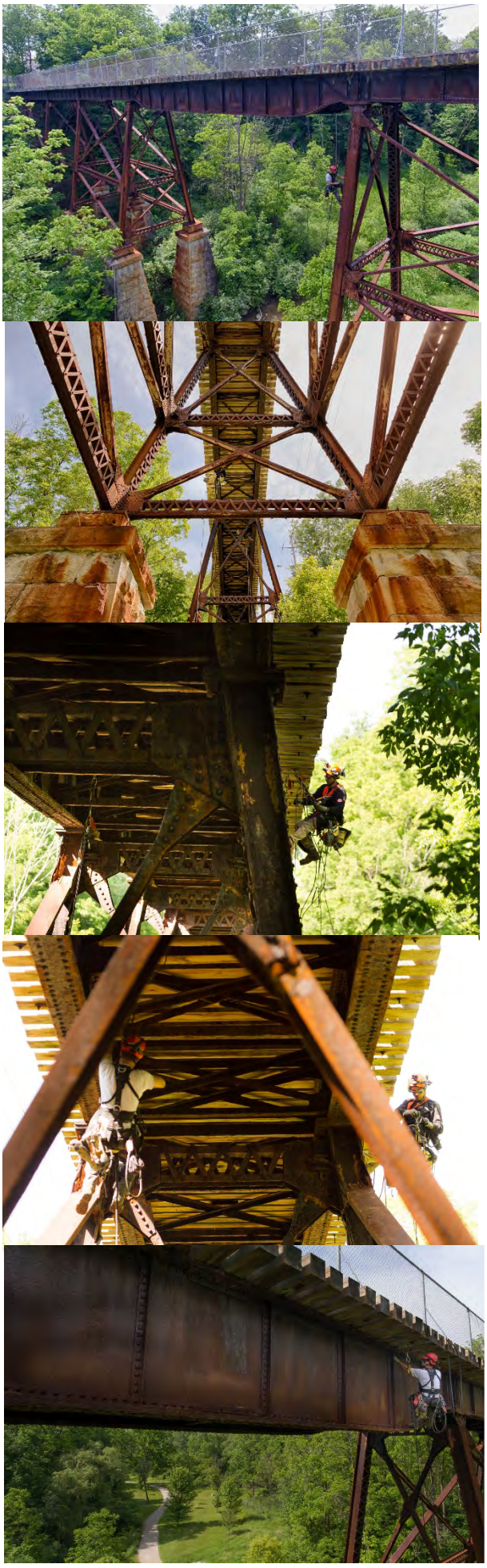

vallee

Consulting Engineers,
Architects & Planners

KINSMEN PEDESTRIAN BRIDGE

EVALUATION REPORT

ENHANCED OSIM INSPECTION, LOAD LIMIT ANALYSIS, & OPTIONS EVALUATION

FOR
THE CORPORATION OF
THE TOWN OF TILLSONBURG

September 2019

Tillsonburg

CONNECTED. ENRICHED. INSPIRED.

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SYNOPSIS

This report contains three distinct sections:

1. an ***Enhanced OSIM Inspection Report*** which was the basis to determine the condition of the bridge and provide data for;
2. a ***Load Limit Analysis Report***, which outlines the load carrying capacity of the bridge based on the calculation methods prescribed in the Canadian Highway Bridge Design Code; and
3. an ***Options Evaluation Report*** which discusses options and costs for the bridge considering the result of the Enhanced OSIM Inspection Report and the Load Limit Analysis Report.

The Town of Tillsonburg has requested G. Douglas Vallee Limited to prepare an Enhanced OSIM Inspection Report for the Kinsmen Pedestrian Bridge. The enhanced OSIM inspection is required by provincial law (O.Reg. 472/10 Standards for Bridges) which requires that inspections be done in accordance with the Ontario Structure Inspection Manual.

The Ontario Structure Inspection Manual (OSIM) further clarifies:

"…Enhanced OSIM inspections should typically be done for structures that are over 30 years old with critical components in poor condition (see note below). The frequency of the Enhanced OSIM inspection can be between one to six years depending on the structure conditions."

The enhanced inspection was also required to determine the condition and measured state of deterioration for the steel members in order to prepare a Load Limit Analysis Report. The Load Limit Analysis was performed in accordance with the requirements of the Canadian Highway Bridge Design Code as required by provincial law (O.Reg. 472/10 Standards for Bridges).

The following is a summary of the key overall points of this full report:

- The Enhanced OSIM Inspection revealed advanced deterioration in lighter gauge steel members and connections, and the factors of safety for some elements have been significantly reduced by deterioration.
    - Longitudinal wood deck planks should be addressed to improve slip resistance.
- The Load Limit Analysis found that the bridge is stable but has some deficiencies.
    - Pedestrian fence barrier does not meet code requirements for lateral load.
- The structure is at a critical decision point. The Options Evaluation recommends that a rehabilitation with be initiated in less than 5 years OR a high level pedestrian replacement bridge be considered.
    - If a high level replacement option is chosen, plans should be undertaken to do so in less than 10 years.
    - If the project is staged the supporting steel structure rehabilitation work must be completed in less than 10 years.

SECTION 1.0

ENHANCED OSIM INSPECTION REPORT

1.0 ENHANCED OSIM INSPECTION REPORT

1.1 INTRODUCTION

At the request of the Town of Tillsonburg, G. Douglas Vallee Limited performed an enhanced OSIM inspection of the Kinsmen Pedestrian Bridge (Structure No. BR_KINS0001) in late June 2019.

Where access to a structure is limited, it is necessary to utilize special equipment to get within arm's-length of all areas of structure elements; inspections of this nature are called enhanced OSIM inspections. The frequency of enhanced OSIM inspections should be a maximum of six (6) years for structures that:

- are over 30 years old; and
- contain critical elements and components in poor condition.

Previous biennial OSIM inspections have been limited visual inspections only, and have not included detailed inspections within arm's-length of all bridge components. The structure has significant access limitations due to the size and height of the structural steel frame. In order to complete the enhanced OSIM inspection, rope access methods and a drone-mounted camera were employed in conjunction with standard inspection methods to complete the assignment.

The actual date of construction is not known, however it is estimated to have been built circa 1910. The former railway bridge is a nine (9) span steel trestle frame structure that was later converted for pedestrian use following the demise of the railway. This bridge has become an important pedestrian link for the downtown core.

The Town does not have drawings or records of the structure from the railway. The level of maintenance and repair for the structure is unknown, however it was kept in safe operational condition for the better part of the century. Currently, it is our observation that there is a significant amount of accumulated deterioration that has progressed over the years.

The structure itself consists of:

- Chain-link fence barriers and wood plank wearing surface, connected to
- Pressure-treated heavy timber deck ties (new in 2010), resting on
- Heavy steel girders, spanning from pier to pier, supported by
- Built-up steel column pier frames, founded on
- Concrete block and cast-in-place concrete abutments and pier foundations.

This report provides a summary of the observations of the Enhanced OSIM Inspection. The technical enhanced OSIM report can be found in Appendix A. Also appended to this report is a schematic drawing of the Kinsmen Pedestrian Bridge that depicts key plan and observed deterioration in the bridge which were noted during the investigation. This drawing is used to reference the location of elements and should be viewed in combination with this written report.

1.2 STRUCTURAL INSPECTION

1.2.1 General

A thorough three (3) day inspection of the structure was carried out on June 18, 20, and 21, 2019. Inspections were halted on June 19 due to rain. The Enhanced OSIM Inspection team consisted of the following personnel:

- A. Ryan Elliott, P.Eng., BDS: Project Manager
- Michael J. Rapai, P,Eng.: Project Engineer
- Jason Timmermans, B.Eng., EIT: Inspector
- Johnathan McMorrow, B.A.Sc., EIT: Inspector
- Jamie Smith, B.Eng., M.Sc., EIT: Drone Pilot
- RAM Inspections (Rope Access) – 3 certified rope access technicians

The technicians from RAM were briefed on the scope of work and were directed by our inspectors on a full-time basis for the duration of the inspection. Our team was provided with live video from cameras equipped on RAM technicians inspecting the structure. Our inspectors provided real-time instructions to the RAM technicians on a point-by-point basis to complete a thorough and detailed inspection. In accordance with enhanced OSIM inspection requirements, the steel sections were cleaned with a wire-brush and caliper measured to determine corrosion section loss in selected areas. Wood ties were tapped with a hammer to test for soundness, and all areas of concrete were tested for soundness with the use of a hammer and a Delam 2000 tool. All relevant photos have been published for context, and additional photos and videos were provided for Town records.

The results of the Enhanced OSIM Inspection are summarized as follows:

1.2.2 Concrete Block Abutments, Concrete Block Pier Bases & Pier Caps

The structure is a nine (9) span bridge supported by two (2) abutments (one at each end) and a series of eight (8) piers along the length of the bridge.

There are no records that indicate the abutments or piers have undergone a rehabilitation since it was constructed. Based on our observations, the abutments are constructed with pre-cast concrete blocks. It is unknown if the block piers are resting on a concrete foundation or a pile cap.

As part of the ground inspection, nondestructive delamination testing of the concrete block abutments and piers was completed using a hammer and a Delam 2000 concrete sounding tool.

During the inspection, minor cracking and delamination of the abutment walls was noted. Deterioration of the mortar was also evident during the inspection; an average of approximately 30% mortar loss in the joints was noted.

Our observations indicate approximately 60% of the abutments are in good condition, 30% are in fair condition, with 10% in poor condition. Maintenance to repair mortar joints for the abutment walls is recommended to be completed within 2 years.

Piers 'B' through 'I' were inspected during the Enhanced OSIM Inspection *(refer to the Kinsmen Pedestrian Bridge drawing appended to report for element locations).* The pier bases are constructed with concrete blocks similar to the abutment construction. The pier bases also display similar deficiencies to the abutments. Small areas of minor delamination and mortar loss were evident throughout all piers. The majority of piers have mortar loss ranging from 15% - 50%, with the North C pier having 50% mortar loss. A minority of piers (ie: North B, South B, North F, and South I) are estimated to have less than 15% mortar loss. Overall, the pier conditions are summarized as 63% good condition, 31% fair condition, and 6% poor condition. Maintenance to reinstate the mortar joints of the pier walls is recommended to be completed within 2 years.

The pier caps are concrete block pedestals located at the foot of each steel column, at the top of the block piers. Narrow to medium cracking with small areas of surface delamination are typical throughout the pier caps. Steel strapping around pier caps have moderate to severe corrosion, with a wide range of 10% - 60% section loss in localized areas. Three (3) pier caps were noted to have large cracks that spanned in the east to west direction. The piers that were observed to have large cracking are the South F, North I, and South I piers. The North I pier was also observed to be missing the steel strapping around the top of the pier cap. The pier caps are summarized as 56% good condition, 25% fair condition, and 19% poor condition. It is recommended that the concrete pier caps be rehabilitated in 1-5 years. The steel strapping around the North I pier cap is recommended to be replaced as soon as possible to prevent further deterioration of the pier cap.

1.2.3 Steel Columns

The columns are comprised of two (2) steel channels, one (1) steel plate on the exterior side, and steel braces on the interior. The steel columns are located at each pier and supported by each pier cap. The columns were observed to have a wide range of light to severe corrosion, flaking, and delamination. The steel laces on the interior side of the columns were noted to be severely corroded with localized areas of failed laces on the north side of Column I. During the inspection, one of the laces broke off the column when being inspected by hand. The columns were found to be 69% in fair condition and 31% in poor condition. The columns are recommended to be rehabilitated in 1-5 years.

1.2.4 Bearing Seats and Pads

There are two (2) bearings at each abutment and two (2) at each pier. In 2010, the timber bearing seats at each abutment were replaced with two (2) 6''x10'' timber members. The bearings at each pier are steel plates. All bearings inspected were observed to have light to severe corrosion. Each bearing pad was also noted to have delamination with flaking of the delaminated steel. Considering all bearings, 95% were found to be in fair condition, and 5% in poor condition. The bearings at the abutments and at the top of the steel pier columns are recommended for rehabilitation in 1-5 years.

1.2.5 Deck Girders and Diaphragms

The deck girders are arranged in two rows along the length of the bridge, with diaphragm cross-braces throughout to maintain alignment and stability. There are eighteen (18) steel girders over

the nine (9) spans that run the length of the structure. These are the main structural girders that carry the deck load to the piers and abutments. The condition of each girder appears to be consistent throughout the span of the bridge with some localized areas of deficiencies. Light to severe corrosion, flaking of delaminated steel, and heavily deteriorated rivet connections are evident throughout the girders.

Each steel beam includes flange tension stiffeners at the mid-span, vertical web stiffener angles spaced evenly between the bearings, and steel rivet connections. Flange tension stiffener plates are located on the top and bottom of the girder flanges. In general, the plates are delaminated with 10%-15% section loss in localized areas. Surface delamination was noted on the exterior face of the web of the south girder between spans E and F. Significant deterioration of the vertical stiffener angle on the interior side of the north girder between spans B and C was also noted. Overall, there was approximately 10%-15% section loss throughout girder flanges, web, and rivets. Overall, the girders were observed to be in 80% fair condition and 20% poor condition. The girders are recommended to be rehabilitated in 1-5 years.

The diaphragm cross-braces, including the horizontal and diagonal components, are generally in fair to poor condition. Like most of the steel components on the bridge, the deficiencies include severe corrosion with flaking of delaminated steel causing section loss. The horizontal components observed 10% - 25% section loss while the diagonal components were observed to have 10% - 20% section loss. The horizontal components are 60% fair condition and 40% poor condition with the diagonal components being 70% fair condition and 30% poor condition. The diaphragms are recommended to be replaced in 1-5 years. As a general observation, it was noted that smaller steel sections were in poorer condition than larger and thicker steel sections.

1.2.6 Wood Deck Ties

Removal and replacement of the former wood railway ties (wood deck ties) was completed in 2010. There were no significant deteriorations to the existing newer wood ties noted during the Enhanced OSIM Inspection. Minor deficiencies such as localized areas of staining with splitting and checking were noted. Overall, the wood deck ties were observed to be 80% good condition and 20% fair condition. There is no recommended work for the wood deck ties.

1.2.7 Non-structural Elements

Visual inspections of non-structural elements took place to ensure the proper functionality of the structure. A complete understanding of the condition of all of the non-structural elements can be found in the Enhanced OSIM Inspection report appended to this document. Below are some elements that are recommended for either rehabilitation or replacement. These elements may be recommended for rehabilitation or replacement as safety precautions, however they did not exhibit signs of significant structural deterioration during the investigation.

1.2.7.1 Bridge Barrier

The current barrier is a steel chain-link fence with barbed wire along the top. The pedestrian barrier has medium surface corrosion and a loose wire at the bottom of the fence. Maintenance is recommended to be completed within one (1) year. Although the current design meets the

geometric requirements of the CHBDC, the barrier does not meet loading CHBDC pedestrian load requirements. This will be discussed in the Load Limit Evaluation under Section 2 of this report.

1.2.7.2 Deck Wearing Surface:

The existing wearing surface is wood plank decking attached to the wood deck ties beneath. The deck wearing surface was observed to be in 75% good condition, 24% fair condition and 1% poor condition. The deterioration noted during the inspection included light to medium weathering and minor checking and splitting. Two boards were also noted to be warped upwards. Maintenance to remove and replace the warped deck boards is recommended. Maintenance of this deck surface will be an ongoing task, given the nature of how it was constructed. This wearing surface was reinstalled following the 2010 wood deck tie replacement project for budgetary reasons. Deck replacement options will be reviewed since the deck surface has been identified as a safety concern due to the slippery conditions in wet weather and winter months. The method of nailing the deck boards directly into the wood tie-beams without an air gap will also cause premature deterioration of the wood deck ties. Alternative deck surface options are considered in the Options Evaluation under Section 3 of this report.

Figure 1 & 2: Existing Barrier and Deck Wearing Surface

1.3 ENHANCED OSIM RECOMMENDATIONS

In order to prevent further deterioration of the original structure, it is the recommendation of this report that a major rehabilitation of the Kinsmen Pedestrian Bridge occur in less than five (5) years. If no rehabilitation work is completed on the structure within this time, then a closure and/or replacement should be considered by the Town of Tillsonburg in less than ten (10) years.

A major rehabilitation to preserve the structure should include (but not necessarily be limited to):

- Abrasive blast cleaning of major structural steel elements, (i.e. girders and columns) and application of protective coating.
- Replacement of severely deteriorated minor members (i.e.: cross braces and diaphragms).
- Replace structural connections throughout the structure as required.
- Reinforcement of existing structural frames.
- Concrete and mortar repairs to piers and abutments.
- Replacement of pedestrian chain link fence barrier.
- Replacement of deck wearing surface.
- Erosion protection of embankments.

The rate of deterioration of the accessible areas of the structure will continue to be monitored through regularly scheduled OSIM inspections. Due to the current condition of the major structural elements, the rehabilitation work is recommended to be completed within five (5) years. Delaying this rehabilitative work beyond this timeframe may incur a level of deterioration that is no longer feasible for repair, resulting in a recommendation for bridge closure.

The primary recommendation, as a result of the Enhanced OSIM Inspection is that the Town of Tillsonburg should begin the necessary planning to:

- **undertake a major rehabilitation of this structure in less than five (5) years, OR**
- **consider planning for the closure of the structure and/or options for replacement within ten (10) years.**

We trust that this report provides the Town of Tillsonburg with an in-depth condition assessment of the Kinsmen Pedestrian Bridge. Please do not hesitate to contact us, should there be any questions or concerns regarding the contents of this report. We thank you for the opportunity to be of service.

SECTION 2.0

LOAD LIMIT ANALYSIS REPORT

2.0 LOAD LIMIT ANALYSIS

2.1 INTRODUCTION

The Kinsmen Pedestrian Bridge, along Veterans Memorial Walkway in the Town of Tillsonburg, is a multi-span steel trestle bridge that was constructed circa 1910. The bridge was built as a high level railway structure, with an overall span length of approximately 106m. After the railway ceased operation, the structure was converted to a pedestrian bridge approximately 20 (+/-) years ago. This structure provides a critical connection to the residential area on the west side of Tillsonburg to the downtown core.

The bridge was previously assessed in an options report dated October 10, 2007 that recommended a steel structure rehabilitation along with full wood removal and a new concrete deck due to severe corrosion and section loss of structural steel members, and decay of the wood deck. New timber deck ties were installed in 2010, however, the existing deck plank wearing surface was reinstalled and no additional rehabilitation work has been performed on the structural steel members.

G. Douglas Vallee Limited (Vallee) was contracted in June 2019 to perform an Enhanced OSIM Inspection and a Load Limit Evaluation on the Kinsmen Pedestrian Bridge. The scope of the Load Limit Evaluation is to review the structure under pedestrian loading, natural loading (ie: snow) and loading anticipated from the usage of a sidewalk snow removal machine. Existing dimensions and section loss used in the evaluation were obtained from the Enhanced OSIM Inspection dated June 2019. A copy of the Enhanced OSIM Inspection has been appended with this report.

2.2 EVALUATION

The Load Limit Evaluation was performed utilizing the Canadian Highway Bridge Design Code (CHBDC), CSA S6-14, and the reference of additional standards which aided in determining geometry and loading of the structural materials which comprise the bridge. The following list summarizes the supplemental documents used to analyze the structure in addition to the CHBDC:

- Handbook of Steel Construction Second Edition CSA Standard S16-1969;
- Handbook of Steel Construction Tenth Edition CSA Standard S16-09;
- Wood Design Manual 2010 CSA Standard O86-09;
- Ontario Building Code (July 1, 2017 update) O. Reg. 332/12.

The load limit analysis is done using the CHBDC, specifically *§14 Evaluation*. The evaluation process includes applying load combinations (ie: transport trucks, etc.) and comparing the load applied to the bridge against the calculated strength of the bridge. In the case of pedestrian bridges, typical traffic loading is not applicable, so the evaluation is completed using standard design calculation methods found elsewhere within the code.

The Enhanced OSIM Inspection revealed that the structural steel members and structural steel connection plates of the bridge are undergoing very severe corrosion and deterioration. Based on the current condition of the structure, the section loss of each member was quantified and used in the evaluation. The section loss quantities will be discussed for each element analyzed in the element section discussion below. Connection elements (plates, rivets, etc.) in which the section loss was not able to be quantified with measurements (inaccessible) were assumed to be equal in condition to the element being analyzed.

Based on the cumulative deterioration of the critical components of the structure, a structural factor of safety of 2.0 was selected. This value was selected based on a desire for a low risk probability for critical failure, good engineering judgment, and best practices for an evaluation of this nature.

The Load Limit Evaluation for the main structural elements was completed using two ultimate limit state (ULS) load combinations:

- Combination 1: Dead Loading + Pedestrian Live Loading;
- Combination 2: Dead Loading + Snow Loading + Sidewalk Snow Clearing Machine Load.

The pedestrian load is not considered to act simultaneously with the snow load because each load is assessed a maximum value. The probability of the maximum snow load occurring simultaneously with a maximum pedestrian load is negligible.

Lateral Loads (ie: wind, seismic, pedestrian, impacts) were considered separately. It was found that the main structural load carrying elements were satisfactory for lateral loads, however the barrier (eg: chain link fence barrier) was not adequate for pedestrian and impact loading. This will be discussed further in later sections.

The elements subjected to the load combinations were identified and analyzed by following the *load path* of the structure in a top-down manner. The load path is simply the route that a force, or load, takes from the point of application until it meets the ground. For example, the load applied by an impact from a sidewalk snow clearing machine would be a lateral load applied to the barrier, which transfers to the deck, then into the girder, then the column, pier cross braces, the foundation, then ultimately into the ground. The following list compiles the elements evaluated following the load path:

i. Chain link Fence Barrier;

ii. Wood Deck Ties;

iii. Steel Girders:
   - Typical Girders;
   - Centre-Span Girders;

iv. Steel Columns;

v. Concrete Foundations, Piers and Abutments.

It was noted that the governing load combination for the wood deck ties was Load Combination 2. Whereas the remaining structural elements below the bridge deck (girders, columns, foundations) were found to be governed by Load Combination 1. The result of the analysis is discussed in detail in the following sections as it pertains to individual elements.

2.2.1 Chain link Fence Barrier

The wood deck of the bridge was repaired in 2007, and the chain link fence was refurbished in accordance with OPSS 541. The existing fence barrier is a 6' tall chain link galvanized fence, supported by posts spaced at 8' on centre. Existing support outrigger angles are attached to each post. The outrigger angles are anchored to the wood curb with four (4) – ¼" lag bolts. The fence posts are anchored to the bridge decking using a base plate secured with four (4) – ¼" lag bolts.

Loading was analyzed for the pedestrian fencing in accordance with the CHBDC § 3.8.8.2, considering the fencing as both a pedestrian and bicycle barrier. Based on the steel section properties, and the material properties of the wood ties, it was determined that **the chain link fence barrier is <u>insufficient</u>** as a barrier to resist the applied factored loading. Furthermore, the impact loading from a sidewalk snow machine would greatly exceed the loading encountered from pedestrian and bicycle traffic.

Therefore, for lateral loads due to pedestrian loading, bicycle loading, or impact loading from a sidewalk snow machine, **the existing chain link fence is <u>inadequate</u> as a barrier** for this purpose.

2.2.2 Wood Deck Ties

The wood deck ties are 4.0m long, 8" x 8" (191mm x 191mm), and spaced at 10" (254mm) on centre. The members were analyzed as number 2 grade Spruce-Pine-Fur (S-P-F), un-incised, preservative treated. The wood deck ties were analyzed as simply supported members bearing on the steel girder flanges, with a clear span of 2.15m flange-to-flange. The analysis determined the following:

- The wood deck ties are **adequate** for **Load Combination 1** with a **4.8** factor of safety**;**
- The wood deck ties are **inadequate** for **Load Combination 2** with a **0.9** factor of safety.

The wood deck planks that are supported by the wood deck ties also pose a serviceability problem due to slippery conditions during cold and wet weather conditions. The results of the analysis indicate that the existing wood deck ties are **adequate for pedestrian loading**. The existing wood deck ties are **not adequate for loading from a sidewalk snow removal machine.**

2.2.3 Steel Girders

Loads from the wood deck ties are directly transferred to the steel girders. The girders have additional cumulative steel plates along the top and bottom flange at the mid-spans to carry the increased bending moment forces concentrated at the mid-span. The centre-span of the structure is longer (17.9m) than the typical span (10.9m). The girders at the centre-span are deeper, with four (4) additional plates attached to the top and bottom flange at the mid-span rather than the three (3) additional bottom plates and two (2) additional top plates installed on the typical girders.

The varying geometry of the girders resulted in three different load analyses:

- Typical span girder moment resistance at mid-span;
- Centre-span girder shear resistance at girder ends;
- Centre-span girder moment resistance at mid-span.

The steel girders are experiencing corrosion throughout the flanges and web as observed during the Enhanced OSIM Inspection. The section loss due to corrosion was measured at 15% for the heavy steel girders, which was considered during the analysis of these members. The depth and thickness of section loss in all steel members is relatively the same, however since the heavy girders are much thicker than other smaller lighter members, the section less has less impact on their capacity.

The moment resistance at the mid-span of the typical 10.9m span girders were analyzed to be adequate with a 10.8 factor of safety. The centre-span shear resistance at the girder ends was analyzed to be adequate with a 2.4 factor of safety. The centre-span moment resistance at mid-span was analyzed to be adequate with an 8.0 factor of safety.

Therefore, the girders are adequate to support Load Combination 1 and 2.

2.2.4 Steel Columns

Each steel girder is supported by steel column tower structures consisting of vertical columns with cross-bracing members providing lateral stability. The steel columns are composed of two C-channels connected to form a hollow section via a steel plate on one side, and steel laces on the other. A reduction in the moment of inertia about the weak axis was applied due to severe corrosion and section loss noted in the steel laces. It is important to note that during the inspection, some of the steel laces had failed due to corrosion.

The worst-case section loss of the steel columns was 50%, as identified by the Enhanced OSIM Inspection. This significant section loss was included in the analysis calculations and safety factors determined. These columns have an adequate slenderness ratio when calculated in accordance with the CHBDC § 10.9.1.3. In the load combinations calculated, the compressive resistance of these columns has a 3.8 factor of safety.

Therefore, the steel columns are <u>adequate</u> to support Load Combination 1 and 2.

2.2.5 Concrete Foundations, Piers, and Abutments

The steel columns rest on piers constructed with concrete block, and on concrete block abutments at each end of the bridge. The piers were analyzed assuming the maximum factored load produced by the centre-span support columns. Assuming a conservative minimum 15 MPa strength of the concrete block, the pier cap is adequate with a large factor of safety of 75.

The foundations supporting the piers are not visible, and could not be quantified and qualified for analysis. Biennial inspections of the structure have shown that the piers are in relatively good condition, but do have mortar loss at the joints. No other changes, settlements, or movements have been noted throughout the biennial inspections.

Therefore, the pier foundations and abutment foundations are in similar condition to the piers themselves, and are <u>adequate</u> to support Load Combination 1 and 2.

Figure 3 & 4: Severely Deteriorated Laces Bracing throughout, Note Broken Brace in Figure 3

2.3 CONCLUSION

The structure is deteriorating more rapidly as time progresses. The bridge will require significant rehabilitation to remain in service in the near future. The severe corrosion of structural members, section loss of structural connections, and cracking and corrosion of rivets throughout the structure have a cumulative effect on the overall condition of the bridge.

Each element was visually examined, and analyzed utilizing the methods as noted in the Canadian Highway Bridge Design Code, and other CSA standards. The load limit evaluation has determined the following results for the independent elements:

Element	Adequate For Load Combination 1	Adequate For Load Combination 2	Governing Factor of Safety
Barrier Fence & Anchorage	**No**	**No**	**0.0 < 2.0**
Wood Deck Ties	✓	**No**	**0.9 < 2.0**
Steel Girders	✓	✓	2.4 > 2.0
Steel Columns	✓	✓	3.8 > 2.0
Concrete Foundations, Piers, and Abutments	✓	✓	75 >> 2.0

Based on the result of the analysis, we can offer the following comments:

- The chain link fence barrier is not adequate to support lateral loads from pedestrians, cyclists, or snow removal vehicles.
- Wood deck planks pose a hazard to pedestrians due to slippery conditions in wet and cold weather. Even though this serviceability issue is not a load carrying issue, it should be considered in the event that a rehabilitation is performed.
- Wood deck ties are inadequate to support a sidewalk snow clearing machine.
- The main load carrying structural components of the structure are adequate in supporting the pedestrian loading combination (Load Combination 1).
- To support the sidewalk snow removal machine, upgrades are required for the barrier fence & anchorage, and the wood deck ties.
- Upgrades to the structure should only be considered if a full major rehabilitation is considered in the near future.

2.4 RECOMMENDATIONS

Our primary recommendations for your consideration include that:

- The wood deck plank wearing surface be replaced with a non-slip surface as soon as feasible.
- The chain link fence barrier is not exhibiting signs of distress and has not experienced a critical failure to-date. The chain link fence barrier should be monitored and any signs of damage or distress should be addressed as soon as they are noted. The chain link fence barrier should be replaced with a suitable barrier if the bridge is rehabilitated.
- The mortar joints and concrete blocks in piers and abutments be repaired within five (5) years.
- A major rehabilitation be performed on all structural steel members throughout the structure within five (5) years to maintain the structural integrity of the main load-carrying members. This would include: abrasive blast cleaning of all steel members and connections; repairs, replacements, and supplemental structural steel where required; and a protective epoxy coat finish.
- If a major rehabilitation of the structural steel is delayed by staging, it must be completed in less than ten (10) years.

The cost of a major rehabilitation to the structural steel will be significant. A phased approach to complete the above recommended work could be considered to lessen the financial impact over time. Each year of delay contributes to additional deterioration and increases to repair costs. The risk of a repair not being feasible and increased liability to the Town also increases with each year.

Lacking the initiation of a major rehabilitation within the noted time frame of less than five (5) years, it is anticipated that the structure will require closure or removal for the public safety in less than ten (10) years.

We trust that this report provides the Town of Tillsonburg with an accurate assessment of the load carrying capacity of the Kinsmen Pedestrian Bridge. Please do not hesitate to contact us, should there be any questions or concerns regarding the contents of this report. We thank you for the opportunity to be of service.

SECTION 3.0

OPTIONS EVALUATION REPORT

3.0 OPTIONS EVALUATION

3.1 INTRODUCTION

The Kinsmen Pedestrian Bridge sits along Veterans Memorial Walkway in the Town of Tillsonburg. The structure is a former railway bridge that was converted to pedestrian use approximately 20 years ago. The bridge is a typical railway trestle, circa 1910 (+/-) that comprises of wood deck ties, supported by heavy steel girders, supported by steel column piers, supported by concrete block abutments and pier bases. The wood deck ties were rehabilitated in 2010, but the bridge has not otherwise undergone significant structural rehabilitation.

In order to evaluate available options, an Enhanced OSIM Inspection Report and a further Load Limit Evaluation Report was prepared. The Enhanced OSIM Inspection Report is a thorough and detailed account of the condition of all of the bridge elements, including the fence barrier, wood deck, steel girders, steel columns piers, and concrete block pier bases and abutments. The load limit analysis reviewed the theoretical capacity of the structure with a focus on public safety.

Based on the material conditions determined by the enhanced inspection, a load limit analysis was completed in accordance with the Canadian Highway Bridge Design Code – which is the national standard for calculating bridge load limits. It was determined that the current bridge in its present form and condition, requires some modifications and repairs to meet current standards.

The bridge is not listed as a protected structure under the Ontario Heritage Act however, if a Cultural Heritage Evaluation Report was undertaken it would likely score high enough to be eligible and recommended for designation. The bridge is not only an important pedestrian link to the downtown core for residents, but also has a lot of potential as an attractive cultural heritage piece for the Town.

As a result of the above noted considerations, this options evaluation report has been prepared.

The four options reviewed as part of this evaluation include:

- Do nothing;
- Close the bridge;
- Repair the bridge; and
- Replace the bridge.

This report will review and evaluate each of these four options, as well as provide some cost estimation for planning purposes. With respect to the repair option or the replace option, there are multiple methods for each that were considered. Following the discussion of these options, this report will summarize and recommend a course of action for consideration.

3.2 OPTIONS

The options to be considered are measured against their adequacy in addressing the problem. For this structure, the problem is that:

> ***The century old former railway bridge is in an advanced state of deterioration. It currently does not meet certain standards, has some serviceability deficiencies, and there is a risk of hazard to public safety.***

An option must address the problem to be considered feasible. In addition to this, the preferred option should also address other factors such as economics, accessibility, aesthetics, and serviceability in order be practical.

3.2.1 Do Nothing

To 'do nothing' does not address the problem. Neglecting to complete the needed rehabilitation work will likely result in the bridge requiring closure in less than 10 years. The bridge would continue to deteriorate and will progress beyond the point of no return for a cost effective rehabilitation.

To do nothing would carry no construction costs in the short term, but would need to have an enhanced OSIM completed (according to provincial law) by 2025, and eventually require a decision to close and remove, repair, or replace the bridge. The structure could remain open in its present state for a short time, however the risk to public safety will increase as time progresses. To do nothing would only effectively delay a decision on the future of the bridge while deterioration continues.

For the above noted concerns, this option is not considered to be a feasible solution.

3.2.2 Close the Bridge

To close the bridge will only address the public safety issue. This option would create a new problem as the pedestrian access corridor would no longer be available. If the bridge were to be closed, it could remain as a heritage monument with some modifications, otherwise it should be demolished, removed, and the affected areas restored with landscaping.

Benefits to this option are the low cost and the protection of public safety, but the bridge would require regular inspections until demolition. At this time however, the bridge does not require closure. If the 'do nothing' option is selected it would become a stage 1 decision and the demolition of the bridge would become stage 2.

For the above noted concerns, this option is not necessary at this point in time but will need to be considered in the future if 'Do Nothing' becomes the selected option.

3.2.3 Repair the Bridge

There are two deck rehabilitation options considered, one is a wood deck repair option and the other is an option that considers the removal and replacement of the wood deck ties and planks with a steel grate deck system. Both options require a new pedestrian barrier and rehabilitation of the supporting steel and concrete structure. Each option could be done in one stage or could be phased into two stages to ease the financial burden over time if required (ie deck replacement first, structural support rehabilitation second). It is extremely important to note however, that if phasing the work is chosen the overall cost will be higher upon completion. It is also imperative to state that the deck replacement should not be considered if the rehabilitation of the supporting structure is delayed more than a few years or neglected entirely. Without the rehabilitation of the supporting structure, the bridge will require closure regardless of the condition of the deck on top.

Repair Option – Wood Deck Replacement

This option would replace the existing wood deck planks with a new wood deck system that is less prone to slippery conditions in wet or cold weather, but would leave the wood deck ties in place. A new wood deck system could be designed to allow air flow between the deck planks and the wood deck ties which increase the lifespan of the wood. This option would require the minimum amount of work for a deck rehabilitation and is the least costly repair. This option also provides the benefit of a modest increase in lifespan. Due to the existing wood deck ties not being able to properly support the weight of a sidewalk snow clearing machine however, the new wood deck replacement would still need to be cleared of snow by hand.

A very similar example would be the deck and barrier recently constructed on the Black Bridge on the Heritage Trail in Waterford, Norfolk County. (An information page is included in Appendix D for reference).

This option would include the following:

Stage 1

- Remove and replace the existing chain link fence barrier with a proper pedestrian guard. A low maintenance and aesthetically improved barrier that meets code requirements for pedestrians and cyclists would be proposed (See Waterford's 'Black Bridge' for example).
- Remove the existing longitudinal wood deck planks and replace with a lateral wood deck on sleeper joists similar to the Waterford Black Bridge. The current deck planks trap moisture in the surface of the deck ties and promote premature deterioration. A lateral deck plank system on sleeper joists provides better protection for the deck ties. Placing the deck boards and wood grain perpendicular to the path of travel provides better slip resistance than the current longitudinal deck planks. Adhesive non-slip strips can also be applied if necessary.
- Recommended to be completed in within five (5) years.

Stage 2

- Abrasive blast clean all structural steel.
- Replace severely deteriorated steel cross-braces, laces, etc., as required.

- Supplemental structural steel frame may be required within steel pier frames dependent upon state of deterioration at the time of rehabilitation.
- Install protective coating on all structural steel (ie: epoxy paint or similar).
- Repair mortar joints and concrete repairs to piers and abutments.
- Recommended to be completed within (5) years, but no more than ten (10) years.

The positive benefits of this option are:

- Least cost rehabilitation.
- Keeps bridge open.
- Lifespan is increased 30 years (+/- 10 years) until next major deck rehabilitation.
- Lifespan of the overall structure is increased 50 years.
- Aesthetics are improved with new attractive and effective barrier.
- Integrity of heritage value is protected with sympathetic modifications.

The negative aspects of this option to consider include:

- Even though it is the least costly rehabilitation option, it is still an expensive project.
- The wood deck will require maintenance and repairs on a 10 year cycle.
- Snow removal must still be done by hand.
- Slippery conditions will be improved, but not eliminated in wet and cold weather.

Notwithstanding the heavy cost for the full rehabilitation, this is a viable option to be considered.

Figure 5 & 6: New wood deck wearing surface and pedestrian barrier on Black Bridge in Waterford

Refer to Appendix D for a brief description of the Black Bridge rehabilitation project.

Repair Option – Steel Deck Replacement

This option would remove the wood deck planks and ties, which would be replaced by an open grate deck system very similar to the Hawkins Pedestrian Bridge on Lake Lisgar. The grated deck would significantly reduce slippery conditions in wet and cold weather, as well it could potentially eliminate the need for snow removal. As with the previous option, the rehabilitation of the supporting structural steel and concrete block piers and abutments will still be required but could also be phased in two stages.

This option would include the following:

Stage 1

- Remove the existing fence barrier and the wood deck planks and wood deck ties.
- Make any required repairs to steel diaphragm cross braces while accessible.
- Install a new steel grate deck system.
- Install a new low maintenance and aesthetically improved barrier that meets code requirements for pedestrians and cyclists (See Waterford's 'Black Bridge' for example).
- Recommended to be completed in within five (5) years.

Stage 2 (Same as Stage 2 for previous option)

- Abrasive blast clean all structural steel.
- Replace severely deteriorated steel cross-braces, laces, etc., as required.
- Supplemental structural steel frame may be required within steel pier frames dependent upon state of deterioration at the time of rehabilitation.
- Install protective coating on all structural steel (ie: epoxy paint or similar).
- Repair mortar joints and concrete repairs to piers and abutments.
- Recommended to be completed within five (5) years but no more than ten (10) years.

The positive benefits of this option are:

- Keeps bridge open.
- Lifespan is increased 40 years (+/- 10 years) until next major deck rehabilitation.
- Lifespan of the overall structure is increased 50 years.
- Aesthetics are improved with new attractive and effective barrier.
- Steel grate deck system is more durable.
- Steel grate deck requires less maintenance and repair.
- Steel grate deck may eliminate need for snow removal.
- Steel deck significantly improves slip resistance.
- Integrity of heritage value is protected with sympathetic modifications.

The negative aspects of this option to consider include:

- More expensive rehabilitation option.
- Some pedestrians may be uncomfortable seeing through the steel grate deck if they are uncomfortable with heights.
- Removal of wood deck ties will have an aesthetic effect on the former railway bridge.

Notwithstanding the heavy cost for the full rehabilitation, this is a viable option to be considered.

Figure 7 & 8: Hawkins Bridge at Lake Lisgar, used as an example for a Steel Grate Deck Option

3.2.4 Replace the Bridge

There are three methods of bridge replacement that were considered. A 'Like-for-Like' railway bridge replacement, a modern high level pedestrian bridge open to new design ideas, and a 'Valley Path' replacement that incorporates a much smaller pedestrian bridge along a path on the valley floor.

The first method is a straight removal and replacement with a similar bridge: 'Like-for-Like'. A new bridge could be designed to look nearly identical to the existing railway bridge. A beneift of this option is that pedestrian path could remain along the current horizontal path and elevation. The bridge would also retain the aesthetic appeal of a former railway bridge, though it would be expensive.

The second method would be to replace the existing railway bridge with a modern pedestrian bridge. This could also be done along the same horizontal path which is a big benefit to pedestrians. The new design could be an opportunity for something new and exciting. It could also be done from a functional perspective with keeping costs low.

The third method to consider would be to remove the bridge (or leave sections as a heritage monument) and build a more modest pedestrian bridge over the waterway at the valley floor and incorporate barrier free accessible switchback paths on each embankment. This 'Valley Path' option is the least expensive replacement option, but individuals with mobility issues may not prefer a long walk up and down the embankments, regardless of barrier free requirements being met.

3.2.4.1 Replace Option – 'Like-for-Like' Replacement

This option would require full demolition of the existing structure. It would then be replaced with a modern pedestrian bridge that meets current design requirements. The bridge deck would be at the same elevation as the current bridge, so the pedestrian path would not be impacted. The structure could be designed to resemble the existing bridge. This option could also be staged (Stage 1: Demolition; Stage 2: Construction) if required for financial reasons, or it could be completed in a single construction season if financing is available.

This option would include the following:

Stage 1

- Complete demolition and removal of the existing bridge.

Stage 2

- Construction of a new railway bridge at the same elevation.

The positive benefits of this option are:

- Keeps bridge open.
- Keeps pedestrian path at the same elevation.
- Bridge can be designed to carry vehicles for maintenance purposes.
- Lifespan is significantly increased to 80 years.
- Aesthetics can be designed to mimic existing railway bridge.

The negative aspects of this option to consider include:

- Most expensive option.
- Heritage value of the existing railway bridge would be lost.

Given the heavy cost for this full replacement, this is may not be a viable option for consideration.

Figure 9: Image of the existing Kinsmen Pedestrian Bridge, to represent a new bridge that would mimic the existing bridge as a 'Like-for-Like' replacement.

3.2.4.2 Replace Option – 'High Level Pedestrian' Replacement

This option would require full demolition of the existing structure. It would then be replaced with a modern pedestrian bridge that meets current design requirements. The bridge deck would be at the same elevation as the current bridge, so the pedestrian path would not be impacted. The structure could be designed with something totally new and modern in mind. It is anticipated that this option would include two abutments and three piers with four prefabricated pedestrian bridges spanning in between. A suspension bridge or other intriguing design could be considered with tourism implications, but this was not considered in the cost estimate below. This option could also be staged (Stage 1: Demolition; Stage 2: Construction) if required for financial reasons, or it could be completed in a single construction season if financing is available.

This option would include the following:

Stage 1

- Complete demolition and removal of the existing bridge.

Stage 2

- Construction of a new pedestrian high level bridge.

The positive benefits of this option are:

- Keeps bridge open.
- Keeps pedestrian path at the same elevation.
- Bridge can be designed to carry vehicles for maintenance purposes.
- Lifespan is significantly increased to 80 years.
- Aesthetics can be designed to suit the Town's wishes.

The negative aspects of this option to consider include:

- Not the least expensive option, but not the most expensive either.
- Heritage value of the existing railway bridge would be lost.

Notwithstanding the heavy cost for the full replacement, this is a viable option to be considered.

Figure 10: Mechanic Street Foot Bridge in Paris, ON, shown as an example of a High Level Pedestrian Bridge Replacement.

3.2.4.3 Replace Option – 'Valley Path' Replacement

This option would require at least a partial demolition of the existing structure if some of it were to remain as a heritage monument. A new valley path would be constructed with a more modest pedestrian bridge constructed over the waterway on the valley floor. The path would continue to the existing embankments where a series of switchback sections and railings along the path up the embankments would be required. This option is the least expensive replacement option, but comes with the cost of losing the high level pedestrian path. This option could also be staged (Stage 1: Demolition; Stage 2: Construction) if required for financial reasons, or it could be completed in a single construction season if financing is available.

This option would include the following:

Stage 1

- Partial demolition of the existing bridge (Full demolition could be done if desired).
- Repairs and preservation of remaining existing structure section as a monument if desired.

Stage 2

- Construction of a new valley floor pedestrian bridge.
- Construction of a new valley floor path.
- Construction of new barrier free accessible switchback paths up each embankment.

The positive benefits of this option are:

- Pedestrian link is maintained.
- Lowest cost replacement option.
- Bridge can be designed to carry vehicles for maintenance purposes.
- Lifespan is significantly increased to 60 years.
- Aesthetics can be designed to suit the Town's wishes.

The negative aspects of this option to consider include:

- The valley path would be difficult for individuals with mobility issues to traverse the switchback paths on the embankments.
- Heritage value of the existing railway bridge would be diminished.

Notwithstanding the pedestrian path issues, this is a viable option to be considered.

Figure 11 & 12: Mechanic Street Foot Bridge in Paris ON, utilizing pedestrian ramps at the bridge approaches, and Summerhaven Bridge in Haldimand, a new path over a low valley waterway.

3.3 COST ESTIMATES

For the purpose of this report, we consider the following classes of construction cost estimates:

Class D – Order of Magnitude:
- Used to screen a project for feasibility.
- Defined scope of work is typically less than 20% known.
- Accuracy of estimate is typically between -50% to +75%.

Class C – Preliminary Design:
- Used to establish a budget for the project once a scope of work is better defined.
- Project definition level is typically 60% (+/- 10%) complete.
- Accuracy of estimate is typically between -30% to +50%.

Class B – Detailed Design:
- Used to confirm a budget for the project prior to tender.
- Project definition level is typically 80% (+/- 10%) complete.
- Accuracy of estimate is typically between -15% to +25%.

Class A – Definitive:
- Prepared by a professional estimator, or
- Project is tendered and bids are received that can be executed with a contract.
- Project definition level is typically 100% (+/-5%) known.
- Accuracy of value is typically between -5% to +10%.

The cost estimates provided for this report are considered to be preliminary Class D cost estimates. These will be useful for evaluating the options provided and choosing a course of action. Once a direction for the project is known, additional information and project scope can be assembled and a Class C estimate can be prepared prior to advancing the project to a detailed design stage. Once a detailed design is near completion, a Class B estimate would be prepared in order to confirm the budget is adequate prior to tendering the work.

The estimates provided below include the engineering and construction costs only; no annual operating costs, maintenance cost, or other ancillary costs are included. This is done to provide some clarity regarding the actual construction cost of each option. It is noted that some options will carry additional operating, maintenance, and ancillary costs, however when considering an order of magnitude Class D estimate, these secondary costs are unlikely to impact the decision path process.

3.3.1 Do Nothing

This option is self-explanatory, but it is important to note that delaying the decision on what to do with this bridge will require consideration of the consequence of doing nothing at this time. To do nothing will not incur short term construction costs, but will require scheduled inspections (eg: enhanced OSIM in 2025) or an unplanned repairs or closure.

Costs	$	20,000
Engineering	$	40,000
Contingency	$	20,000
TOTAL	**$**	**80,000**

3.3.2 Close the Bridge

This option would require modest work to be done in order to close the bridge to pedestrian traffic, such as approach barriers, signage, etc. It also would require consideration of the eventual decision to demolish or replace the structure.

Stage 1 (Closure)		**Stage 2 (Demolition)**	
Cost of Construction	$ 15,000	Cost of Construction	$ 200,000
Engineering (10%)	$ 1,500	Engineering (10%)	$ 20,000
5Contingency (15%)	$ 2,250	Contingency (15%)	$ 30,000
TOTAL	**$ 18,750**	**TOTAL**	**$ 300,000**
		Total Combined =	**$ 318,750**

3.3.3.1 Repair – Wood Deck

This option is viewed as the least cost rehabilitation option. Staging the project would defer the structural steel rehabilitation costs to within 10 years for budget planning purposes. Completing stages 1 and 2 at one time would reduce the overall cost.

Stage 1		**Stage 2**	
Cost of Construction	$ 320,000	Cost of Construction	$ 2,000,000
Engineering (10%)	$ 32,000	Engineering (10%)	$ 200,000
5Contingency (15%)	$ 48,000	Contingency (15%)	$ 300,000
TOTAL	**$ 400,000**	**TOTAL**	**$ 2,500,000**
		Total Combined =	**$ 2,900,000**

3.3.3.2 Repair – Steel Deck

This option is the higher cost rehabilitation option but is more durable than the wood option. Staging the project would defer the structural steel rehabilitation costs to within 10 years for budget planning purposes. Completing stages 1 and 2 at one time would reduce the overall cost.

Stage 1		**Stage 2**	
Cost of Construction	$ 540,000	Cost of Construction	$ 2,000,000
Engineering (10%)	$ 54,000	Engineering (10%)	$ 200,000
Contingency (15%)	$ 81,000	Contingency (15%)	$ 300,000
TOTAL	**$ 675,000**	**TOTAL**	**$ 2,500,000**
		Total Combined =	**$ 3,175,000**

3.3.4.1 Replace – Like for Like (Same elevation)

This is the highest cost option, but it has a long lifespan and truly replaces the heritage railway bridge with a heritage railway bridge. The cost below reflects a replacement railway bridge, 'Like-for-Like' as shown in the OSIM report estimates. A new bridge however, is not required to carry train loads any longer, and never will be required to do so. For this reason, a new pedestrian bridge at the same high elevation has also been considered (see below), but this option has been included for comparative purposes.

Cost of Construction	$ 3,500,000
Engineering (10%)	$ 350,000
Contingency (15%)	$ 525,000
TOTAL	**$ 4,375,000**

3.3.4.2 Replace – High Elevation Pedestrian Bridge (Same elevation)

This option has a high cost but it has the longest lifespan and the greatest functionality. The actual cost of this option may vary significantly depending on the type and style of bridge design chosen. A more modest replacement pedestrian bridge that isn't required to carry train or traffic loading could be designed and constructed for a much lower cost than a 'Like-for-Like' option. For this estimate, a 4-span 'eagle' bridge style structure on concrete piers and abutments was considered.

Cost of Construction	$ 1,800,000
Engineering (10%)	$ 180,000
Contingency (15%)	$ 270,000
TOTAL	**$ 2,250,000**

3.3.4.3 Replace – Valley Path

This option is the lower cost replacement option. It has a similarly long lifespan as the Like-for-Like or High Elevation replacement but it has reduced functionality due to the required barrier free accessible switchback paths up the embankments.

Cost of Construction	$ 1,000,000
Engineering (10%)	$ 100,000
Contingency (15%)	$ 150,000
TOTAL	**$ 1,250,000**

3.3 EVALUATION

Below are the considered criterion and their respective weights. These were used simply to provide a basis for an opinion of the evaluation – ultimately a decision on the criterion and the valuation of each are arbitrary to the reader. This has been provided to illustrate the context of the evaluation that was performed. The criteria, the assigned weights, and the associated assigned values are described below and shown on the 3.3.2 Evaluation Chart on the next page.

3.3.1 Criteria

The evaluation criteria used for this report include the following:

Accessibility & Functionality: /20
How accessible is the option being considered? Does it present additional challenges or does it remove barriers to the path of travel? Lower challenges and barriers to the path of travel result in better functionality and a higher score.

Aesthetics & Heritage: /15
Does the option have aesthetic appeal? Is the visual appearance sympathetic to the heritage value of the existing structure? Better visual appeal and lower impacts to heritage aesthetics result in a higher score.

Durability & Lifespan: /20
Does the option have durable materials that do not require periodic repair and replacement? Assuming that needed repairs and maintenance is carried out, does the option have a short, medium, or long term life expectancy? More durable options that require less maintenance and have a long lifespan result in a higher score.

Safety & Liability: /15
It is assumed that regulatory requirements (ie CHBDC, etc.) will be met, but are there hazards that may pose a liability to the Town? Lower risks result in a higher score.

Construction Cost: /30
How does the cost of construction compare to the other considered options? Lower costs result in a higher score.

TOTAL: /100
The sum total of all considered categories represent a score out of 100 points. The highest score being the more desirable option using the weighted criteria considered.

3.3.2 Evaluation Chart

OPTIONS	CRITERIA								
	Accessibility & Functionality /20	Aesthetics & Heritage /15	Durability & Lifespan /20	Safety & Liability /15	Comparative Cost /30	Estimated Lifespan (years)	Cost Estimate (Class D) $ (k)	Value per year (cost / lifespan in years) $ (k)	OVERALL RATING /100
Do Nothing						10	$80	$8	46
Close Bridge						10	$320	$32	49
Rehabilitation – Wood Deck						50	$2,900	$58	54
Rehabilitation – Steel Deck						50	$3,180	$64	73
Replace 'Like-for-Like'						80	$4,375	$55	66
Replace 'High Elev Pedestrian'						80	$2,250	$28	78
Replace 'Valley Path'						60	$1,250	$21	71

Most Desirable  Least Desirable

The evaluation chart above indicates:

- **Most preferred** - High Elevation Pedestrian Replacement, Steel Deck Rehabilitation
- **Less preferred** - Valley Path Replacement, Like-for-Like Replacement, Wood Deck Rehabilitation
- **Least preferred** - Close the Bridge, Do Nothing

It should be noted that if no work is undertaken within five (5) years, the rehabilitation options would no longer be feasible.

3.4 RECOMMENDATION

The scores shown on the evaluation table provide a basis for the recommendation to consider the most desirable options.

The Kinsmen Pedestrian Bridge is at a critical decision point. To 'do nothing' will limit the feasible options available; as each year passes the cost and viability of a rehabilitation option diminishes.

Based on the result of the Enhanced OSIM Inspection Report, the Load Limit Evaluation Report, and the result of the Options Evaluation Report, we offer the following recommendation:

The preferred options are a High Level Pedestrian Replacement or a Rehabilitation – Steel Deck Replacement

Each option should be reviewed with respect to the required schedule of a Municipal Class Environmental Assessment (EA). It is likely that a closure option or a rehabilitation option would require a Schedule A+ EA. A replacement option would require a Schedule B EA unless the cost exceeds $2.4M, which would then require a Schedule C EA.

It is recommended that a Schedule B EA be commenced in order to confirm a preferred solution with public consultation and Council direction.

We trust that this report provides the Town of Tillsonburg with an in-depth and thorough evaluation of the options to be considered for the Kinsmen Pedestrian Bridge. Please do not hesitate to contact us, should there be any questions or concerns regarding the contents of this report.

We are able to pursue any option that the Town wishes to explore further, and we thank you for the opportunity to be of service.

STATEMENT OF LIMITATIONS

The information presented in this Enhanced OSIM Report is limited to the conditions and observations that were made over the course of the inspection. The observations and recommendations made in this report reflect the conditions observed at the time of the inspection.

The information presented in this Load Limit Evaluation Report is limited to the conditions and observations that were made over the course of the Enhanced OSIM Inspection.

The information presented in this Options Evaluation Report is based on the result of the Enhanced OSIM Inspection Report and the Load Limit Analysis Report. The recommendations made in this report reflect the result of the supporting reports as well as our expertise and experience in bridge engineering, design, and construction practices.

The comments contained herein are intended to provide guidance to the Town of Tillsonburg staff, for the purpose of providing informed advice for the planning of this project to the Council of the Town of Tillsonburg. No other warranty or representation, either expressed or implied is intended or included in this report.

CLOSURE

In closing, the following is a summary of the key overall points of this full report:

- The Enhanced OSIM Inspection revealed advanced deterioration in lighter gauge steel members and connections, and the factors of safety for some elements have been significantly reduced by deterioration.
    - Longitudinal wood deck planks should be addressed to improve slip resistance.
- The Load Limit Analysis found that the bridge is stable but the pedestrian chain link fence barrier does not meet current code (CHBDC) requirements for lateral loads.
- The structure is at a critical decision point. The Options Evaluation recommends that a high level pedestrian replacement **OR** bridge rehabilitation be initiated in less than five (5) years be considered.
    - If a high level replacement option is chosen, plans should be undertaken to do so in less than 10 years.
    - If the project is staged the supporting steel structure rehabilitation work must be completed in less than 10 years.

It is recommended that a Schedule B EA be commenced in order to confirm a preferred solution with public consultation and Council direction.

We trust that this full three part report provides the Town of Tillsonburg with the information required to discuss the essential aspects of the project and to decide upon the future of the Kinsmen Pedestrian Bridge.

It has been our pleasure work with the Town once again. Please do not hesitate to contact us, should there be any questions or concerns regarding the contents of this report. We thank you for the opportunity to be of service.

Yours truly,

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APPENDICES

APPENDIX A - KINSMEN PEDESTRIAN BRIDGE SNAPSHOT PAGE

APPENDIX B - ENHANCED OSIM DATA REPORT

APPENDIX C - KINSMEN PEDESTRIAN BRIDGE ENHANCED OSIM DRAWING

APPENDIX D - BLACK BRIDGE, WATERFORD HERITAGE TRAIL

APPENDIX A

KINSMEN PEDESTRIAN BRIDGE SNAPSHOT PAGE

Town of Tillsonburg

OSIM Inspection Performance Snapshot

Kinsmen Pedestrian Bridge

MAP LINK

Site Number: BR_KINS0001

Location: 170m West of Rolph St.

OSIM Recommendation: Major Rehab - 1 to 5 years

BCI 45

Overall Comments:

Enhanced OSIM Inspection completed with use of rope access technicians. All structure members inspected to determine severity of deterioration. Steel members showing light to severe corrosion and delamination. Delaminated steel sections are flaking. Steel strapping missing on North I pier cap (refer to Enhanced OSIM Drawing for element locations). The overall condition... Refer to OSIM for details.

General Structure Information:

Lanes:	1
Type:	I-Beam or Girders
Spans:	9
Span Length:	8 @ 11m, 1 @18m
AADT:	
Posted Speed:	
Load Limit (Tonnes):	None
Construction Date:	1910
Inspection Date:	June 17, 2019

Costing Summary:

Task	Cost Estimate
Construction Costs	$1,721,000.00
Associated Costs	$1,130,000.00
Total Costs	**$2,851,000.00**

Rehabilitation / Replacement Recommendations: *(Refer to OSIM elements for full details)*

Element	Timing	Work Required	Element	Timing	Work Required
Abutment Walls			Ballast Walls		
Bearing / Bearing Seat	1 - 5 yr	Rehab	Bearings (At Piers)	1 - 5 yr	Rehab
Wingwalls			Wearing Surface (Approaches)		
Railing Systems	1 - 5 yr	Rehab	Diaphragms (Horizontals)	1 - 5 yr	Replace
Diaphragms (Diagonals)	1 - 5 yr	Replace	Floor Beams		
Girders	1 - 5 yr	Rehab	Stringers		
Diagonal Bracing Element	1 - 5 yr	Rehab	Horizontal Bracing Element	1 - 5 yr	Rehab
Bracing Element	1 - 5 yr	Replace	Structural Connections	1 - 5 yr	Rehab
Wearing Surface (Decks)			Embankments		
Streams and Waterways			Foundation (Below Ground Level)		
Bearings			Caps	1 - 5 yr	Rehab
Shafts/Columns/Pile Bents	1 - 5 yr	Rehab	Shafts/Columns/Pile Bents		

Maintenance Needs: *(Refer to OSIM elements for full details)*

Element	Timing	Work Required	Element	Timing	Work Required
Abutment Walls	2 yr	Other: Reinstall Mortar	Ballast Walls		
Bearing / Bearing Seat			Bearings (At Piers)		
Wingwalls	2 yr	Other: Reinstall Mortar	Wearing Surface (Approaches)	2 yr	Rout & Seal
Railing Systems	1 yr	Other: Fix Loose Wire	Diaphragms (Horizontals)		
Diaphragms (Diagonals)			Floor Beams		
Girders			Stringers		
Diagonal Bracing Element			Horizontal Bracing Element		
Bracing Element			Structural Connections		
Wearing Surface (Decks)	1 yr	Deck Surface Repair	Embankments	1 yr	Erosion Control at Bridges
Streams and Waterways			Foundation (Below Ground Level)		
Bearings			Caps	Urgent	Other: Replace Missing Strapping
Shafts/Columns/Pile Bents			Shafts/Columns/Pile Bents	2 yr	Other: Reinstall Mortar

Additional Investigation:

Comment: Enhanced OSIM Inspection completed. Next Enhanced OSIM Inspection to be completed in 2025.

APPENDIX B

ENHANCED OSIM DATA REPORT

Enhanced OSIM Inspection

Kinsmen Pedestrian Bridge

Site Number BR_KINS0001

Veterans Memorial Walkway

170m West of Rolph St.

Ontario Structure Inspection Manual - Enhanced Inspection Form **Site Number:** BR_KINS0001

Inventory Data:

Structure Name	Kinsmen Pedestrian Bridge							
Estimated BCI	45	[X] On [ ] Under	Map: LINK	Crossing Type:	[ ] Rail	[ ] Road	[ ] Navig. Water	
					[X] Ped.	[ ] Other	[X] Non-Navig. Water	
Hwy/Road Name	Veterans Memorial Walkway							
Structure Location	170m West of Rolph St.							
Latitude	42.860481			Heritage Designation:	[X] Not Cons.	[ ] List/not Design.	[ ] Desig. & List	
Longitude	-80.735114				[ ] Cons./not App.	[ ] Desig./not List		
Owner(s)	Town of Tillsonburg							
MTO Region	30 Southwestern			Road Class:	[ ] Freeway	[ ] Arterial	[ ] Collector	[ ] Local
MTO District	31 London/Stratford			Posted Speed		No. of Lanes	1	
Old County	23 Oxford			AADT		% Trucks		
Geographic Twp.				Min. Vertical Clearance		(m)		
Structure Type	6 I-Beam or Girders			Special Route	[ ] Truck	[ ] Emergency	[ ] School	[ ] Transit
Total Deck Length	107 (m)			Detour Length Around Bridge	- (km)			
Overall Str. Width	4 (m)			Direction of Structure	East -- West			
Total Deck Area	278 (m^2)			Fill on Structure	0 (m)			
Roadway Width	2.6 (m)			Skew Angle	0 (degrees)			
No. of Spans	9			Span Length	8 @ 11m, 1 @18m (m)			

Historical Data:

Year Built	1910	Year of Last Major Rehab.	2010
Last OSIM Inspection	June 2, 2017	Current Load Limit	/ / (tonnes)
Last Enhanced OSIM Inspection	-	Last Evaluation	-
Last Condition Survey	-		

Historical Comments:

2010: Replacement of bearing seats at abutmnets and railway ties along bridge deck.

Field Inspection Information:

Inspection Date:	June 17, 2019		
Inspector:	Johnathan McMorrow, B.A.Sc., E.I.T., G. Douglas Vallee Ltd.	Others in Party:	Jason Timmermans, B.Eng, E.I.T., G. Douglas Vallee Ltd., R.A.M. Technicians

Overall Comments:

Enhanced OSIM Inspection completed with use of rope access technicians. All structure members inspected to determine severity of deterioration. Steel members showing light to severe corrosion and delamination. Delaminated steel sections are flaking. Steel strapping missing on North I pier cap (refer to Enhanced OSIM Drawing for element locations). The overall condition of structural connections located throughout the substructure is severe. Replacement or reinforcement of all structural connections may be required.

Ontario Structure Inspection Manual - Enhanced Inspection Form **Site Number:** BR_KINS0001

	Additional Investigation Required:	Priority		
		None	Normal	Urgent
	Material Condition Survey			
X	Detailed Deck Condition Survey:	X		
X	Non-destructive Delamination Survey of Asphalt-Covered Deck:	X		
X	Concrete Substructure Condition Survey:	X		
X	Detailed Coating Condition Survey:	X		
X	Detailed Timber Investigation	X		
X	Post-Tensioned Strand Investigation	X		
	Underwater Investigation:	X		
	Fatigue Investigation:	X		
	Seismic Investigation:	X		
	Structure Evaluation:	X		
	Monitoring			
X	Monitoring of Deformations, Settlements and Movements:	X		
X	Monitoring Crack Widths:	X		

Investigation Notes:
Enhanced OSIM Inspection completed. Next Enhanced OSIM Inspection to be completed in 2025.

Overall Structure Recommendations:

Recommended Work on Structure:	☐ None ☐ Minor Rehab ☐ Replace ☐ Maintenance ☒ Major Rehab
Timing of Recommended Work:	☐ Urgent ☐ < 1yr ☒ 1 to 5 years ☐ 6 to 10 years
Date of Next Inspection:	June 2021

	Element	Recommended Work			Maintenance Timing
		Rehab	Replace	Timing	
1	Abutment Walls				2 yr
2	Ballast Walls				
3	Bearing / Bearing Seat	X		1 - 5 yr	
4	Bearings (At Piers)	X		1 - 5 yr	
5	Wingwalls				2 yr
6	Wearing Surface (Approaches)				2 yr
7	Railing Systems	X		1 - 5 yr	1 yr
8	Diaphragms (Horizontals)		X	1 - 5 yr	
9	Diaphragms (Diagonals)		X	1 - 5 yr	
10	Floor Beams				
11	Girders	X		1 - 5 yr	
12	Stringers				
13	Diagonal Bracing Element	X		1 - 5 yr	
14	Horizontal Bracing Element	X		1 - 5 yr	
15	Bracing Element		X	1 - 5 yr	
16	Structural Connections	X		1 - 5 yr	
17	Wearing Surface (Decks)				1 yr
18	Embankments				1 yr
19	Streams and Waterways				
20	Foundation (Below Ground Level)				
21	Bearings				
22	Caps	X		1 - 5 yr	Urgent
23	Shafts/Columns/Pile Bents	X		1 - 5 yr	
24	Shafts/Columns/Pile Bents				2 yr

Ontario Structure Inspection Manual - Inspection Form

Site Number: BR_KINS0001

Repair and Rehabilitation Required		**Priority**												Estimated
Element #	Repair and Rehabilitation Required	6-10 years			1-5 years			Within 1 year			Urgent			Construction Cost
3	Sandblast and coat bearings at abutments.					X								$10,000.00
4	Sandblast and coat bearings at piers.					X								$40,000.00
8	Replace horizontal diaphragm members.					X								$75,000.00
9	Remove and replace diagonal diaphragm members.					X								$75,000.00
11	Sandblast and coat girders.					X								$200,000.00
11	Replace deteriorated web stiffeners at girders.					X								$25,000.00
13	Sandblast and coat diagonal bracing between steel					X								$300,000.00
14	Sandblast and coat horizontal bracing elements between steel trestle piers.					X								$125,000.00
14	Replace lace bracing along horizontal bracing					X								$50,000.00
15	Replace the lateral bracing beneath the bridge deck.					X								$70,000.00
16	Sandblast and coat structural connections throughout					X								$100,000.00
22	Sandblast and coat steel strapping on the pier caps.					X								$30,000.00
22	Repair cracks in the concrete pier caps.					X								$30,000.00
23	Sandblast and coat composite steel pier columns.					X								$90,000.00
23	Replace lace bracing along steel pier columns.					X								$50,000.00
													Repair and Rehabilitation Total Cost:	$1,270,000.00
Maintenance Work Required		**Priority**												Estimated
Element #	Maintenance Required	2 years			1 year			Within 1 year			Urgent			Construction Cost
1	Repair mortar on abutment walls.		X											$10,000.00
5	Repair mortar on wingwalls.		X											$10,000.00
6	Rout and seal cracking on the approaches.		X											$2,000.00
7	Fix loose wire at bottom of chain-link fence.		X											$2,500.00
17	Remove and replace warped and lifting deck boards.					X								$1,500.00
18	Provide rip rap erosion control at quadrants.					X								$50,000.00
22	Replace missing strapping on the north column I pier											X		$5,000.00
24	Repair mortar in piers.		X											$50,000.00
													Maintenance Work Required Total Cost:	$131,000.00
Additional Repair and Rehabilitation		**Priority**												
Element #	Repair and Rehabilitation Required	6-10 years			1-5 years			Within 1 year			Urgent			
7	Replace deck wearing surface.					X								$150,000.00
17	Replace pedestrian barrier.					X								$170,000.00
													Additional Repair or Rehabilitation Total Cost:	$320,000.00
													Construction Sub-Total:	**$1,721,000.00**

Associated Work:	Comments	Estimated Cost
Traffic Management	Close bridge for construction.	$10,000.00
Utilities	Allowance.	$10,000.00
Temporary Support	Allowance.	$600,000.00
Environmental Assessment	Allowance.	$10,000.00
Engineering	Engineering, Contract Administration (Superstructure and substructure inspections)	$125,000.00
Mobilization/Demobilization		$175,000.00
Contingencies		$200,000.00
	Associated Work Sub-Total:	**$1,130,000.00**

Justification

Note: The total cost estimation for all work is shown below. The elements listed in the "Additional Repair and Rehabilitation" section are included as requested by the Town of Tillsonburg for serviceability purposes and represent a deck replacement prior to completing a major rehab of all steel elements (i.e. beams, piers, bracing, bearings, diaphragms etc.) If the rehabilitation work is separated into multiple projects, additional costs for associated work will be required for each.

Construction Cost:	$1,721,000.00
Associated Work Cost:	$1,130,000.00
TOTAL Estimated Cost	$2,851,000.00

Ontario Structure Inspection Manual - Enhanced Inspection Form **Site Number:** BR_KINS0001

Element Data

Element Group:	Abutments					Length:	0.9
Element Name:	Abutment Walls					Width:	5
Location:	East and West					Height:	2.5
Material:	Block					Count:	2
Element Type:	Gravity Wall					Total Quantity:	25 sq.m
Environment:	Benign					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition	Units	Exc.	Good	Fair	Poor		
Data:	sq.m	0	15	7.5	2.5		

Comments:
Isolated narrow cracks with delamination in three stone faces at west abutment and one stone face at east abutment. Corrosion staining from bridge. Loss of mortar at surface at approximately 30% of joints.

Recommended Work:	Rehab ☐	Replace ☐				Maintenance Needs:	Other: Reinstall Mortar
Timing:	Urgent ☐	< 1yr ☐	1 - 5 yr ☐	6 - 10 yr ☐		☐ Urgent ☐ 1 year	☒ 2 year

Element Group:	Abutments					Length:	
Element Name:	Ballast Walls					Width:	5
Location:	East and West					Height:	1.2
Material:	Block					Count:	2
Element Type:						Total Quantity:	12 sq.m
Environment:	Benign					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition	Units	Exc.	Good	Fair	Poor		
Data:	sq.m	0	10.8	1.2	0		

Comments:
Minor isolated narrow to medium cracks. Corrosion staining from bridge. Loss of mortar.

Recommended Work:	Rehab ☐	Replace ☐			Maintenance Needs:	
Timing:	Urgent ☐	< 1yr ☐	1 - 5 yr ☐	6 - 10 yr ☐	☐ Urgent ☐ 1 year	☐ 2 year

Element Group:	Abutments					Length:	0.52
Element Name:	Bearing / Bearing Seat					Width:	0.365
Location:	East and West					Height:	
Material:	Steel / Wood					Count:	4
Element Type:	Plate					Total Quantity:	0.8 sq.m
Environment:	Benign					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition	Units	Exc.	Good	Fair	Poor		
Data:	sq.m	0	0	0.7	0.1		

Comments:
Bearings sit on 2-6"x10"x13' timbers which sit on each abutment. Light cracking and splitting evident. Timbers in good to fair condition. Light to severe corrosion of bearing plate throughout with flaking of delaminated steel and light section loss.

Recommended Work:	Rehab ☒	Replace ☐			Maintenance Needs:	
Timing:	Urgent ☐	< 1yr ☐	1 - 5 yr ☒	6 - 10 yr ☐	☐ Urgent ☐ 1 year	☐ 2 year

Ontario Structure Inspection Manual - Enhanced Inspection Form **Site Number:** BR_KINS0001

Element Data

Element Group:	Piers					Length:	0.805
Element Name:	Bearings (At Piers)					Width:	0.52
Location:	Top of Steel Pier Columns					Height:	
Material:	Steel					Count:	16
Element Type:	Plate					Total Quantity:	6.7 sq.m
Environment:	Benign					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition	Units	Exc.	Good	Fair	Poor		
Data:	sq.m	0	0	6.1	0.6		

Comments:
Medium corrosion of bearing plates. Delamination typical throughout. Flaking of steel evident.

Recommended Work:	Rehab [X]	Replace [ ]				Maintenance Needs:			
Timing:	Urgent [ ]	< 1yr [ ]	1 - 5 yr [X]	6 - 10 yr [ ]		[ ] Urgent	[ ] 1 year	[ ] 2 year	

Element Group:	Abutments					Length:	4.3
Element Name:	Wingwalls					Width:	
Location:	Quadrants					Height:	2.4
Material:	Block					Count:	4
Element Type:	Block					Total Quantity:	41.3 sq.m
Environment:	Benign					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition	Units	Exc.	Good	Fair	Poor		
Data:	sq.m	0	34.4	6.8	0.1		

Comments:
Isolated narrow cracks with delamination. Loss of mortar on approximately 50% of joints (surface of mortar only).

Recommended Work:	Rehab [ ]	Replace [ ]				Maintenance Needs:	Other: Reinstall Mortar		
Timing:	Urgent [ ]	< 1yr [ ]	1 - 5 yr [ ]	6 - 10 yr [ ]		[ ] Urgent	[ ] 1 year	[X] 2 year	

Element Group:	Approaches					Length:	16.25
Element Name:	Wearing Surface (Approaches)					Width:	2.8
Location:	East and West					Height:	
Material:	Asphalt					Count:	2
Element Type:						Total Quantity:	91 sq.m
Environment:	Severe					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition	Units	Exc.	Good	Fair	Poor		
Data:	sq.m	0	63.2	27.3	0.5		

Comments:
Narrow to medium longitudinal and transverse cracking. Isolated settlement with medium cracking at east approach, north edge. Patches at bridge deck (0.4m x 2.8m at east, 1.25m x 2.8m at west). Narrow to medium transverse cracking in west approach.

Recommended Work:	Rehab [ ]	Replace [ ]				Maintenance Needs:	Rout & Seal		
Timing:	Urgent [ ]	< 1yr [ ]	1 - 5 yr [ ]	6 - 10 yr [ ]		[ ] Urgent	[ ] 1 year	[X] 2 year	

Ontario Structure Inspection Manual - Enhanced Inspection Form **Site Number:** BR_KINS0001

Element Data

Element Group:	Barriers					Length:	137
Element Name:	Railing Systems					Width:	
Location:	North and South					Height:	1.9
Material:	Steel Fence					Count:	2
Element Type:	Steel Fence					Total Quantity:	520.6 sq.m
Environment:	Severe					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition Data:	Units	Exc.	Good	Fair	Poor		
	sq.m	0	321.2	177.8	21.6		

Comments:
Light to medium surface corrosion of post base plates. Light corrosion throughout. Loose fencing due to loose bottom wire.

Recommended Work: Rehab [X] Replace [ ]
Timing: Urgent [ ] < 1yr [ ] 1 - 5 yr [X] 6 - 10 yr [ ]

Maintenance Needs: Other: Fix Loose Wire
[ ] Urgent [X] 1 year [ ] 2 year

Element Group:	Beam/MLE'S					Length:	2.15
Element Name:	Diaphragms (Horizontals)					Width:	0.1
Location:	Beneath Deck between Girders					Height:	0.1
Material:	Steel					Count:	92
Element Type:	Cross Type					Total Quantity:	92 Each
Environment:	Benign					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition Data:	Units	Exc.	Good	Fair	Poor		
	Each	0	0	55	37		

Comments:
Includes top and bottom horizontal members in diaphragm. Very severe corrosion with delamation throughout all diaphragms. Delaminated steel flaking causing 10-25% section loss in localized areas.

Recommended Work: Rehab [ ] Replace [X]
Timing: Urgent [ ] < 1yr [ ] 1 - 5 yr [X] 6 - 10 yr [ ]

Maintenance Needs:
[ ] Urgent [ ] 1 year [ ] 2 year

Element Group:	Beam/MLE'S					Length:	2.4
Element Name:	Diaphragms (Diagonals)					Width:	0.1
Location:	Beneath Deck between Girders					Height:	0.1
Material:	Steel					Count:	92
Element Type:	Cross Type					Total Quantity:	92 Each
Environment:	Benign					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition Data:	Units	Exc.	Good	Fair	Poor		
	Each	0	0	64	28		

Comments:
Includes both diagonal members in diaphragm. Severe corrosion with delamination throughout all diaphragms. Delaminated steel flaking causing 10-20% section loss in localized areas.

Recommended Work: Rehab [ ] Replace [X]
Timing: Urgent [ ] < 1yr [ ] 1 - 5 yr [X] 6 - 10 yr [ ]

Maintenance Needs:
[ ] Urgent [ ] 1 year [ ] 2 year

Ontario Structure Inspection Manual - Enhanced Inspection Form **Site Number:** BR_KINS0001

Element Data

Element Group:	Beam/MLE'S					Length:	4
Element Name:	Floor Beams					Width:	0.25
Location:						Height:	0.25
Material:	Wood					Count:	290
Element Type:	Rectangular Wood					Total Quantity:	290 Each
Environment:	Severe					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition Data:	Units	Exc.	Good	Fair	Poor		
	Each	0	232	58	0		

Comments:
Light weathering with staining evident at localized areas. Localized areas of minor splitting and checking at timber edges.

Recommended Work: Rehab ☐ Replace ☐
Timing: Urgent ☐ < 1yr ☐ 1 - 5 yr ☐ 6 - 10 yr ☐

Maintenance Needs:
☐ Urgent ☐ 1 year ☐ 2 year

Element Group:	Beam/MLE'S					Length:	106
Element Name:	Girders					Width:	0.3
Location:						Height:	0.95
Material:	Steel					Count:	2
Element Type:	I-Type					Total Quantity:	695.4 sq.m
Environment:	Benign					Limited Inspection:	X
Protection System:	None					Perform. Deficiencies	
Condition Data:	Units	Exc.	Good	Fair	Poor		
	sq.m	0	0	556.3	139.1		

Comments:
Light to severe corrosion evident throughout both girders. Rivets are heavily deteriorated throughout. Rivet connections appear to be stable. Medium delamination of top and bottom girder flanges typical throughout. Web appears to have minor delamination and corrosion with approximately 10% section loss. Stiffener plates attached to top and bottom of each girder. Top flange has 2 plates at mid-span. Bottom flange has 3 plates at mid-span. Plates are delaminated with 10-15% section loss in localized areas. Girder at mid-span of bridge (Span E-F on structure drawing) measures 0.3m x 1.5m. Flanges at span E-F has 4 stiffener plates at the top and bottom. Surface delamination on exterior south girder at Span E-F. Delamination located at 5th bay from F column. Vertical web stiffener (angle) located in first span from C column at Span B-C has 30% section loss. Deterioration of girder-end flange at south H column. Beams not visible on top where covered by the deck structure.

Recommended Work: Rehab ☒ Replace ☐
Timing: Urgent ☐ < 1yr ☐ 1 - 5 yr ☒ 6 - 10 yr ☐

Maintenance Needs:
☐ Urgent ☐ 1 year ☐ 2 year

Element Group:	Beam/MLE'S					Length:	106
Element Name:	Stringers					Width:	0.2
Location:	North and South on Top of Floor Beams					Height:	0.1
Material:	Wood					Count:	2
Element Type:	Rectangular Solid					Total Quantity:	84.8 sq.m
Environment:	Benign					Limited Inspection:	
Protection System:	None					Perform. Deficiencies	
Condition Data:	Units	Exc.	Good	Fair	Poor		
	sq.m	0	73.3	11.5	0		

Comments:
Light to medium weathering, checking and splitting.

Recommended Work: Rehab ☐ Replace ☐
Timing: Urgent ☐ < 1yr ☐ 1 - 5 yr ☐ 6 - 10 yr ☐

Maintenance Needs:
☐ Urgent ☐ 1 year ☐ 2 year

Ontario Structure Inspection Manual - Enhanced Inspection Form **Site Number:** BR_KINS0001

Element Data

Element Group:	Bracing					Length:	
Element Name:	Diagonal Bracing Element					Width:	
Location:	Between Steel Trestle Pier					Height:	
Material:	Steel					Count:	52
Element Type:						Total Quantity:	52 Each
Environment:	Benign					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition	Units	Exc.	Good	Fair	Poor		
Data:	Each	0	0	42	10		

Comments:
Medium to severe corrosion throughout with flaking of delaminated steel. Areas with 10% section loss.

Recommended Work: Rehab [X] Replace [ ]
Timing: Urgent [ ] < 1yr [ ] 1 - 5 yr [X] 6 - 10 yr [ ]

Maintenance Needs:
[ ] Urgent [ ] 1 year [ ] 2 year

Element Group:	Bracing					Length:	
Element Name:	Horizontal Bracing Element					Width:	
Location:	Between Steel Trestle Pier					Height:	
Material:	Steel					Count:	34
Element Type:						Total Quantity:	34 Each
Environment:	Benign					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition	Units	Exc.	Good	Fair	Poor		
Data:	Each	0	0	27	7		

Comments:
Members comprised of 2 C-Channels on top and bottom with lace bracing on exterior sides. Medium to severe corrosion throughout with flaking of delaminated steel. Channels are in fair condition. Lace braces are severely delaminated.

Recommended Work: Rehab [X] Replace [ ]
Timing: Urgent [ ] < 1yr [ ] 1 - 5 yr [X] 6 - 10 yr [ ]

Maintenance Needs:
[ ] Urgent [ ] 1 year [ ] 2 year

Element Group:	Bracing					Length:	
Element Name:	Bracing Element					Width:	3
Location:	Beneath Deck					Height:	
Material:	Steel					Count:	76
Element Type:	Steel Angle					Total Quantity:	76 Each
Environment:	Moderate					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition	Units	Exc.	Good	Fair	Poor		
Data:	Each	0	0	30	46		

Comments:
Medium to very severe corrosion throughout with flaking of delaminated steel. Areas with 25-30% sections loss.

Recommended Work: Rehab [ ] Replace [X]
Timing: Urgent [ ] < 1yr [ ] 1 - 5 yr [X] 6 - 10 yr [ ]

Maintenance Needs:
[ ] Urgent [ ] 1 year [ ] 2 year

Ontario Structure Inspection Manual - Enhanced Inspection Form **Site Number:** BR_KINS0001

Element Data

Element Group:	Connections					Length:	
Element Name:	Structural Connections					Width:	
Location:	Substructure					Height:	
Material:	Steel					Count:	
Element Type:	Plate					Total Quantity:	1 All
Environment:	Benign to Moderate					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition Data:	Units: All	Exc.: 0	Good: 0	Fair: 0	Poor: 1		

Comments:
Severe corrosion is exhibited on the gusset plates of the structural connections, along with section loss due to delamination. Cracking and severe corrosion leading to section loss was noted on various riveted connections. Rehabilitate connections throughout the structure.

Recommended Work:	Rehab [X]	Replace [ ]				Maintenance Needs:	
Timing:	Urgent [ ]	< 1yr [ ]	1 - 5 yr [X]	6 - 10 yr [ ]		[ ] Urgent	[ ] 1 year [ ] 2 year

Element Group:	Decks					Length:	107
Element Name:	Wearing Surface (Decks)					Width:	2.6
Location:						Height:	
Material:	Wood					Count:	1
Element Type:						Total Quantity:	278.2 sq.m
Environment:	Severe					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition Data:	Units: sq.m	Exc.: 0	Good: 206.9	Fair: 67.6	Poor: 3.7		

Comments:
Light to medium weathering, checking and splitting. Corrosion at nails. Two boards warping upward from the deck.

Recommended Work:	Rehab [ ]	Replace [ ]				Maintenance Needs:	Deck Surface Repair
Timing:	Urgent [ ]	< 1yr [ ]	1 - 5 yr [ ]	6 - 10 yr [ ]		[ ] Urgent	[X] 1 year [ ] 2 year

Element Group:	Embankments and Streams					Length:	
Element Name:	Embankments					Width:	
Location:	Quadrants and Base of Abutments					Height:	
Material:	Vegetation					Count:	6
Element Type:						Total Quantity:	6 Each
Environment:	Benign					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition Data:	Units: Each	Exc.: 0	Good: 4	Fair: 0	Poor: 2	Unstable Embankments	

Comments:
Light erosion at quadrant embankments. Severe erosion at base of east abutment. Severe erosion at northwest wingwall embankment. Subdrain running down the northwest wingwall embankment.

Recommended Work:	Rehab [ ]	Replace [ ]				Maintenance Needs:	Erosion Control at Bridges
Timing:	Urgent [ ]	< 1yr [ ]	1 - 5 yr [ ]	6 - 10 yr [ ]		[ ] Urgent	[X] 1 year [ ] 2 year

Ontario Structure Inspection Manual - Enhanced Inspection Form **Site Number:** BR_KINS0001

Element Data

Element Group:	Embankments and Streams					Length:	
Element Name:	Streams and Waterways					Width:	
Location:	Beneath Span					Height:	
Material:						Count:	1
Element Type:						Total Quantity:	1 All
Environment:	Benign					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition Data:	Units	Exc.	Good	Fair	Poor		
	All	0	1	0	0		

Comments:
Light erosion of stream banks at east piers. Wood debris downstream slightly restricting flow.

Recommended Work: Rehab ☐ Replace ☐
Timing: Urgent ☐ < 1yr ☐ 1 - 5 yr ☐ 6 - 10 yr ☐

Maintenance Needs:
☐ Urgent ☐ 1 year ☐ 2 year

Element Group:	Foundations					Length:	
Element Name:	Foundation (Below Ground Level)					Width:	
Location:	Below Piers					Height:	
Material:						Count:	1
Element Type:						Total Quantity:	1 All
Environment:	Benign					Limited Inspection:	X
Protection System:	None					Perform. Deficiencies	
Condition Data:	Units	Exc.	Good	Fair	Poor		
	All	0	0	1	0		

Comments:
Limited inspection due to the foundations being buried. Condition data of foundations based on condition of concrete piers.

Recommended Work: Rehab ☐ Replace ☐
Timing: Urgent ☐ < 1yr ☐ 1 - 5 yr ☐ 6 - 10 yr ☐

Maintenance Needs:
☐ Urgent ☐ 1 year ☐ 2 year

Element Group:	Piers					Length:	0.76
Element Name:	Bearings					Width:	0.46
Location:	Top of Concrete Pier Caps					Height:	0.1
Material:	Steel					Count:	16
Element Type:	Plate					Total Quantity:	16 Each
Environment:	Severe					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition Data:	Units	Exc.	Good	Fair	Poor		
	Each	0	0	16	0		

Comments:
Light to medium corrosion of plates and fasteners throughout.

Recommended Work: Rehab ☐ Replace ☐
Timing: Urgent ☐ < 1yr ☐ 1 - 5 yr ☐ 6 - 10 yr ☐

Maintenance Needs:
☐ Urgent ☐ 1 year ☐ 2 year

Element Data

Element Group:	Piers					Length:	1.85
Element Name:	Caps					Width:	1.85
Location:	Top of Piers					Height:	1.2
Material:	Concrete					Count:	16
Element Type:						Total Quantity:	136 sq.m
Environment:	Benign					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition	Units	Exc.	Good	Fair	Poor		
Data:	sq.m	0	76	28	32		

Comments:
Few narrow and medium cracks with small surface delaminations. Corrosion staining from bridge. Loss of mortar. Steel strapping around pier caps have moderate corrosion (10 - 60% section loss). Three (3) pier caps have a vertical crack through top cap (South F, North I, and South I). Cracks in east to west orientation. Steel strapping missing at North I pier cap.

Recommended Work:	Rehab	[X]	Replace	[ ]		Maintenance Needs:	Other: Replace Missing Strapping		
Timing:	Urgent [ ]	< 1yr [ ]	1 - 5 yr	[X]	6 - 10 yr [ ]		[X] Urgent	[ ] 1 year	[ ] 2 year

Element Group:	Piers					Length:	
Element Name:	Shafts/Columns/Pile Bents					Width:	
Location:	From Pier Caps to Underside of Girders					Height:	
Material:	Steel Trestle					Count:	16
Element Type:						Total Quantity:	16 Each
Environment:	Benign					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition	Units	Exc.	Good	Fair	Poor		
Data:	Each	0	0	11	5		

Comments:
Column comprised of 2 C-Channels, 1 steel plate on exterior side, and lace braces on interior side. Light to medium corrosion throughout all members . Lace braces on each column have severely corroded. Localized areas of broken lace braces on north side of Column I.

Recommended Work:	Rehab	[X]	Replace	[ ]		Maintenance Needs:			
Timing:	Urgent [ ]	< 1yr [ ]	1 - 5 yr	[X]	6 - 10 yr [ ]		[ ] Urgent	[ ] 1 year	[ ] 2 year

Element Group:	Piers					Length:	1.85
Element Name:	Shafts/Columns/Pile Bents					Width:	1.85
Location:	Between Ground and Pier Caps					Height:	
Material:	Concrete					Count:	16
Element Type:	Concrete Block					Total Quantity:	16 Each
Environment:	Benign					Limited Inspection:	
Protection System:						Perform. Deficiencies	
Condition	Units	Exc.	Good	Fair	Poor		
Data:	Each	0	10	5	1		

Comments:
North C - Two small surface delaminations, typical 50% grout pop-out. South C - Small surface delamination, small hole, 30% grout popout. North D - Small sapling growing in south face mortar joint, typical 30% grout loss. South D - One small delamination, 20% grout loss. South E - One small delamination, 15% grout loss. North E - One 0.3m square surface delamination, 30% grout loss. South F - Two small facial delaminations, few short hairline cracks in blocks, 15% grout loss. North G - Small delamination at base, 25% grout loss. South G - Three small surface delaminations, one hairline crack, 20% grout loss. North H - One small delamination, 30% grout loss, corrosion staining evident. South H - One small delamination, 30% grout loss. North I - One 0.3m square delamination, typical corrosion staining, 30% grout loss.

Recommended Work:	Rehab	[ ]	Replace	[ ]		Maintenance Needs:	Other: Reinstall Mortar		
Timing:	Urgent [ ]	< 1yr [ ]	1 - 5 yr	[ ]	6 - 10 yr [ ]		[ ] Urgent	[ ] 1 year	[X] 2 year

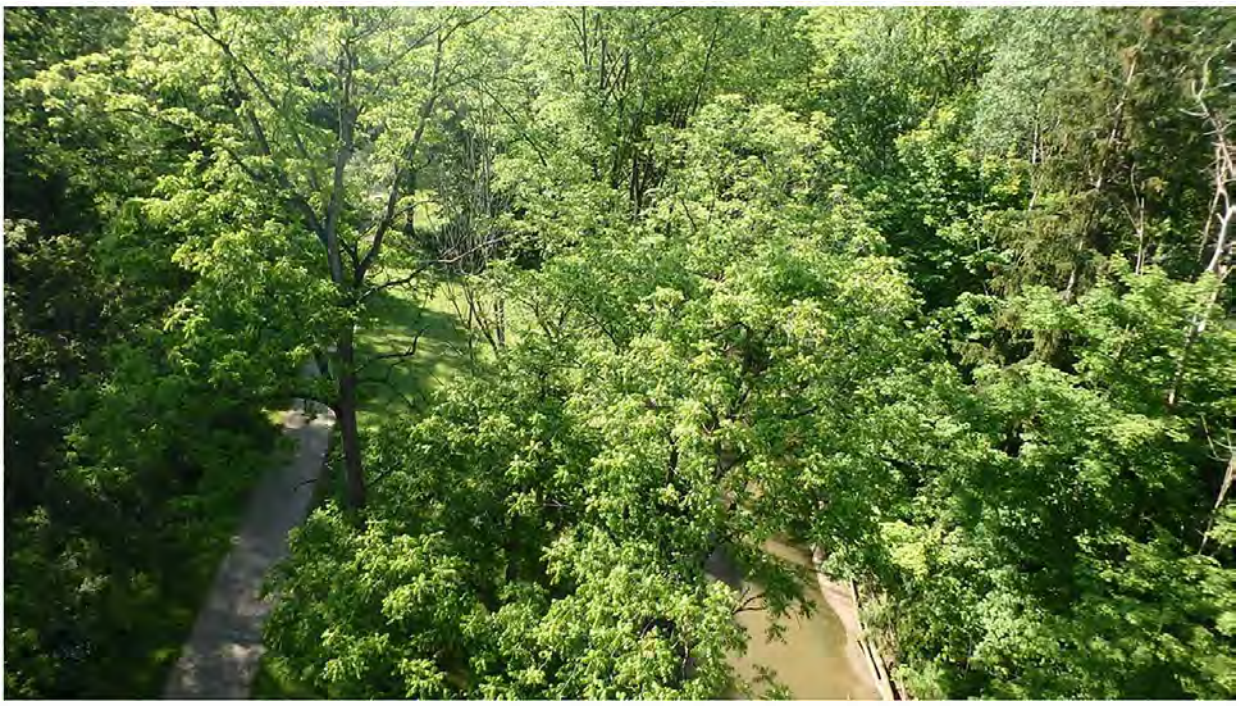
1. East Approach

2. West Approach

3. North Elevation

4. South Elevation

5. Upstream



6. Downstream

7. Surface Corrosion on Diagonal Bracing, Typical

8. Severe Corrosion and Delamination on Girder and Diaphragm

9. Severe Corrosion and Delamination on Horizontal Component of Diaphragm

10. Severe Corrosion and Rivet Cracking on Lateral Bracing on Soffit

11. Medium Corrosion and Delamination of Diaphragm and Girder Connection

12. Severe Corrosion and Delamination of Diagonal Components of Diaphragm

13. Severe Corrosion, Delamination, and Cracking of Rivets at Lateral Bracing and Girder

14. Severe Corrosion and Delamination on Columns

15. Severe Corrosion and Delamination on Girder

16. Medium Corrosion of Bearing Plate

17. Medium Corrosion and Delamination of Connection Plate at Column End

18. Very Severe Corrosion and Delamination with Complete Section Loss on Column Lace Bracing

19. Surface Corrosion on Diagonal Bracing

20. Medium Corrosion and Delamination on Column

21. Medium Corrosion of Column at Girder

22. Medium Corrosion, Delamination, and Cracking of Rivets at Connection Plates on Girder

23. Severe Corrosion and Delamination of Column

24. Severe Corrosion and Delamination of Bottom Horizontal Chord

25. Medium Corrosion on Bearing Plate, and Surrounding Members; Cracking of Rivets

26. Medium Corrosion and Delamination on Girder at Soffit; Severe Corrosion of Lateral Bracing

27. Very Severe Corrosion of Bracing on Lateral Support

28. Very Severe Corrosion and Delamination at Connection of Column and Lateral Support

29. Severe Corrosion and Delamination on Column Bracing

30. Medium Corrosion and Delamination of Connection at Middle of Column

31. Medium Corrosion of Bearing Plate; Staining of Pier Cap

32. Severe Corrosion and Delamination of Bottom Horizontal Chord of Lateral Support

33. Medium Corrosion of Girder; Cracking of Rivets and Delamination of Bottom Flange

34. Medium Corrosion and Delamination of Girder

35. Severe Corrosion on Bottom Flange of Girder; Cracked Rivets

36. Deterioration of the Girder Flange at the South H Column

37. Very Severe Corrosion and Delamination at Column Connection to Girder; Separation of Bracing at Weld

38. Severe Corrosion and Delamination of Diaphragm; Medium Corrosion and Delamination of Girder and Bearing Plate

39. Severe Deterioration and Delamination at Connection of Girder, Column, and Diagonal Bracing

40. Medium Corrosion and Delamination of Bearing Plate at Girder; Medium Corrosion and Delamination on Bottom Flange of Girder

41. Severe Corrosion and Delamination on Top Flange of Girder

42. Very Severe Corrosion on Connection Plate Between Diagonal Lateral Bracing Members

43. Very Severe Corrosion and Delamination at Ends of Girders Over Columns

44. Severe Corrosion on Bottom Flange of Girder Resting on Bearing Plate; Medium Corrosion and Delamination of Bearing Plate

45. Very Severe Deterioration and Delamination of Bearing Seat at Top of Column

46. Severe Corrosion and Delamination on Both Flanges of Column

47. Very Severe Corrosion and Delamination of Horizontal Chord

48. Medium Corrosion on Girder, Typical

49. Severe Corrosion and Delamination of Angle Connections at the Top of Girder

50. Localized Delamination on Exterior Face of Girder

51. Severe Corrosion and Delamination of Connections and Cracking of Rivets at Lateral Support

52. Severe Corrosion and Delamination on Bottom Flange of Girder at Column Connection

53. Very Severe Corrosion with Section Loss on Column Connection at South Column E

54. Severe Corrosion of Lateral Support and Lace Bracing at Centre of Columns, Typical

55. Medium Corrosion of Connection Between Column and Bearing Seat; Vertical Crack in Pier Cap

56. Severe Corrosion and Delamination of Column Bearing Connection

57. Severe Corrosion and Delamination at Connection of Column to Girder

58. Medium Corrosion and Delamination of Steel Between Pier and Pier Cap

59. Very Severe Corrosion and Forty Percent Section Loss of Vertical Web Stiffener

60. Severe Corrosion and Delamination of Steel at Bottom of Pier Cap; Vertical Crack in Pier Cap

61. Vertical Crack in Bearing Block; Severe Corrosion of Column at Connection

62. Severe Corrosion and Delamination of Web Stiffener

63. Severe Corrosion of Connection Plate and Bearing Plate at Connection Between Column and Girder

64. Vertical Cracking Through Pier Cap

65. Severe Corrosion and Delamination of Angle at Bottom Flange of Girder

66. Rivet Cracking; Typical Thoughout Structure

67. Very Severe Corrosion and Fifty Percent Section Loss of Bracket Under Bearing Seat

68. Severe Corrosion and Delamination at Connection Between Column and Girder

69. Medium Corrosion of Bearing Plate, and Severe Corrosion and Delamination of Girder End at East Abutment

70. Minor Checks and Shakes in Wood at East Abutment

71. Medium to Severe Corrosion on Lateral Supports

72. Soffit; Staining on Piers, Typical

73. Soffit at West Abutment

74. Erosion at Northeast Quadrant

75. Minor Staining on West Abutment

76. Vertical Cracking in Bearing Block; Separation of Concrete Blocks in South B Pier

77. Staining and Vertical Cracking in Bearing Block; Staining in North B Pier

78. South C Pier; Staining Throughout

79. North C Pier; Staining Throughout

80. South D Pier; Staining Throughout

81. North D Pier; Staining Throughout

82. South E Pier

83. North E Pier

84. North F Pier; Staining Throughout

85. South F Pier

86. South G Pier

87. Soffit at G Set of Piers Looking West

88. Upstream

89. Downstream

90. Trail Looking South From Beneath Structure

91. Trail Looking North From Beneath Structure

92. South H Pier; Staining Throughout

93. South I Pier; Staining Typical

94. North I Pier

95. Cracking and Mortar Loss on Piers, Typical

96. Erosion Between East Piers

97. Severe Erosion From East Abutment Wall to North Pier

98. East Abutment Wall

99. South East Bearing; Medium Corrosion and Delamination

100. Wooden Posts at East Approach

101. Checks and Splits in Wooden Posts at West Approach

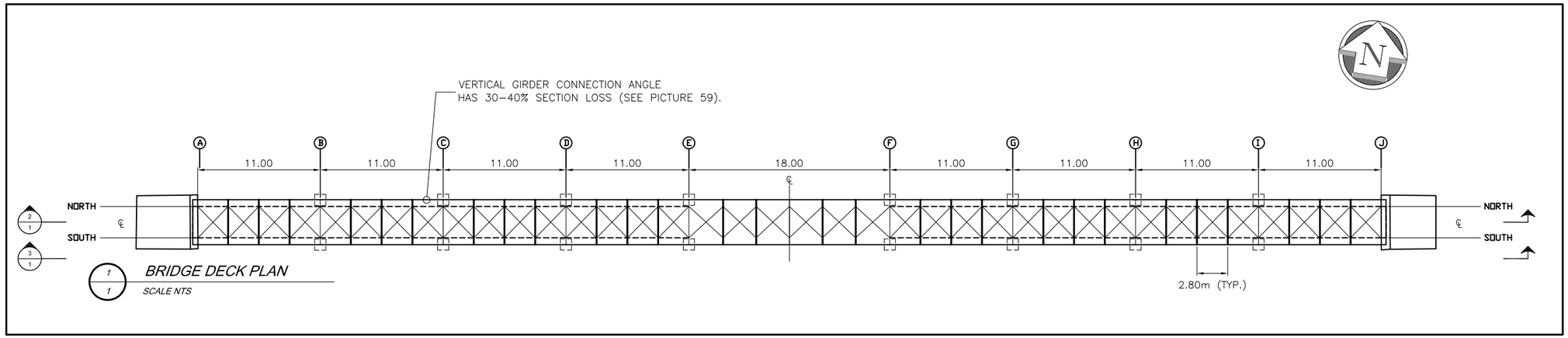
102. Light Corrosion on Fence at Both Sides of Deck, Typical

103. Medium Corrosion of Posts for Fencing on Bridge Deck

104. Lifting of Deck Boards Along Deck Wearing Surface

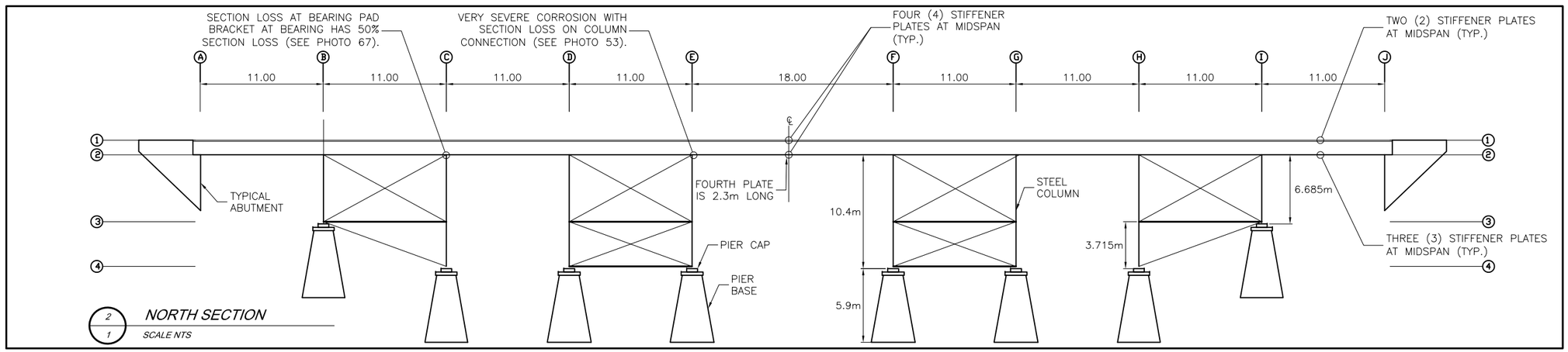
APPENDIX C

KINSMEN PEDESTRIAN BRIDGE ENHANCED OSIM DRAWING



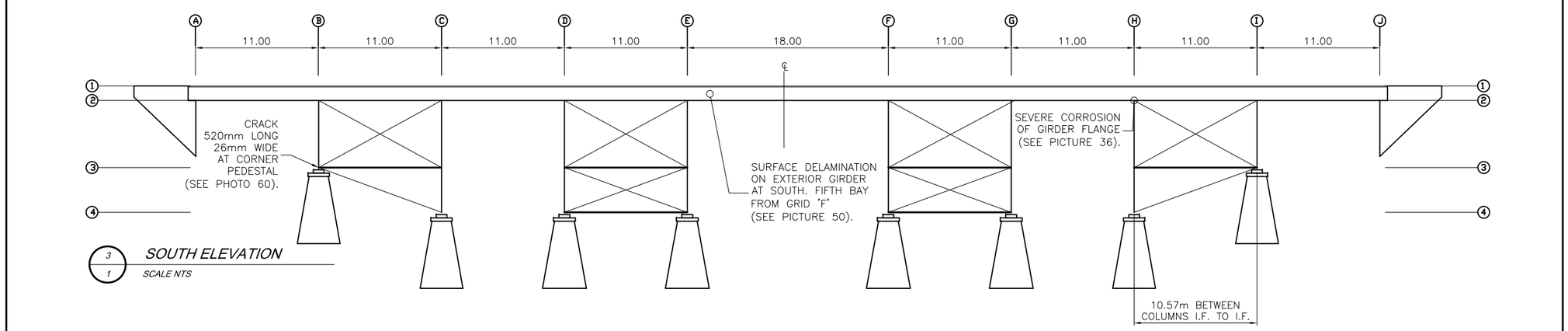
2/1 3/1 1/1 *BRIDGE DECK PLAN*

SCALE NTS



2/1 *NORTH SECTION*

SCALE NTS



3/1 *SOUTH ELEVATION*

SCALE NTS

No.	DATE	ISSUED
1	JUNE 18, 2019	DATE OF INSPECTION
2	AUG. 21, 2019	SUBMITTED TO TOWN FOR REVIEW
3	SEPT. 29, 2019	DRAFT REPORT SUBMITTED FOR REVIEW
No.	DATE	REVISION

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Consulting Engineers, Architects & Planners
G. DOUGLAS VALLEE LIMITED
2 TALBOT STREET NORTH
SIMCOE, ONTARIO N3Y 3W4
(519) 426-6270

Stamp

Project Title
KINSMEN PED. BRIDGE
ENHANCED OSIM INSPECTION

Drawing Title
ENHANCED OSIM INSPECTION DRAWING

Designed by :	Drawn By : JCM
Checked by :	Date Started : JUNE 17, 2019
Drawing Scale : AS NOTED	Drawing No. 1
Project No. 19-037	

DATE LAST PLOTTED :

APPENDIX D

BLACK BRIDGE, WATERFORD HERITAGE TRAIL

Black Bridge

Client: Norfolk County

Location: Waterford Heritage Trails

The century old Black Bridge, spans the Nanticoke Creek over the Waterford Ponds. The historic rail bridge consists of a through-truss, and multiple high level simply-supported spans. Following the abandonment of the railway, the Waterford Heritage Trail Association assumed stewardship of the structure, and commissioned a retrofit of the bridge for pedestrian use. The wood deck was repaired and modified, lookout areas were added, and a beautiful railing was installed. The work done for the rehabilitation of Black Bridge was completed by Cedar Springs Landscaping Group in 2012.

Notable Design Features:

- Deck design prevents further deterioration of rail ties.
- Has become the most photographed bridge location in Norfolk.

Tendered Value: $134,300 **Construction Cost:** $134,300

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