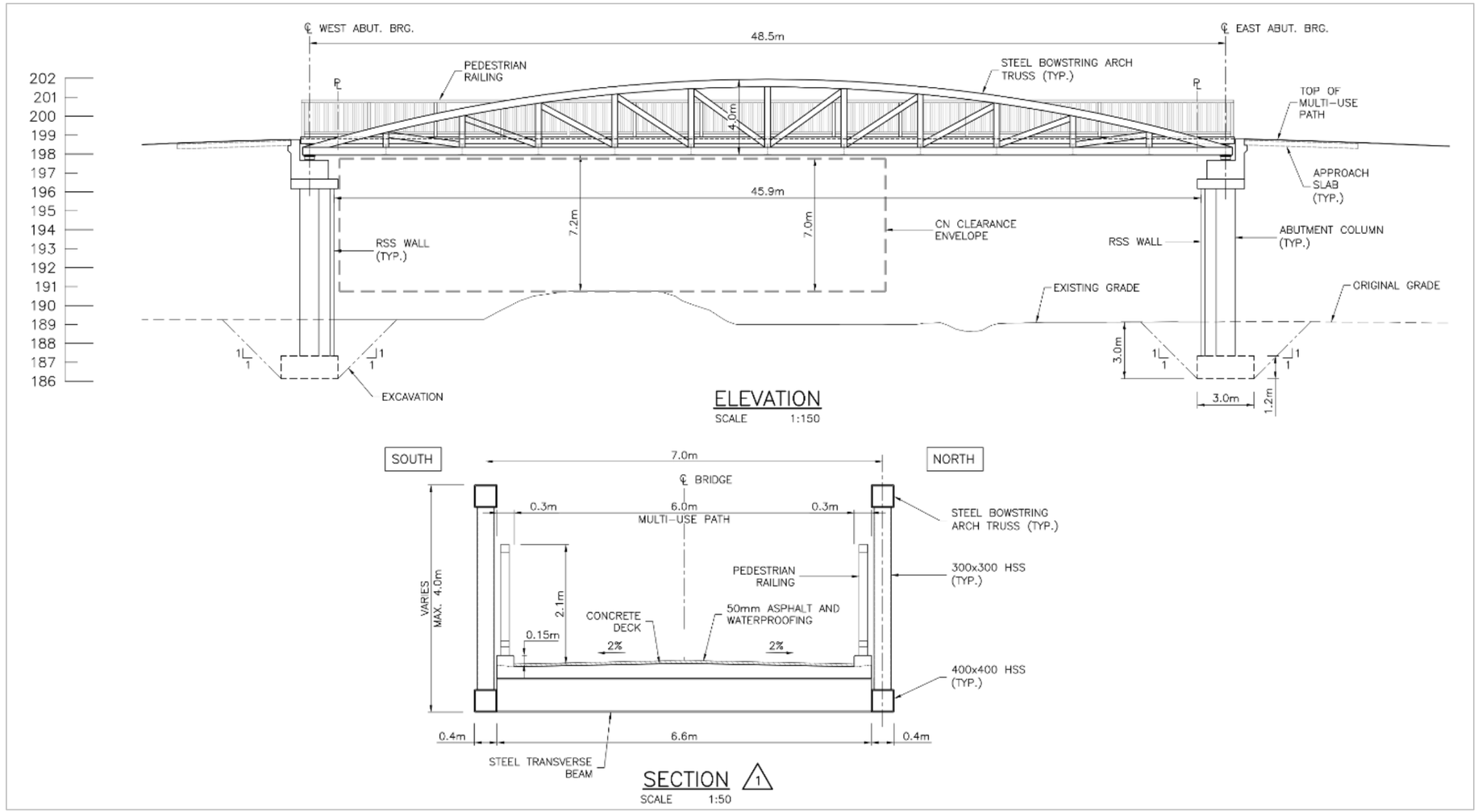


Figure 4-7: Alternative B1: Girder Bridge with Approach Alternative 1

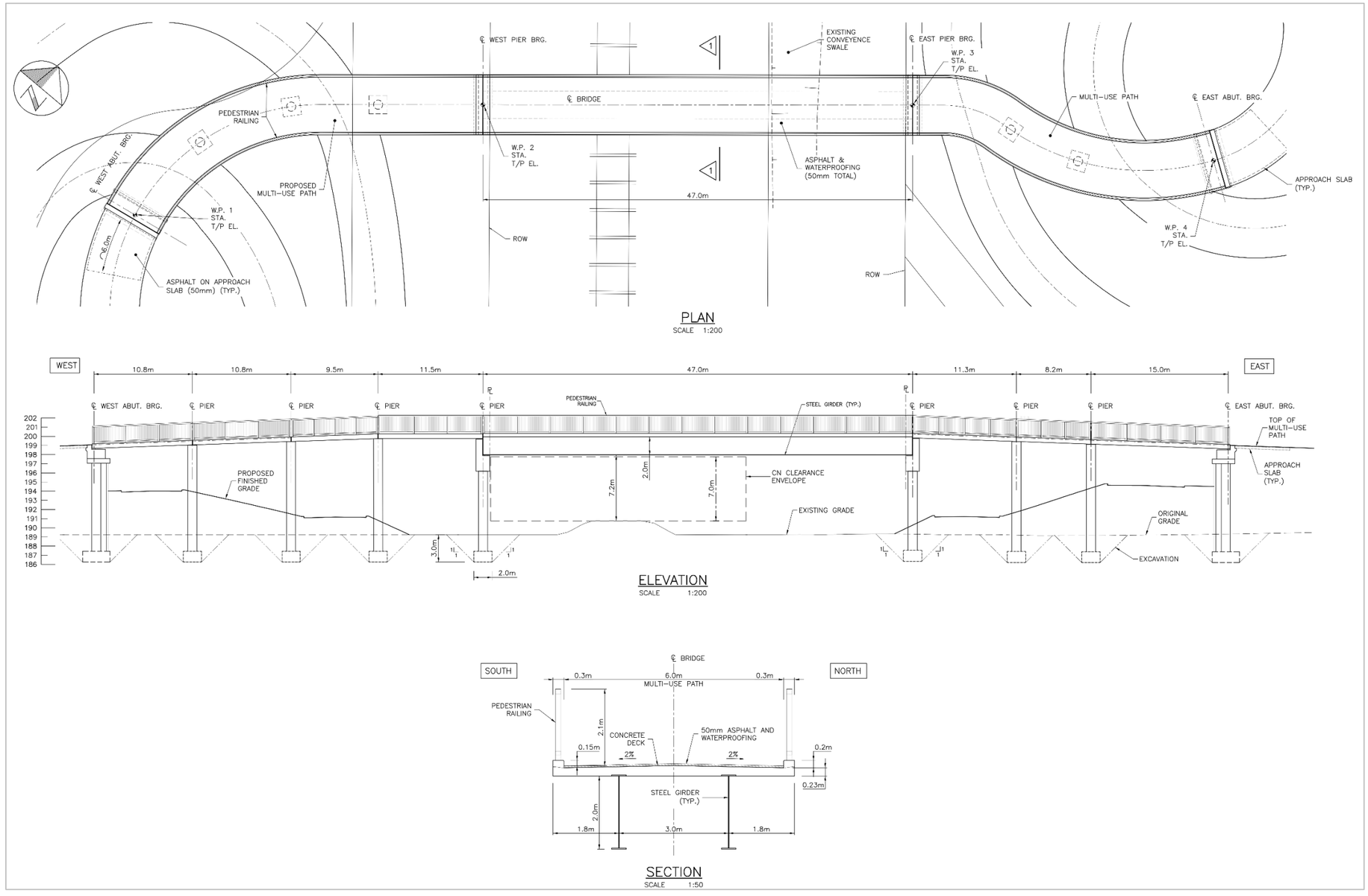


Figure 4-8: Alternative B2: Girder Bridge with Approach Alternative 2, 3 or 4

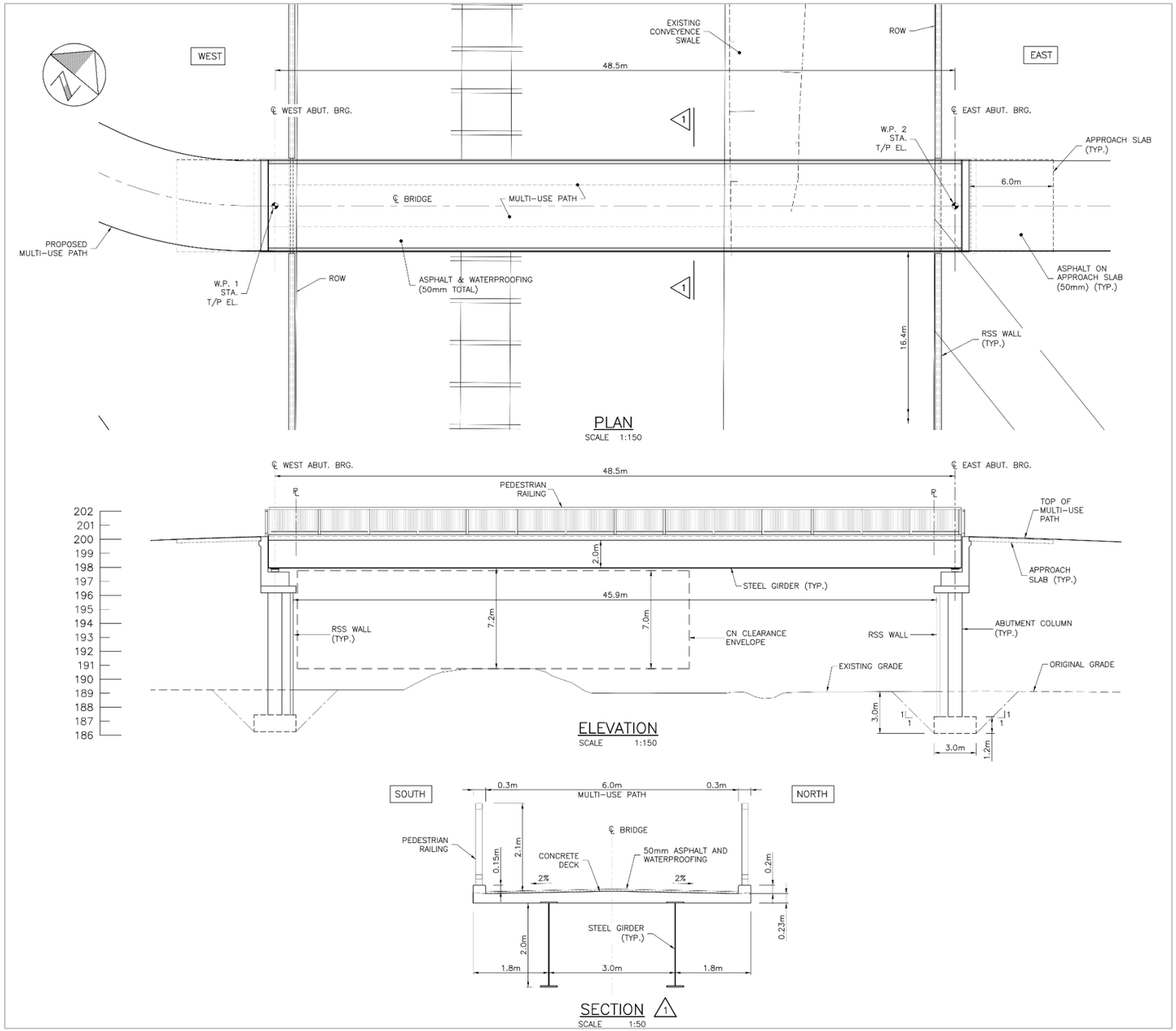


Figure 4-9: Alternative C1: Tied Arch Bridge with Hanger Cables with Approach Alternative 1

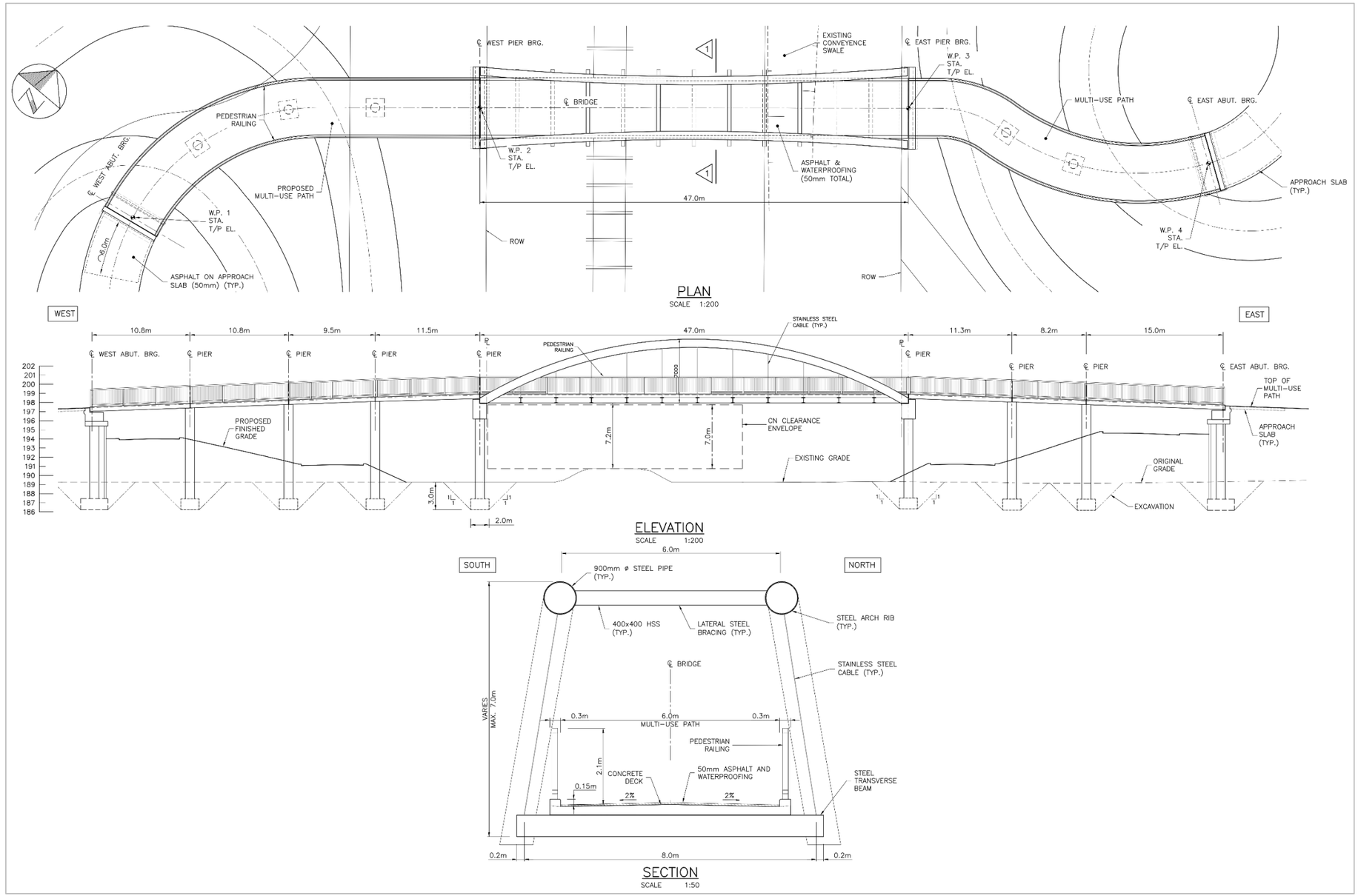


Figure 4-10: Alternative C2: Tied Arch Bridge with Hanger Cables with Approach Alternative 2, 3 or 4

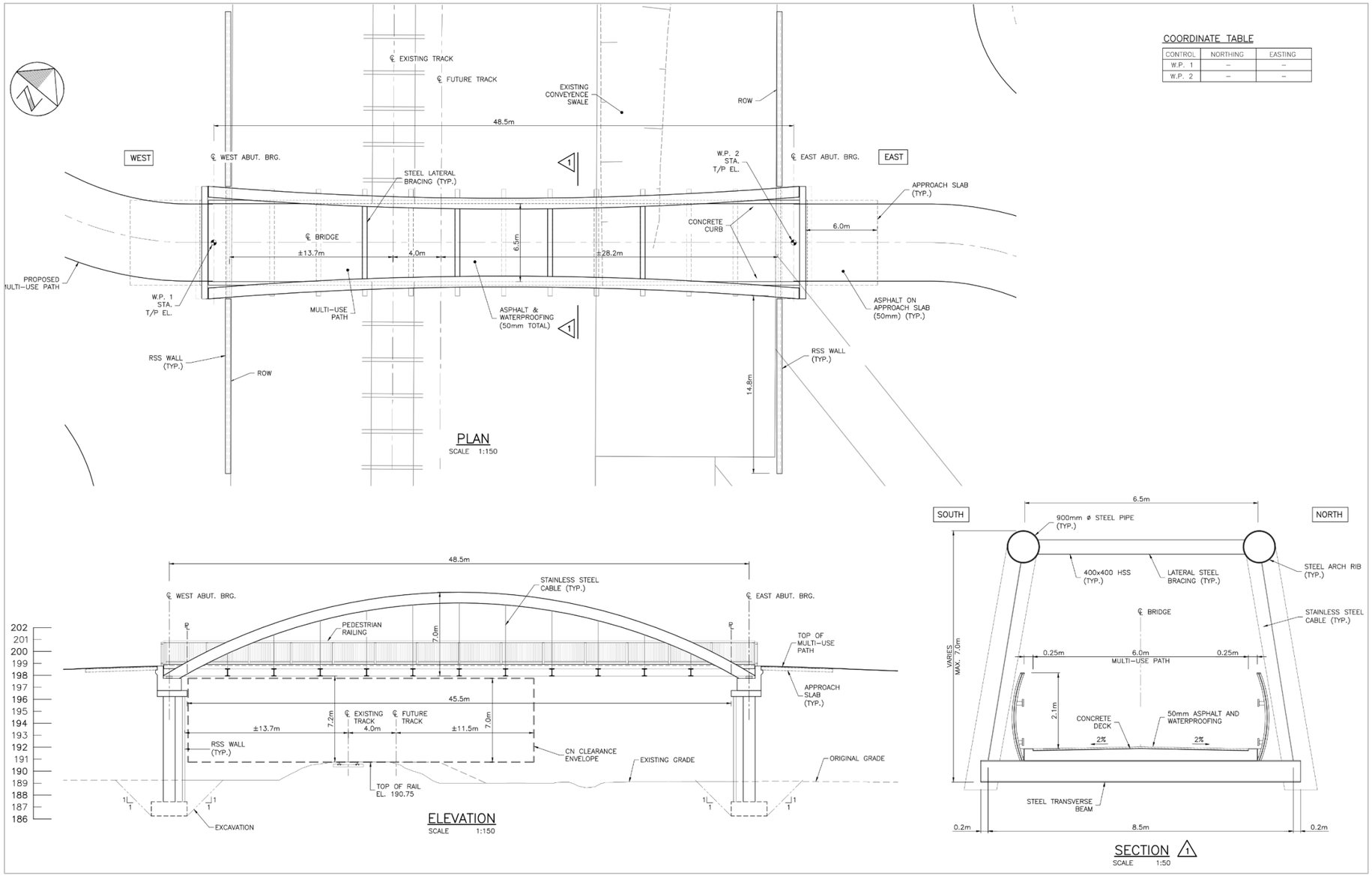


Figure 4-11: Alternative D1: Full Height Arch Bridge with Hanger Cables with Alternative Option 1

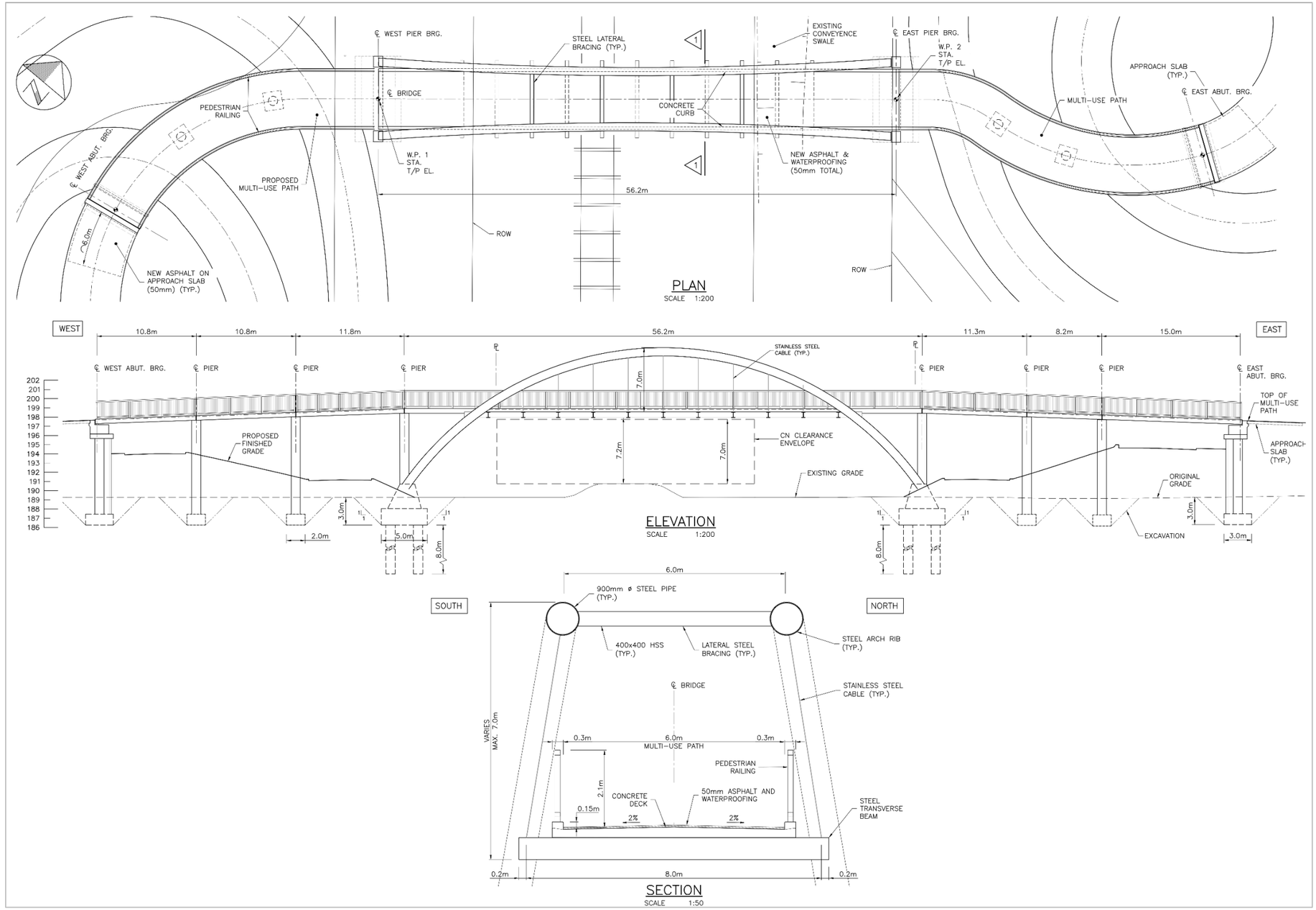


Figure 4-12: Alternative D2: Full Height Arch Bridge with Hanger Cables with Alternative Option 2, 3 or 4

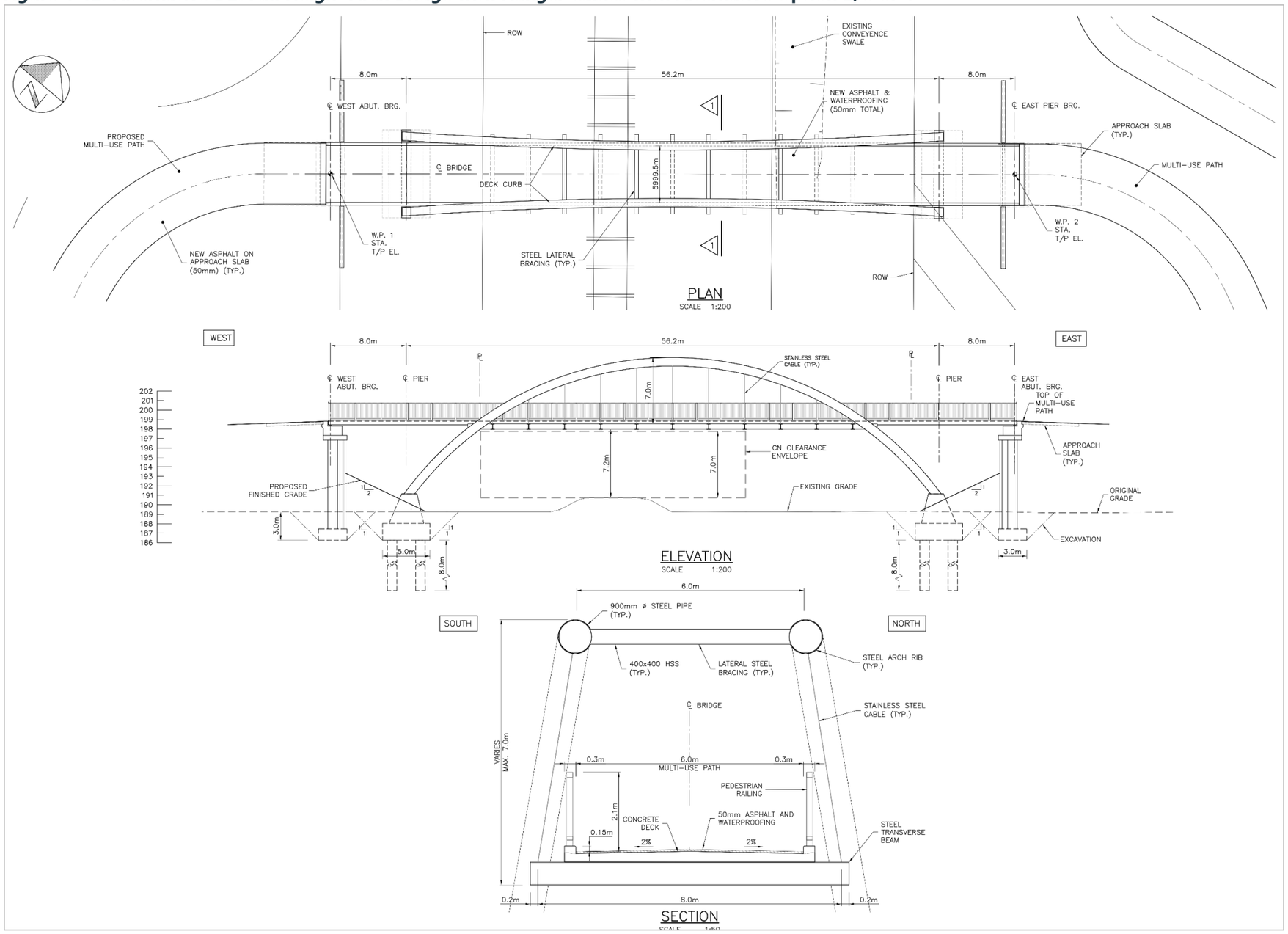


Table 4-1: Evaluation of Design Alternatives for Bridge Approaches

Evaluation Criteria		Alternative 1: Spiral Approach	Alternative 2: "S" Shaped Approach	Alternative 3: Undulating Approach	Alternative 4: Ramp Approach
Planning	Planning Policy	✓ Complies with Boyne Survey Secondary Plan (July 2017).	✓ Complies with Boyne Survey Secondary Plan (July 2017).	✓ Complies with Boyne Survey Secondary Plan (July 2017).	✓ Complies with Boyne Survey Secondary Plan (July 2017).
	Active Transportation Needs	× Although this alternative will provide an Active Transportation link, its configuration impacts the future north-south and east-west walkways on the west.	✓ This alternative addresses Active Transportation needs, and it provides connection to the future north-south and east-west walkways on the west side.	× Although this alternative will provide an Active Transportation link, its configuration impacts the future north-south and east-west walkways on the west.	× Although this alternative will provide an Active Transportation link, its configuration impacts the future north-south and east-west walkways on the west.
Structural Design Requirements	Implications to Number of Structures	× Requires additional structures for trail over trail separation.	✓ No additional structures needed.	✓ No additional structures needed.	✓ No additional structures needed.
Socio-economic Environment	Compatibility with Future Development	× This alternative is not compatible with future development. Its configuration impacts the future development layout on the west.	✓ This alternative is compatible with future development due to its configuration. Its configuration aligns with future development layout on the west. Ramp and bridge can function as a unique landmark in the area, visible from immediate adjacent future development.	× This alternative is not compatible with future development. Its configuration impacts the future development layout on the west.	× This alternative is not compatible with future development. Its configuration impacts the future development layout on the west.
	User Experience through Vista Opportunities	× The location of rest area on the east ramp will not provide views to the Future District Park. × The location of rest area on the west ramp will not provide views to the Niagara Escarpment.	✓ The location of rest area on the east ramp will provide best views to the Future District Park. ✓ The location of rest area on the west ramp will provide best views to the Niagara Escarpment.	× The location of rest area on the east ramp will not provide views to the Future District Park. × The location of rest area on the west ramp will not provide views to the Niagara Escarpment.	× The location of rest area on the east ramp will not provide views to the Future District Park. ✓ The location of rest area on the west ramp will provide best views to the Niagara Escarpment.
	Property Taking	✓ Comparatively lower property taking impact.	✓ Comparatively lowest property taking impact.	× Comparatively higher property taking impact.	× Comparatively highest property taking impact.

Table 4-1: Evaluation of Design Alternatives for Bridge Approaches

Evaluation Criteria		Alternative 1: Spiral Approach	Alternative 2: "S" Shaped Approach	Alternative 3: Undulating Approach	Alternative 4: Ramp Approach
Natural Environment	Wildlife and Wildlife Habitat	× Potential minor impacts to the pond on the east (Isolated Specialized Habitat Unit (BXi)), which is a habitat for green frogs.	✓ No impacts to wildlife and wildlife habitat (Isolated Specialized Habitat Unit (BXi).	✓ No impacts to wildlife and wildlife habitat (Isolated Specialized Habitat Unit (BXi).	✓ No impacts to wildlife and wildlife habitat (Isolated Specialized Habitat Unit (BXi).
	Vegetation	× Comparatively higher loss of vegetation.	✓ Comparatively lowest loss of vegetation.	× Comparatively highest loss of vegetation.	✓ Comparatively lower loss of vegetation.
	Aquatic Habitat	✓ Minor impacts to the 10m buffer around the channel block of the regulated watercourse I-NE-1B-1. This will trigger a permit from Conservation Halton.	✓ No impacts to the channel block of the regulated watercourse I-NE-1B-1, as a result of construction of a retaining wall.	× Likely impacts to the channel block of the regulated watercourse I-NE-1B-1. Conservation Halton would not permit development within channel block. ✓ Can be mitigated through construction of a retaining wall.	× Likely impacts to the channel block of the regulated watercourse I-NE-1B-1. Conservation Halton would not permit development within channel block. ✓ Can be mitigated through construction of a retaining wall.
		It is anticipated that the construction of this project will proceed after watercourse I-NE-1B-2 is realigned by the developer. Per communication with Consultation Halton, a permit would not be required provided that all works for the crossing and approaches (i.e. grading and placement of structure) occur outside of the realigned watercourse I-NE-1B-1. Further, if construction of this project proceeds in advance of the realignment of watercourse I-NE-1B-1, a permit may be required if works are proposed within the limits of the Regulatory Floodplain for the existing watercourse.			
Cultural Environment	Archaeology and Cultural Heritage	✓ No impacts to archaeology and designated built heritage resources.	✓ No impacts to archaeology and designated built heritage resources.	✓ No impacts to archaeology and designated built heritage resources.	✓ No impacts to archaeology and designated built heritage resources.
Safety	Safety	× Produces areas where individuals may hide and may not be visible to other users. × Requires users to make sharp turn and provides poor sight distances for higher speed bicycles.	✓ Wider turns/switchbacks make it easier and safer to navigate by bicycle and mobility devices.	× Indirect approach and tightness on the turns on the west side.	× Longer uninterrupted tangents could result in higher speeds descending the ramp, with associated safety issues.

Table 4-1: Evaluation of Design Alternatives for Bridge Approaches

Evaluation Criteria		Alternative 1: Spiral Approach	Alternative 2: "S" Shaped Approach	Alternative 3: Undulating Approach	Alternative 4: Ramp Approach
Cost	Construction Cost	× $2,370,000 (Plus structure premium (see the table below)). × Comparatively higher construction cost.	✓ $2,341,000 (Plus structure premium (see the table below)). ✓ Comparatively lowest construction cost.	× $2,566,000 (Plus structure premium (see the table below)). × Comparatively highest construction cost.	× $2,566,000 (Plus structure premium (see the table below)). × Comparatively highest construction cost.
	Maintenance Cost	× Higher maintenance cost than Alternatives 2, 3 and 4, due to additional structures.	✓ Similar to Alternative 3 and 4.	✓ Similar to Alternatives 2 and 4.	✓ Similar to Alternatives 2 and 3.
Summary		**Not Preferred**	**Preferred**	**Not Preferred**	**Not Preferred**

Table 4-2: Evaluation of Design Alternatives for Bridge Structure

Evaluation Criteria		Alternative A1: Bowstring Truss Bridge with Approach Alternative 1	Alternative A2: Bowstring Truss Bridge with Alternative Option 2, 3 or 4	Alternative B1: Girder Bridge with Approach Alternative 1	Alternative B2: Girder Bridge with Approach Alternative 2, 3 or 4	Alternative C1: Tied Arch Bridge with Hanger Cables with Approach Alternative 1	Alternative C2: Tied Arch Bridge with Hanger Cables with Approach Alternative 2, 3 or 4	Alternative D1: Full Height Arch Bridge with Hanger Cables with Approach Alternative 1	Alternative D2: Full Height Arch Bridge with Hanger Cables with Approach Alternative 2, 3 or 4
Aesthetics	Aesthetics	✓ Good aesthetics. Provides positive change to the community. Truss is a light structure with shallow deck. Ends of arch can integrate with landscaped approach.		✗ Neutral aesthetics. Will not provide positive change to the community. Girders are deep and visually imposing. Clearance requirements mean ramp must be higher and therefore ramp is also more visually imposing.		✓ Very good aesthetics. Will provide very positive change to community. Arch combined with thin hanger cables and shallow structure under deck achieve transparency of the structure.		✓ Will provide very positive change to community. Extended deck and low reaching arch compared to Alternative C provide additional transparency to structure.	
Constructability	Complexity of Construction	✓ Moderately complex to construct. Approach piers need to be installed before ramps, creating restrictions on staging.	✓ Moderately complex to construct. Trusses need to be lifted into place first over rail track and temporarily supported while remaining deck steel is installed.	✓ Easy to construct. Note that approach piers need to be installed before ramps, creating restrictions on staging.	✓ Easy to construct. Girders can be lifted easily into place over rail track.	✓ Moderately complex to construct. Approach piers need to be installed before ramps, creating restrictions on staging.	✓ Moderately complex to construct. Arches, cables and tie members can be connected before lifting into place, and temporarily supported while remaining deck steel is installed.	✗ Very complex to construct. Approach piers need to be installed before ramps, creating restrictions on staging.	✗ Very complex to construct. Full height arches would need to be installed in two stages, adding extra complexity compared to tied arch option.

Table 4-2: Evaluation of Design Alternatives for Bridge Structure

Evaluation Criteria		Alternative A1: Bowstring Truss Bridge with Approach Alternative 1	Alternative A2: Bowstring Truss Bridge with Alternative Option 2, 3 or 4	Alternative B1: Girder Bridge with Approach Alternative 1	Alternative B2: Girder Bridge with Approach Alternative 2, 3 or 4	Alternative C1: Tied Arch Bridge with Hanger Cables with Approach Alternative 1	Alternative C2: Tied Arch Bridge with Hanger Cables with Approach Alternative 2, 3 or 4	Alternative D1: Full Height Arch Bridge with Hanger Cables with Approach Alternative 1	Alternative D2: Full Height Arch Bridge with Hanger Cables with Approach Alternative 2, 3 or 4
Constructability	Impact on Rail Corridor	× Steelwork and then work protection platform would be lifted into place at times in between trains running (estimated to be gaps of 1-2 hours). After this work can be carried out while trains run underneath. However, because trusses need to be temporarily supported after they are lifted into place, work may take longer and there is possibility that the two work blocks for the trusses would need to be extended, leading to rescheduling of trains.		✓ Steelwork and then work protection platform would be lifted into place at times in between trains running (estimated to be gaps of 1-2 hours). After this work can be carried out while trains run underneath.		× Steelwork and then work protection platform would be lifted into place at times in between trains running (estimated to be gaps of 1-2 hours). After this work can be carried out while trains run underneath. However, because arches need to be temporarily supported after they are lifted into place, work may take longer and there is possibility that the two work blocks for the arches would need to be extended, leading to rescheduling of trains.		× Steelwork and then work protection platform would be lifted into place at times in between trains running (estimated to be gaps of 1-2 hours). After this work can be carried out while trains run underneath. However, because arches need to be temporarily supported after they are lifted into place, work may take longer and there is possibility that the two work blocks for the arches would need to be extended, leading to rescheduling of trains.	
Cost	Construction	× $2,270,000 × Comparatively higher construction cost.	✓ $1,450,000 ✓ Comparatively lower construction cost.	× $2,140,000 × Comparatively higher construction cost.	✓ $1,320,000 ✓ Comparatively lowest construction cost.	× $2,470,000 × Comparatively higher construction cost.	✓ $1,650,000 ✓ Comparatively lower construction cost.	× $2,940,000 × Comparatively highest construction cost.	× $2,290,000 × Comparatively higher construction cost.

Table 4-2: Evaluation of Design Alternatives for Bridge Structure

Evaluation Criteria		Alternative A1: Bowstring Truss Bridge with Approach Alternative 1	Alternative A2: Bowstring Truss Bridge with Alternative Option 2, 3 or 4	Alternative B1: Girder Bridge with Approach Alternative 1	Alternative B2: Girder Bridge with Approach Alternative 2, 3 or 4	Alternative C1: Tied Arch Bridge with Hanger Cables with Approach Alternative 1	Alternative C2: Tied Arch Bridge with Hanger Cables with Approach Alternative 2, 3 or 4	Alternative D1: Full Height Arch Bridge with Hanger Cables with Approach Alternative 1	Alternative D2: Full Height Arch Bridge with Hanger Cables with Approach Alternative 2, 3 or 4
Cost	Maintenance	× Raised concrete approaches will create additional maintenance costs. The additional structure will require rehabilitation after roughly 50 years and the cost will be in the order of half the initial construction cost	✓ Truss members are exposed to de-icing salts so may need recoating after 50 years.	× Raised concrete approaches will create additional maintenance costs. The additional structure will require rehabilitation after roughly 50 years and the cost will be in the order of half the initial construction cost	✓ Structural members are not exposed to de-icing salts, so re-coating limited to ends near expansion joints.	× Raised concrete approaches will create additional maintenance costs. The additional structure will require rehabilitation after roughly 50 years and the cost will be in the order of half the initial construction cost	✓ Arch members are exposed to de-icing salts so may need recoating after 50 years.	× Raised concrete approaches will create additional maintenance costs. The additional structure will require rehabilitation after roughly 50 years and the cost will be in the order of half the initial construction cost	✓ Arch members are exposed to de-icing salts so may need recoating after 50 years.
Safety	Safety	✓ Railing and lighting can be extended on approaches	✓ Climb-proof guard system and lighting can be easily installed on bridge.	✓ Railing and lighting can be extended on approaches.	✓ Climb-proof guard system and lighting can be easily installed on bridge.	✓ Railing and lighting can be extended on approaches.	✓ Climb-proof guard system and lighting can be easily installed on bridge.	✓ Railing and lighting can be extended on approaches.	✓ Climb-proof guard system and lighting can be easily installed on bridge.
Summary		**Not Preferred**	**Preferred**	**Not Preferred**	**Preferred**	**Not Preferred**	**Preferred**	**Not Preferred**	**Not Preferred**

5.0 Preliminary Preferred Design

The Alternative Design Concepts for Bridge Approaches and Bridge Structure were evaluated in **Table 4-1** and **Table 4-2**, respectively, to identify the Preliminary Preferred Design.

5.1 Preliminary Preferred Design for Bridge Approaches

Alternative 2: "S" Shaped Approach was identified as the Preferred Design for Bridge Approaches due to a number of advantages compared to the other alternatives. A summary of the key benefits of Alternative 2 is provided below:

- This alternative will address Active Transportation needs, and it provides connection to the future north-south and east-west walkways on the west side.
- This alternative is compatible with future development due to its configuration. Its configuration aligns with future development layout on the west. Ramp and bridge can function as a unique landmark in the area, visible from immediately adjacent future development.
- The location of rest areas on the east ramp and the west ramp will provide best views to the Future District Park (to the east) and Niagara Escarpment (to the northwest).
- This alternative will require lowest amount of property taking.
- This alternative will require lowest amount of vegetation removal.
- There are no impacts anticipated to the channel block of the regulated watercourse I-NE-1B-1, as a result of construction of a retaining wall.
- This alternative has the lowest construction cost, compared to the other alternatives.

Preliminary Preferred Design for Bridge Approaches is illustrated in **Figure 5-1**. It is important to note that the ultimate location of the western terminus of the west ramp will be determined during detailed design in coordination with adjacent subdivision design. In addition, minimum of 3.0 m buffers between the edge of walkway blocks and bottom of slopes to be provided by the future development to intercept drainage coming down from the slope prior to forming into sheet flow across the walkways. Slope areas may be subject to change if configuration of west approach is changed during detailed design.

5.2 Preliminary Preferred Design for Bridge Structure

Although, Bridge Structure Alternatives A2, B2 and C2 were identified as the preferred alternatives for the bridge structure, Alternative C2: Tied Arch Bridge with Hanger Cables was carried forward as the Preferred Design Concept for Bridge Structure due to a number of advantages compared to the other alternatives as outlined below:

- This bridge structure will provide very good aesthetics and very positive change to the future community. Arch combined with thin hanger cables and shallow structure under deck achieve transparency of the structure.
- It has a lower construction cost, compared to the other Bridge Structure Alternatives.
- Climb-proof guard system and lighting can be easily installed to provide safety.

Preliminary Preferred Design for Bridge Structure is illustrated in **Figure 5-2**.

Figure 5-1: Preliminary Preferred Design for Bridge Approach - "S" Shaped Approach

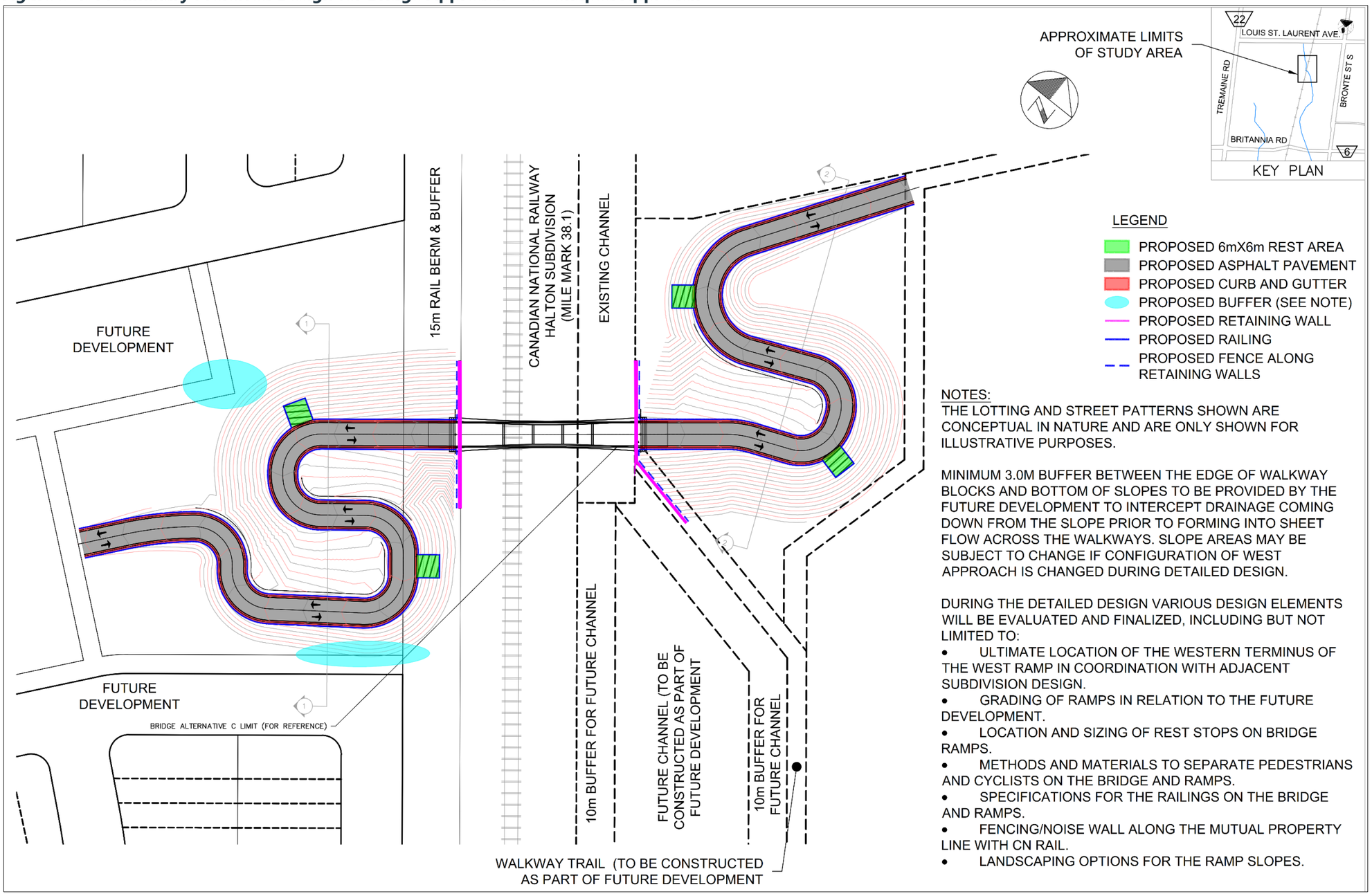


Figure 5-2: Preliminary Preferred Design for Bridge Structure - Tied Arch Bridge with Hanger Cables

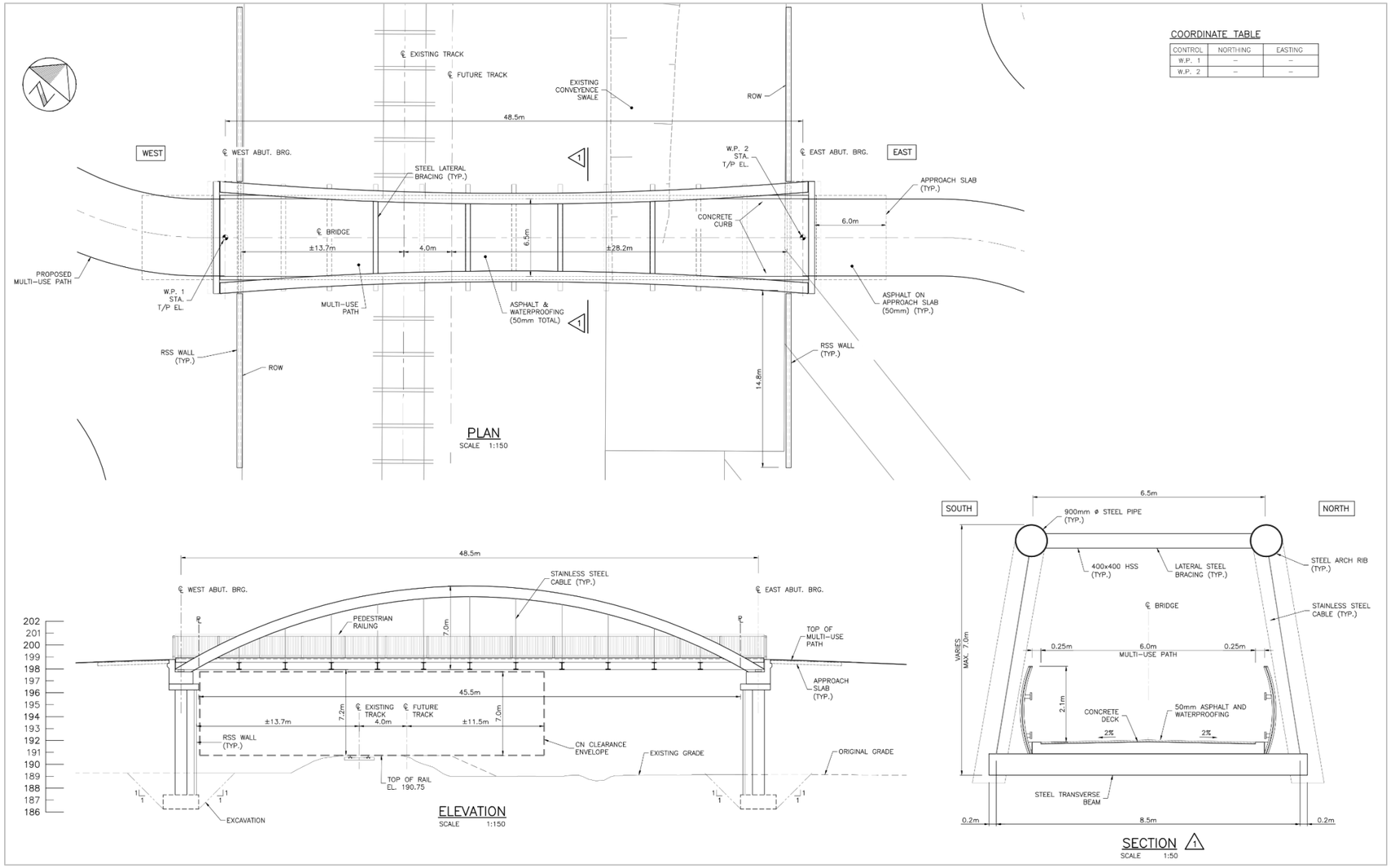


Figure 5-3: Preliminary Preferred Design – Conceptual Rendering 1

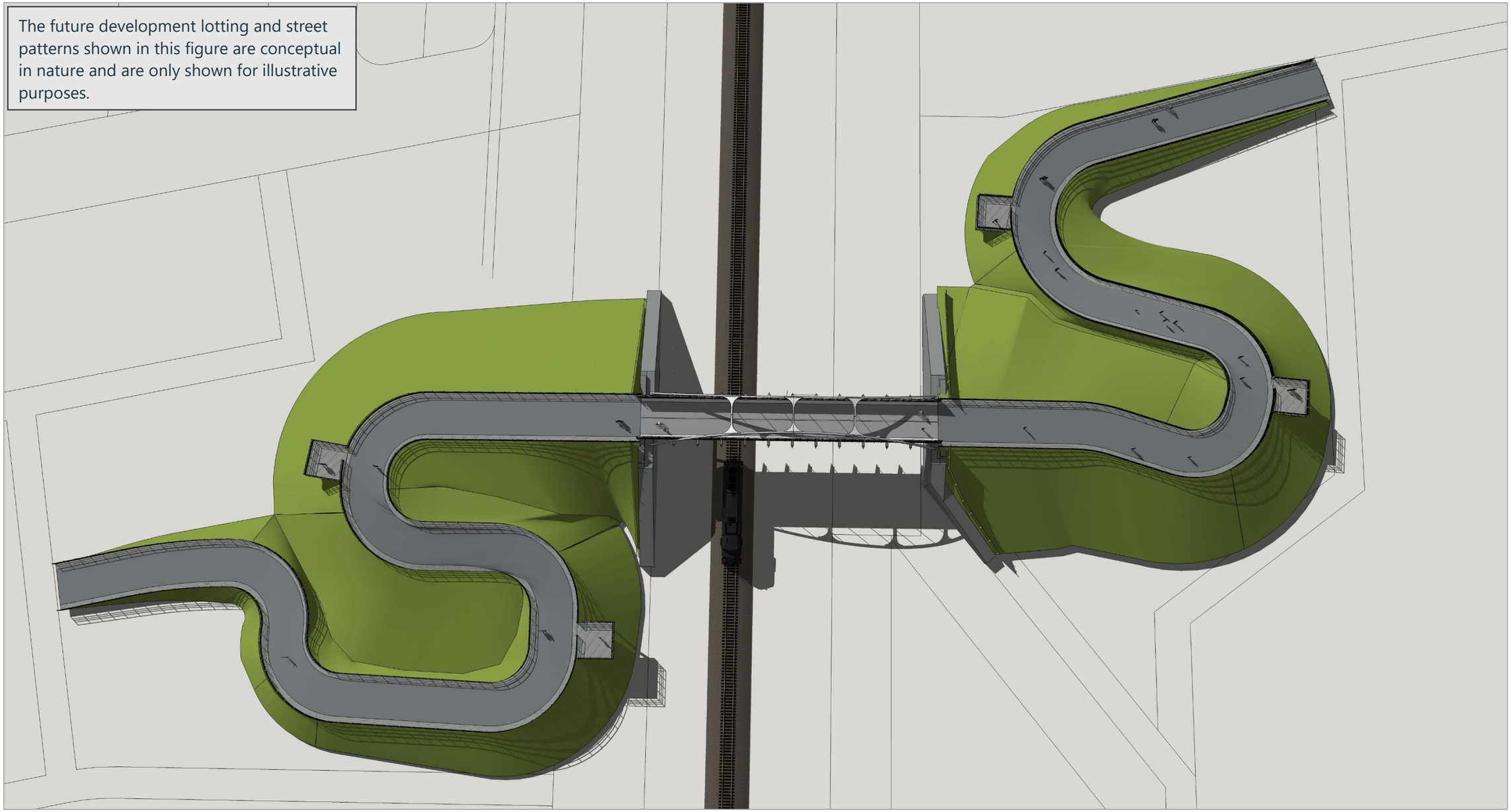


Figure 5-4: Preliminary Preferred Design – Conceptual Rendering 2 (Looking from north-east to south-west)

The future development lotting and street patterns shown in this figure are conceptual in nature and are only shown for illustrative purposes.

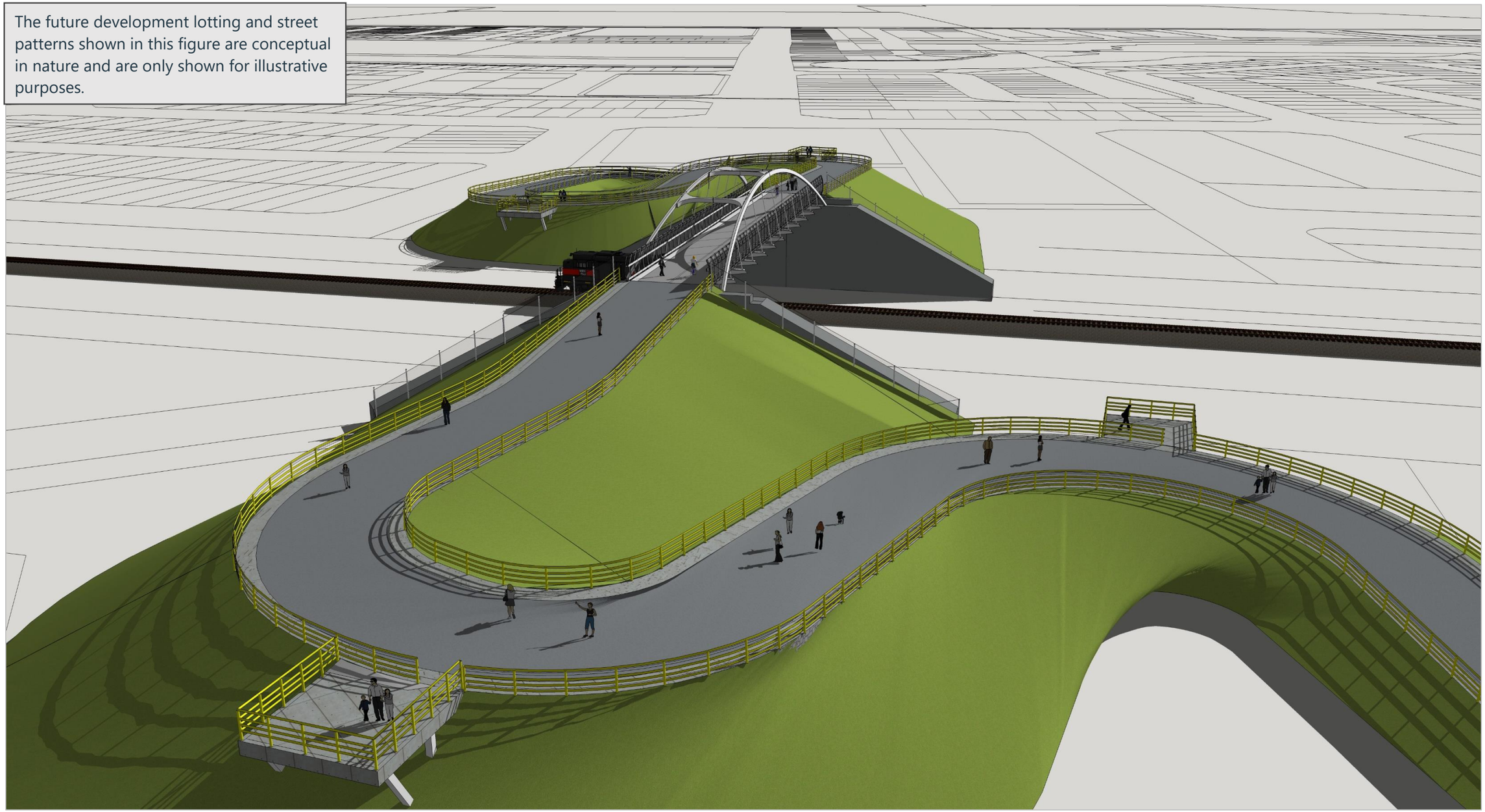
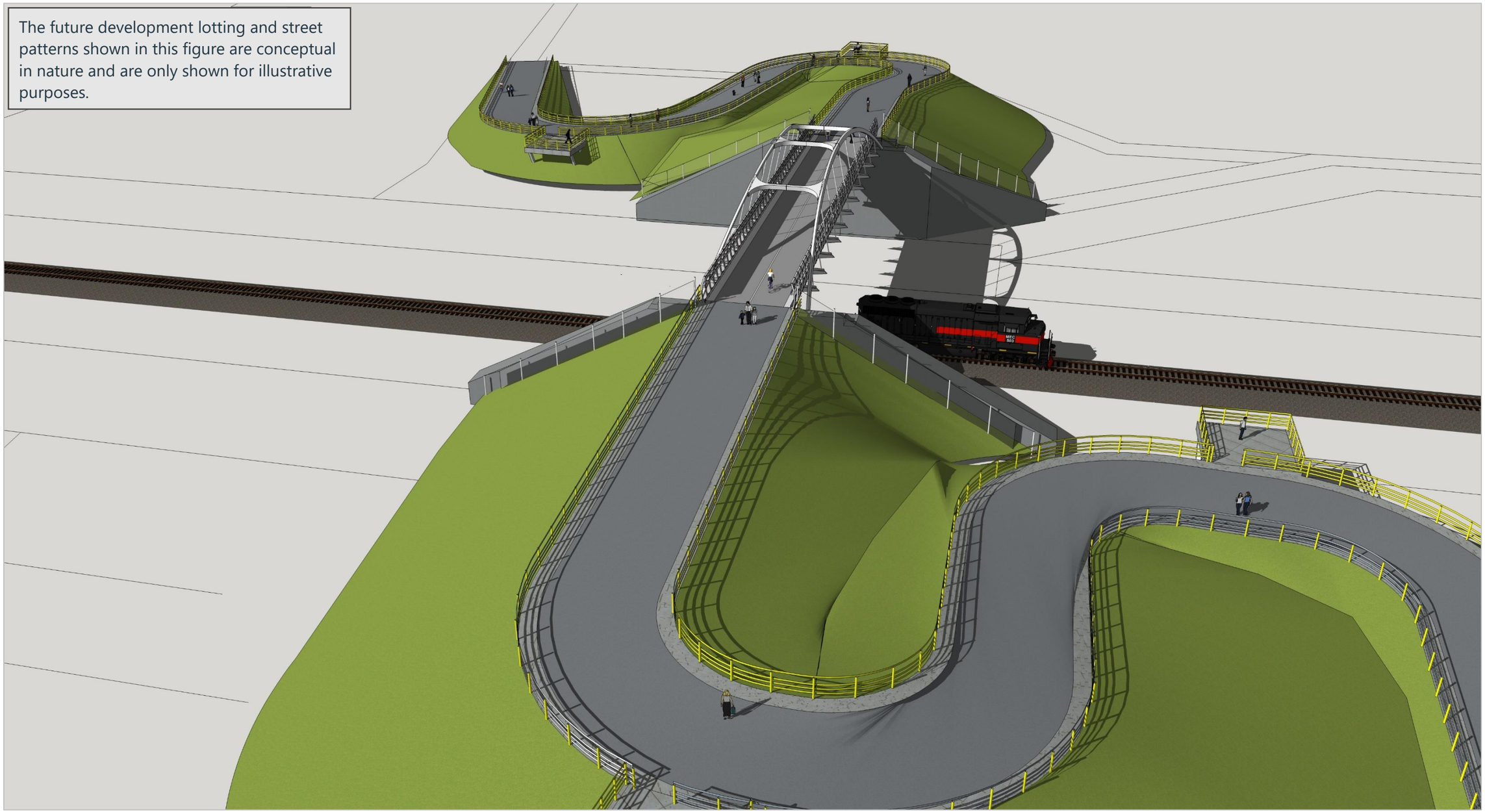


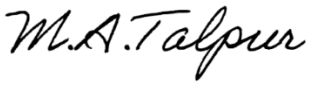
Figure 5-5: Preliminary Preferred Design – Conceptual Rendering 3 (Looking from south-west to north-east)



Sincerely,

Wood Environment & Infrastructure Solutions
a Division of Wood Canada Limited

Prepared by:



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