Appendix G

Stage 1 Archaeological Assessment Report

Stage 1 Archaeological Assessment
West Montrose Bridge
(Lot 71, Beasley Tract, Former Township of Woolwich, County of Waterloo)
Regional Municipality of Waterloo, Ontario

Original Report

Prepared for:

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Executive Summary

Archaeological Services Inc. was contracted by Doug Dixon & Associates Inc. to conduct a Stage 1 Archaeological Assessment (Background Research and Property Inspection) as part of the West Montrose Bridge Rehabilitation. This project involves the rehabilitation of the West Montrose Bridge, located on Covered Bridge Drive over the Grand River, in the Region of Waterloo.

The Stage 1 background study determined no previously registered archaeological sites are located within one kilometre of the Study Area. The property inspection determined that the Study Area has been subject to deep and extensive disturbance.

In light of these results, the following recommendations are made:

1. The Study Area does not retain archaeological potential on account of deep and extensive land disturbance. These lands do not require further archaeological assessment; and
2. Should the proposed work extend beyond the current Study Area, further Stage 1 archaeological assessment should be conducted to determine the archaeological potential of the surrounding lands.



Project Personnel

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1.0 Project Context

Archaeological Services Inc. (A.S.I.) was contracted by Doug Dixon & Associates Inc., on behalf of the Region of Waterloo to conduct a Stage 1 Archaeological Assessment (Background Research and Property Inspection) as part of the West Montrose Bridge Rehabilitation (Figure 1). This project involves the rehabilitation of West Montrose Bridge, located on Covered Bridge Drive over the Grand River. The existing bridge abutments and pier will be rehabilitated and rock protection will be placed around both the abutments and pier.

All activities carried out during this assessment were completed in accordance with the *Ontario Heritage Act* (Ontario Heritage Act, R.S.O. c. O.18, 1990, as amended in 2019) and the 2011 *Standards and Guidelines for Consultant Archaeologists* (S & G), administered by the Ministry of Heritage, Sport, Tourism and Culture Industries (MHSTCI 2011).

1.1. Development Context

All work has been undertaken as required by the *Environmental Assessment Act, RSO* (Environmental Assessment Act, R.S.O., 1990 as amended 2020) and regulations made under the Act, and are therefore subject to all associated legislation. This project is being conducted in accordance with the Municipal Engineers' Association document *Municipal Class Environmental Assessment* (Municipal Class Environmental Assessment, 2000, as amended 2015).

The Regional Municipality of Waterloo Archaeological Facilities Master Plan (Region of Waterloo, 1989) was also referenced.

Authorization to carry out the activities necessary for the completion of the Stage 1 archaeological assessment and property inspection was granted by the Region of Waterloo on May 18, 2021.

1.1.1. Treaties and Traditional Territories

Following the 1764 Niagara Peace Treaty and the follow-up treaties with Pontiac, the English colonial government considered the Mississaugas to be their allies

since they had accepted the Covenant Chain. The English administrators followed the terms of the Royal Proclamation and insured that no settlements were made in the hunting grounds that had been reserved for their use (Johnston 1964; Lytwyn 2005). In 1784, under the terms of the "Between the Lakes Purchase" signed by Sir Frederick Haldimand and the Mississaugas, the Crown acquired over one million acres of land in-part spanning westward from near modern day Niagara-on-the-Lake along the south shore of Lake Ontario to modern day Burlington (Aboriginal Affairs and Northern Development Canada 2016).

During the American Revolution, Mississauga warriors supported the English military. Rebel forces destroyed the villages of the Six Nations Iroquois in New York and many people were forced to move to the Niagara area. When Six Nations Iroquois leaders learned that the English planned to make a peace treaty with the Americans and establish a boundary line that would give away their homelands they were angry. The English government offered to protect Six Nations Iroquois peoples and give them land within their boundaries. On August 8, 1783, Lord North instructed Governor Haldimand to set apart land for the Six Nations Iroquois and ensure that they carried on their hunting and fur trading with the British. On May 22, 1784, a tract of land along the Grand River was purchased by the British government from the Mississaugas who lived in the vicinity (Johnston 1964; Lytwyn 2005). The land set apart is called the Haldimand Tract. Joseph Brant led Haudenosaunee loyalists (1600 people) to the Haldimand tract in 1784 and in the fall of 1784, Sir Frederick Haldimand formally awarded the tract to the Mohawks "and others of the Six Nations [Iroquois]." They were authorized to "Settle upon the Banks of the River" and were allotted "for that Purpose six miles [10 km] deep from each Side of [it] beginning at Lake Erie, & extending in the Proportion to [its] Head." The precise boundaries of the grant were unclear as there was no survey; for example, the northern boundary of the original deed from the Mississaugas to the Crown stated that the line extended "from the creek that falls from a small lake into…the bay known by the name of Waghquata [Burlington Bay] until it strikes the river La Tranche [Thames]." The 1790 survey by Augustus Jones intentionally failed to include the headwaters of the Grand, an action made all the more difficult to address given the unclear description of the extent in the original deeds (Johnston 1964; Lytwyn 2005).

Brant regarded the territory as his own to manage on behalf of the Confederacy and interpreted the proclamation as tantamount to full national recognition of the Mohawks and fellow tribesmen. This interpretation was strongly denied by the British (Johnston 1964; Lytwyn 2005). Appointed as Lieutenant Governor of the new colony of Upper Canada in 1791, Simcoe refused to permit the Six Nations Iroquois to sell/lease any part of their reserve because they were arranged independently of the Crown. Brant, on the other hand, argued for the Six Nations Iroquois' need for an immediate assured income from land sales as they could no longer hope to survive by hunting exclusively. Simcoe thought that if such practices were permitted, it could lead to other Europeans attempting to seize control by any means of the better part of the Six Nations Iroquois' reserve and it was therefore unresolved as to whether Six Nations Iroquois people could dispose of their lands directly to whomever they chose (Johnston 1964; Lytwyn 2005). In the first few years, Brant, who had been described, by some, as a Europeanized entrepreneur, took the initiative and invited white friends and acquaintances to the tract and provided them with rough land titles. Over the next 25 years (1784-1810), a considerable number of Europeans and Americans obtained similar leases authorizing them (in Brant's opinion) to occupy and improve lots overlooking the river (Johnston 1964; Lytwyn 2005).

The subsequent Peter Russel administration (1797-1798), however, recognized the leases and the sales that Brant arranged with white settlers along the Grand River Valley. Trustees were appointed to act on the behalf of the Six Nations Iroquois with the authority to receive payment of purchases. On the other hand, some Six Nations Iroquois thought that the land sale practices violated the ancient principle that land was not a "commodity which could be conveyed." Two Mohawk sachems even tried to take up arms to depose Brant because they did not agree with his ways. Their efforts were for naught and they returned to the Bay of Quinte where other Six Nation Iroquois peoples, led by Sachem John Deseronto, had settled after the American Revolution (Johnston 1964; Lytwyn 2005). A formal investigation of the matter was launched in 1812 although leases were not set aside. Due to problems of white encroachment including squatters without titles, settlers who bought land from individuals or through other transactions with Six Nations Iroquois, many of the leases were confirmed by the

Crown in 1834-5. Unauthorized sales and agreements remained rampant (Johnston 1964; Lytwyn 2005).

In 1841, Samuel P. Jarvis (Indian Superintendent) informed the Six Nations Iroquois that the only way to keep white intruders off their land would be for them to surrender it to the Crown, to be administered for their sole benefit. With this plan, the Six Nations Iroquois would retain lands that they actually occupied and a reserve of approximately 8,094 ha. The surrender of land was made by the Confederacy in January, 1841 (Johnston 1964; Lytwyn 2005).

Today, this history and those surrenders are still contested and there are numerous specific land claims that have been filed by the Six Nations Iroquois with the federal government in regard to lands within the Haldimand Tract (Johnston 1964; Lytwyn 2005).

1.2. Historical Context

1.2.1. Indigenous Land Use and Settlement

Southern Ontario has been occupied by human populations since the retreat of the Laurentide glacier approximately 13,000 years before present (B.P.) (Ferris, 2013). Populations at this time would have been highly mobile, inhabiting a boreal-parkland similar to the modern sub-arctic. By approximately 10,000 B.P., the environment had progressively warmed (Edwards & Fritz, 1988) and populations now occupied less extensive territories (Ellis & Deller, 1990).

Between approximately 10,000-5,500 B.P., the Great Lakes basins experienced low-water levels, and many sites which would have been located on those former shorelines are now submerged. This period produces the earliest evidence of heavy wood working tools, an indication of greater investment of labour in felling trees for fuel, to build shelter, and watercraft production. These activities suggest prolonged seasonal residency at occupation sites. Polished stone and native copper implements were being produced by approximately 8,000 B.P.; the latter was acquired from the north shore of Lake Superior, evidence of extensive exchange networks throughout the Great Lakes region. The earliest evidence for cemeteries dates to approximately 4,500-3,000 B.P. and is indicative of increased

social organization, investment of labour into social infrastructure, and the establishment of socially prescribed territories (Brown, 1995, p. 13; Ellis et al., 1990, 2009).

Between 3,000-2,500 B.P., populations continued to practice residential mobility and to harvest seasonally available resources, including spawning fish. The Woodland period begins around 2,500 B.P. and exchange and interaction networks broaden at this time (Spence et al., 1990, pp. 136, 138) and by approximately 2,000 B.P., evidence exists for small community camps, focusing on the seasonal harvesting of resources (Spence et al., 1990, pp. 155, 164). By 1,500 B.P. there is macro botanical evidence for maize in southern Ontario, and it is thought that maize only supplemented people's diet. There is earlier phytolithic evidence for maize in central New York State by 2,300 B.P. - it is likely that once similar analyses are conducted on Ontario ceramic vessels of the same period, the same evidence will be found (Birch & Williamson, 2013, pp. 13–15). As is evident in detailed Anishinaabek ethnographies, winter was a period during which some families would depart from the larger group as it was easier to sustain smaller populations (Rogers, 1962). It is generally understood that these populations were Algonquian-speakers during these millennia of settlement and land use.

From the beginning of the Late Woodland period at approximately 1,000 B.P., lifeways became more similar to that described in early historical documents. Between approximately 1000-1300 Common Era (C.E.), the communal site is replaced by the village focused on horticulture. Seasonal disintegration of the community for the exploitation of a wider territory and more varied resource base was still practised (Williamson, 1990, p. 317). By 1300-1450 C.E., this episodic community disintegration was no longer practised and populations now communally occupied sites throughout the year (Dodd et al., 1990, p. 343). From 1450-1649 C.E. this process continued with the coalescence of these small villages into larger communities (Birch & Williamson, 2013). Through this process, the socio-political organization of the First Nations, as described historically by the French and English explorers who first visited southern Ontario, was developed.

By 1600 C.E., the Huron- Wendat communities within Simcoe County had formed the Confederation of Nations encountered by the first European explorers and

missionaries. Samuel de Champlain in 1615 reported that a group of Iroquoian-speaking people situated between the Haudenosaunee and the Huron-Wendat were at peace and remained “la nation neutre”. Like the Huron-Wendat, Petun, and Haudenosaunee, the Neutral or Attawandaron people were settled village agriculturalists. In the 1640s, the Attawandaron and the Huron-Wendat (and their Algonquian allies such as the Nippissing and Odawa) were decimated by epidemics and ultimately dispersed by the Haudenosaunee. Shortly afterwards, the Haudenosaunee established a series of settlements at strategic locations along the trade routes inland from the north shore of Lake Ontario. By the 1690s however, the Anishinaabeg were the only communities with a permanent presence in southern Ontario. From the beginning of the eighteenth century to the assertion of British sovereignty in 1763, there was no interruption to Anishinaabeg control and use of southern Ontario.

1.2.2. Post-Contact Settlement

Historically, the Study Area is located in the former Township of Woolwich, County of Waterloo in Lot 71 and Beasley Tract.

The S & G stipulates that areas of early Euro-Canadian settlement (pioneer homesteads, isolated cabins, farmstead complexes), early wharf or dock complexes, pioneer churches, and early cemeteries are considered to have archaeological potential. Early historical transportation routes (trails, passes, roads, railways, portage routes), properties listed on a municipal register or designated under the Ontario Heritage Act or a federal, provincial, or municipal historic landmark or site are also considered to have archaeological potential.

For the Euro-Canadian period, the majority of early nineteenth century farmsteads (i.e., those that are arguably the most potentially significant resources and whose locations are rarely recorded on nineteenth century maps) are likely to be located in proximity to water. The development of the network of concession roads and railroads through the course of the nineteenth century frequently influenced the siting of farmsteads and businesses. Accordingly, undisturbed lands within 100 metres of an early settlement road are also considered to have potential for the presence of Euro-Canadian archaeological sites.

The first Europeans to arrive in the area were transient merchants and traders from France and England, who followed Indigenous pathways and set up trading posts at strategic locations along the well-traveled river routes. All of these occupations occurred at sites that afforded both natural landfalls and convenient access, by means of the various waterways and overland trails, into the hinterlands. Early transportation routes followed existing Indigenous trails, both along the lakeshore and adjacent to various creeks and rivers (ASI 2006).

Township of Woolwich

Woolwich Township was one of the earliest townships secured for settlement in Waterloo County but was slow to be settled. It includes such settlements as Montrose, Conestogo, Elmira, St. Jacobs, and Winterbourne. The land was divided into three blocks, which were later incorporated into the townships of Waterloo, Woolwich and Dumfries in 1816. The first settler in the township was Captain Thomas Smith of Vermont, who arrived around 1810 and lived in a house on the east side of the Grand River, followed by George Eby, who settled on Lot 2 in 1813 near the township boundary of Waterloo and Woolwich, and later other families such as Cress, Martin, Musselman, Reist, Meyer, Kressler and Bowman. Most of these early settlers were Mennonites who tended to settle west of the Grand River, while English (many of them Methodists) and Scots-Presbyterians settled to the east of the river and in 1808, lots totalling 26,600 acres were purchased by Mennonites. David Musselman built the first mill in about 1834 the township at the site of Conestogo, which had a population of about 70 people by 1850. Meyer laid out the boundaries of Heidelberg, while Bowman and Snider began the settlement of St. Jacobs around a saw and grist mill circa 1851. The township also includes the community of Elmira, which was founded by Edward Bristow in 1825 and after 1845 a large influx of German settlers greatly increased the population, and by the 1890s the population was over 1000 people. A large Mennonite population still lives in the township, including a small number of Old Order Mennonites. In 1973, a restructuring of the municipal boundaries and organization brought about the dissolution of Waterloo Township, the creation of the Cities of Cambridge, Kitchener and Waterloo, and the western portion of the former Waterloo Township, including Breslau, was transferred into Woolwich

Township (Mika and Mika 1983:673-674; Region of Waterloo 2010; Waterloo Region Museum 2017).

West Montrose Bridge

The West Montrose Covered Bridge represents the only authentic vehicular covered bridge in Ontario and the eighth oldest covered bridge in Canada. The bridge is an integral component of the local community and has been designated under Township of Woolwich to be of cultural heritage value (IBI Group, 2014). Located over the Grand River, the bridge was built by Sam and John Baer in 1881. The finished structure measures 196.5 feet across the river with an additional six foot overhand at each portal. The bridge was 17 feet wide and consisted of two equal spans resting on cedar cribs, now replaced with concrete abutments and a stone centre pier. A major rehabilitation of the structure was conducted by the Ontario Department of Highways in 1950 when the original flooring was replaced with laminated deck (IBI Group, 2014). It was also noted that approach modifications, installation of electric lighting and rebuilding of the centre pier was also included in this rehabilitation. Due to structural integrity concerns, the Ministry reinforced the bridge with trusses placed adjacent to the existing timber trusses. New tounge and grove paneling was added resulting in a reinforcement of the structure retaining the visual characteristics of the original bridge. The superstructure is now supported by concrete abutments and a masonry pier that is believed to be constructed around 1900. Maintenance and general replacements have been conducted since then.

1.2.3. Map Review

The *1861 County of Waterloo* (Tremaine, 1861), the *1881 Illustrated Historical Atlas of Waterloo and Wellington* (Parsell & Co., 1881), the *1935* and *1994 NTS Guelph Sheet* (Department of Energy, Mines and Resources, 1994; Department of National Defence, 1935) maps were examined to determine the presence of historic features within the Study Area during the nineteenth and twentieth centuries (Figures 2-4, 6).

The 1861 map illustrates that Montrose was a small community located along the Grand River in the County of Waterloo. The Study Area and surrounding roads,

including present day Hill Street, Rivers Edge Drive and Covered Bridge Road were historical surveyed at this time. Mapping shows that the Study Area connected the north and south bank of the river. Within Lot 71, the land was divided into a few smaller properties that were owned by Issac Swope and Jacob Benner. The southern portion of the Study Area located on the Beasley Tract was also owned by Jacob Benner.

The 1881 map illustrates that the community of Montrose had grown since 1861 and renamed to West Montrose. Little detail is provided on the 1881 map but does include the identification of a church and cemetery north of the Hill Street and Covered Bridge Road intersection. The 1935 topographic map shows individual structures located in West Montrose including the addition of a post office and sawmill.

Aerial imagery from 1954 shows that little change had occurred to West Montrose since previous 1935 mapping. By 1994, mapping shows that West Montrose had expanded to included additional roads, residential development, a campground, and picnic area.

1.2.4. Aerial and Orthoimagery Review

A review of available Google satellite imagery since 2006 shows that the Study Area has remained relatively unchanged.

1.3. Archaeological Context

This section provides background research pertaining to previous archaeological fieldwork conducted within and in the vicinity of the Study Area, its environmental characteristics (including drainage, soils or surficial geology and topography, etc.), and current land use and field conditions. Three sources of information were consulted to provide information about previous archaeological research: the site record forms for registered sites available online from the MHSTCI through “Ontario’s Past Portal”; published and unpublished documentary sources; and the files of ASI.

1.3.1. Current Land Use and Field Conditions

West Montrose Bridge is a covered vehicular bridge located over the Grand River in West Montrose. The Grand River divides the settlement of West Montrose into the north and south side. On the north side the area consists of single-family homes, a church, a few small businesses, farmland and the West Montrose Family Campground. The south side is less developed and only includes a few single-family homes. The Study Area includes the covered bridge, bridge embankments, portion of the Grand River, and part of the paved road leading to the south entrance (**Error! Reference source not found.**).

The Stage 1 property inspection was conducted on June 2, 2021, under the field direction of Jessica Lytle (P1066).

1.3.2. Geography

In addition to the known archaeological sites, the state of the natural environment is a helpful indicator of archaeological potential. Accordingly, a description of the physiography and soils are briefly discussed for the Study Area.

The S & G stipulates that primary water sources (lakes, rivers, streams, creeks, etc.), secondary water sources (intermittent streams and creeks, springs, marshes, swamps, etc.), ancient water sources (glacial lake shorelines indicated by the presence of raised sand or gravel beach ridges, relic river or stream channels indicated by clear dip or swale in the topography, shorelines of drained lakes or marshes, cobble beaches, etc.), as well as accessible or inaccessible shorelines (high bluffs, swamp or marsh fields by the edge of a lake, sandbars stretching into marsh, etc.) are characteristics that indicate archaeological potential.

Water has been identified as the major determinant of site selection and the presence of potable water is the single most important resource necessary for any extended human occupation or settlement. Since water sources have remained relatively stable in Ontario since 5,000 BP (Karrow & Warner, 1990, Figure 2.16), proximity to water can be regarded as a useful index for the evaluation of

archaeological site potential. Indeed, distance from water has been one of the most commonly used variables for predictive modeling of site location.

Other geographic characteristics that can indicate archaeological potential include elevated topography (eskers, drumlins, large knolls, and plateaux), pockets of well-drained sandy soil, especially near areas of heavy soil or rocky ground, distinctive land formations that might have been special or spiritual places, such as waterfalls, rock outcrops, caverns, mounds, and promontories and their bases. There may be physical indicators of their use, such as burials, structures, offerings, rock paintings or carvings. Resource areas, including; food or medicinal plants (migratory routes, spawning areas) are also considered characteristics that indicate archaeological potential (S & G, Section 1.3.1).

The Study Area is situated within a spillway of the Guelph Drumlin Field physiographic region of southern Ontario in a former spillway (Chapman and Putnam 1984). The Guelph Drumlin Field (Chapman and Putnam 1984: 137-139) centres upon the City of Guelph and Guelph Township, occupies roughly 830 km^2. and contains approximately 300 drumlins of varying sizes. For the most part these hills are of the broad oval type with slopes less steep than those of the Peterborough drumlins and are not as closely grouped as those in some other areas. The till in these drumlins is loamy and calcareous, and was derived mostly from dolostone of the Amabel Formation that can be found exposed below the Niagara Escarpment. Spillways are the former glacial meltwater channels. They are often found in association with moraines but in opposition are entrenched rather than elevated landforms. They are often, though not always, occupied by stream courses, the fact of which raises the debate of their glacial origin. Spillways are typically broad troughs floored wholly or in part by gravel beds and are typically vegetated by cedar swamps in the lowest beds (Chapman & Putnam, 1984, p. 15).

Natural soils within the area could not be identified due to urban expansion (Figure 7).Figure 8 depicts surficial geology within the Study Area. The mapping demonstrates that the Study Area is underlain by Glaciofluvial and modern alluvial deposits (Ontario Geological Survey, 2010).

The study area crosses the Grand River, which drains an area of approximately 673,397 ha. Its mainstream begins northeast of Dundalk at 526 m above sea level and flows for approximately 290 km to Lake Erie at Port Maitland (Chapman and Putnam 1984:95). The Grand River was an important transportation route and a critical resource extraction area for generations of Indigenous people. Historically, the Grand River has been utilized as a navigable waterway, as a power source (such power sites served as settlement nuclei), and above Brantford as a course for driving logs (Chapman and Putnam 1984:98). It is also the focus of the Haldimand Tract; Joseph Brant was awarded six miles (10 km) on either side of the river (Johnston, 1964, pp. 35–38; Lytwyn, 2005). The Grand River (and its tributaries the Nith, Conestogo, Speed and Eramosa Rivers) was designated as a Canadian Heritage River in 1994 for its cultural history and recreation (Canadian Heritage Rivers System, 2016).

1.3.3. Previously Registered Archaeological Sites

In Ontario, information concerning archaeological sites is stored in the Ontario Archaeological Sites Database (OASD) maintained by the MHSTCI. This database contains archaeological sites registered within the Borden system. Under the Borden system, Canada has been divided into grid blocks based on latitude and longitude. A Borden block is approximately 13 kilometres east to west, and approximately 18.5 kilometres north to south. Each Borden block is referenced by a four-letter designator, and sites within a block are numbered sequentially as they are found. The Study Area under review is located in Borden block *AjHc.*

According to the OASD, no previously registered archaeological sites are located within one kilometre of the Study Area (Ministry of Heritage, Sport, Tourism and Culture Industries, 2021).

1.3.4. Previous Archaeological Assessments

According to the background research, no previous reports detail fieldwork within 50 metres of the Study Area.

2.0 Field Methods

A Stage 1 property inspection must adhere to the S & G, Section 1.2, Standards 1-6, which are discussed below. The entire property and its periphery must be inspected. The inspection may be either systematic or random. Coverage must be sufficient to identify the presence or absence of any features of archaeological potential. The inspection must be conducted when weather conditions permit good visibility of land features. Natural landforms and watercourses are to be confirmed if previously identified. Additional features such as elevated topography, relic water channels, glacial shorelines, well-drained soils within heavy soils and slightly elevated areas within low and wet areas should be identified and documented, if present. Features affecting assessment strategies should be identified and documented such as woodlots, bogs or other permanently wet areas, areas of steeper grade than indicated on topographic mapping, areas of overgrown vegetation, areas of heavy soil, and recent land disturbance such as grading, fill deposits and vegetation clearing. The inspection should also identify and document structures and built features that will affect assessment strategies, such as heritage structures or landscapes, cairns, monuments or plaques, and cemeteries.

The Stage 1 archaeological assessment property inspection was conducted under the field direction of Jessica Lytle (P1066) of ASI, on June 2, 2021, in order to gain first-hand knowledge of the geography, topography, and current conditions and to evaluate and map archaeological potential of the Study Area. It was a systematic visual inspection from publicly accessible lands/public right-of-ways only and did not include excavation or collection of archaeological resources. Fieldwork was conducted when weather conditions were deemed clear with good visibility (sunny with seasonal temperatures), per S & G Section 1.2., Standard 2. Field observations are compiled onto the existing conditions of the Study Area in Section 8.0 (Figures 2-9) and associated photographic plates are presented in Section 7.0 (Images 1-9).

3.0 Analysis and Conclusions

The historical and archaeological contexts have been analyzed to help determine the archaeological potential of the Study Area. Results of the analysis of the Study Area property inspection and background research are presented in Section 3.1.

3.1. Analysis of Archaeological Potential

The S & G, Section 1.3.1, lists criteria that are indicative of archaeological potential. The Study Area meets the following criteria indicative of archaeological potential:

- Water sources: primary, secondary, or past water source (Grand River);
- Early historic transportation routes (Middlebrook Place, River Edge Drive, Covered Bridge Drive, Hill Street);
- Proximity to early settlements (Montrose); and

According to the S & G, Section 1.4 Standard 1e, no areas within a property containing locations listed or designated by a municipality can be recommended for exemption from further assessment unless the area can be documented as disturbed. The Municipal Heritage Register was consulted and one property within the Study Area is Listed or Designated under the Ontario Heritage Act:

- West Montrose Covered Bridge, 1881

These criteria are indicative of potential for the identification of archaeological resources, depending on soil conditions and the degree to which soils have been subject to deep disturbance.

The entire Study Area has been subjected to deep and extensive disturbance due to the construction of the West Montrose Bridge, including the artificially built-up lands associated with the north and south bridge abutment, and existing stone support pillar in the centre of the Grand River. Construction activities associated with the original bridge pier, pier replacement and pier rehabilitation have disturbed the original riverbed (see Appendix A). According to the S & G Section 1.3.2 the Study Area does not retain archaeological potential (Images 1-9; Figure 9: areas highlighted in yellow) and does not require further survey.

3.2. Conclusions

The Stage 1 background study determined no previously registered archaeological sites are located within one kilometre of the Study Area. The property inspection determined that the Study Area has been subject to deep and extensive disturbance.

4.0 Recommendations

In light of these results, the following recommendations are made:

1. The Study Area does not retain archaeological potential on account of deep and extensive land disturbance. These lands do not require further archaeological assessment; and

2. Should the proposed work extend beyond the current Study Area, further Stage 1 archaeological assessment should be conducted to determine the archaeological potential of the surrounding lands.

NOTWITHSTANDING the results and recommendations presented in this study, ASI notes that no archaeological assessment, no matter how thorough or carefully completed, can necessarily predict, account for, or identify every form of isolated or deeply buried archaeological deposit. In the event that archaeological remains are found during subsequent construction activities, the consultant archaeologist, approval authority, and the Cultural Programs Unit of the Ministry of Heritage, Sport, Tourism and Culture Industries should be immediately notified.

The above recommendations are subject to Ministry approval and it is an offence to alter any archaeological site without Ministry of Heritage, Sport, Tourism and Culture Industries concurrence. No grading or other activities that may result in the destruction or disturbance of any archaeological sites are permitted until notice of MHSTCI approval has been received.

5.0 Legislation Compliance Advice

ASI advises compliance with the following legislation:

- This report is submitted to the Ministry of Heritage, Sport, Tourism and Culture Industries as a condition of licensing in accordance with Part VI of the Ontario Heritage Act, RSO 2005, c 0.18. The report is reviewed to ensure that it complies with the standards and guidelines that are issued by the Minister, and that the archaeological field work and report recommendations ensure the conservation, preservation, and protection of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the Ministry of Heritage, Sport, Tourism and Culture Industries, a letter will be issued by the Ministry stating that there are no further concerns with regards to alterations to archaeological sites by the proposed development.

- It is an offence under Sections 48 and 69 of the Ontario Heritage Act for any party other than a licensed archaeologist to make any alteration to a known archaeological site or to remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed archaeological field work on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest, and the report has been filed in the Ontario Public Register of Archaeology Reports referred to in Section 65.1 of the Ontario Heritage Act.

- Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48 (1) of the Ontario Heritage Act. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with sec. 48 (1) of the Ontario Heritage Act.

- The Funeral, Burial and Cremation Services Act, 2002, S.O. 2002, c.33, requires that any person discovering or having knowledge of a burial site shall immediately notify the police or coroner. It is recommended that the

Registrar of Cemeteries at the Ministry of Consumer Services is also immediately notified.

- Archaeological sites recommended for further archaeological field work or protection remain subject to Section 48(1) of the Ontario Heritage Act and may not be altered, nor may artifacts be removed from them, except by a person holding an archaeological license.

6.0 Bibliography and Sources

A.S.I. (2006). *Historical Overview and Assessment of Archaeological Potential Don River Watershed, City of Toronto*. Report on file with the Ontario Ministry of Heritage, Sport, Tourism and Culture Industries.

Birch, J., & Williamson, R. F. (2013). *The Mantle Site: An Archaeological History of an Ancestral Wendat Community*. Rowman & Littlefield Publishers, Inc.

Brown, J. (1995). On Mortuary Analysis – with Special Reference to the Saxe-Binford Research Program. In L. A. Beck (Ed.), *Regional Approaches to Mortuary Analysis* (pp. 3–23). Plenum Press.

Canadian Heritage Rivers System. (2016). *Grand River*. http://chrs.ca/the-rivers/grand/

Chapman, L. J., & Putnam, F. (1984). *The Physiography of Southern Ontario* (Vol. 2). Ontario Ministry of Natural Resources.

Department of Energy, Mines and Resources. (1994). *Guelph Sheet* [Map].

Department of National Defence. (1935). *Guelph Sheet* [Map].

Dodd, C. F., Poulton, D. R., Lennox, P. A., Smith, D. G., & Warrick, G. A. (1990). The Middle Ontario Iroquoian Stage. In C. J. Ellis & N. Ferris (Eds.), *The Archaeology of Southern Ontario to A.D. 1650* (pp. 321–360). Ontario Archaeological Society Inc.

Edwards, T. W. D., & Fritz, P. (1988). Stable-Isotope Palaeoclimate Records from Southern Ontario, Canada: Comparison of Results from Marl and Wood. *Canadian Journal of Earth Sciences*, *25*, 1397–1406.

Ellis, C. J., & Deller, D. B. (1990). Paleo-Indians. In C. J. Ellis & N. Ferris (Eds.), *The Archaeology of Southern Ontario to A.D. 1650* (pp. 37–64). Ontario Archaeological Society Inc.

Ellis, C. J., Kenyon, I. T., & Spence, M. W. (1990). The Archaic. In C. J. Ellis & N. Ferris (Eds.), *The Archaeology of Southern Ontario to A.D. 1650* (pp. 65–124). Ontario Archaeological Society Inc.

Ellis, C. J., Timmins, P. A., & Martelle, H. (2009). At the Crossroads and Periphery: The Archaic Archaeological Record of Southern Ontario. In T. D. Emerson, D. L. McElrath, & A. C. Fortier (Eds.), *Archaic Societies: Diversity and Complexity across the Midcontinent.* (pp. 787–837). State University of New York Press.

Ferris, N. (2013). Place, Space, and Dwelling in the Late Woodland. In M. K. Munson & S. M. Jamieson (Eds.), *Before Ontario: The Archaeology of a Province* (pp. 99–111). McGill-Queen's University Press. http://www.jstor.org/stable/j.ctt32b7n5.15

IBI Group. (2014). *West Montrose Covered Bridge Preservation Plan*.

Johnston, C. E. (1964). *The Valley of the Six Nations: A Collection of Documents on the Indian Lands of the Grand River*. The Champlain Society.

Karrow, P. F., & Warner, B. G. (1990). The Geological and Biological Environment for Human Occupation in Southern Ontario. In *The Archaeology of Ontario to A.D. 1650* (pp. 5–36). London Chapter, Ontario Archaeological Society.

Lytwyn, V. P. (2005). *Historical research report: Aboriginal Settlement and Use of the North Pickering Development Planning Area and Adjacent Lands, 1690-1923*.

Ontario Heritage Act, R.S.O. c. O.18, (1990).

Mika, N., & Mika, H. (1983). *Places In Ontario: Their Name Origins and History, Part III, N-Z.* Mika Publishing Company.

Ministry of Heritage, Sport, Tourism and Culture Industries. (2021). *Ontario's Past Portal*. PastPortal. https://www.pastport.mtc.gov.on.ca

Environmental Assessment Act, R.S.O., (1990).

Ministry of Tourism and Culture. (2011). *Standards and Guidelines for Consultant Archaeologists*. Cultural Programs Branch, Ontario Ministry of Tourism and Culture.

Municipal Class Environmental Assessment, (2000).

Ontario Geological Survey. (2010). *Surficial geology of Southern Ontario. Miscellaneous Release—Data 128 – Revised.* [Map]. http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm_dir.asp?type=pub&id=MRD128-REV

Parsell & Co. (1881). *Illustrated Historical Atlas of Waterloo & Wellington Counties, Ontario* [Map]. Walker & Miles.

Region of Waterloo. (1989). *The Regional Municipality of Waterloo Archaeological Facilities Master Plan*. Archaeology Division - Planning and Development Department.

Region of Waterloo. (2010). *History*. http://www.regionofwaterloo.ca/en/discoveringTheRegion/history.asp

Rogers, E. S. (1962). *The Round Lake Ojibwa* (Occasional Paper 5). Royal Ontario Museum.

Spence, M. W., Pihl, R. H., & Murphy, C. (1990). Cultural Complexes of the Early and Middle Woodland Periods. In C. J. Ellis & N. Ferris (Eds.), *The Archaeology of Southern Ontario to A.D. 1650*. Ontario Archaeological Society Inc.

Tremaine, G. C. (1861). *Tremaine's Map of Waterloo County* [Map]. George C. Tremaine.

Waterloo Region Museum. (2017). *Woolwich Township*. http://www.waterlooregionmuseum.ca/en/collections-and-research/woolwich-township.aspx

Williamson, R. F. (1990). The Early Iroquoian Period of Southern Ontario. In C. J. Ellis & N. Ferris (Eds.), *The Archaeology of Southern Ontario to A.D. 1650* (pp. 291–320). Ontario Archaeological Society Inc.

7.0 Images

7.1. Field Photography



Image 1: View of disturbed Study Area from Rivers Edge Drive; no potential.



Image 2: View of the Study Area looking down towards the Grand River; Area around Grand River is disturbed; no potential.



Image 3: View of the Study Area looking down towards the Grand River; area of the embankment and stone pillar is disturbed; no potential.



Image 4: View of the disturbed Study Area; no potential.



Image 5: View of disturbed Study Area; no potential.



Image 6: View inside the West Montrose Bridge.



Image 7: View of Study Area; area is artificially sloped and disturbed; no potential.



Image 8: View of Study Area; area is disturbed; no potential.



Image 9: View of Study Area; area is artificially sloped and disturbed; no potential.

8.0 Maps

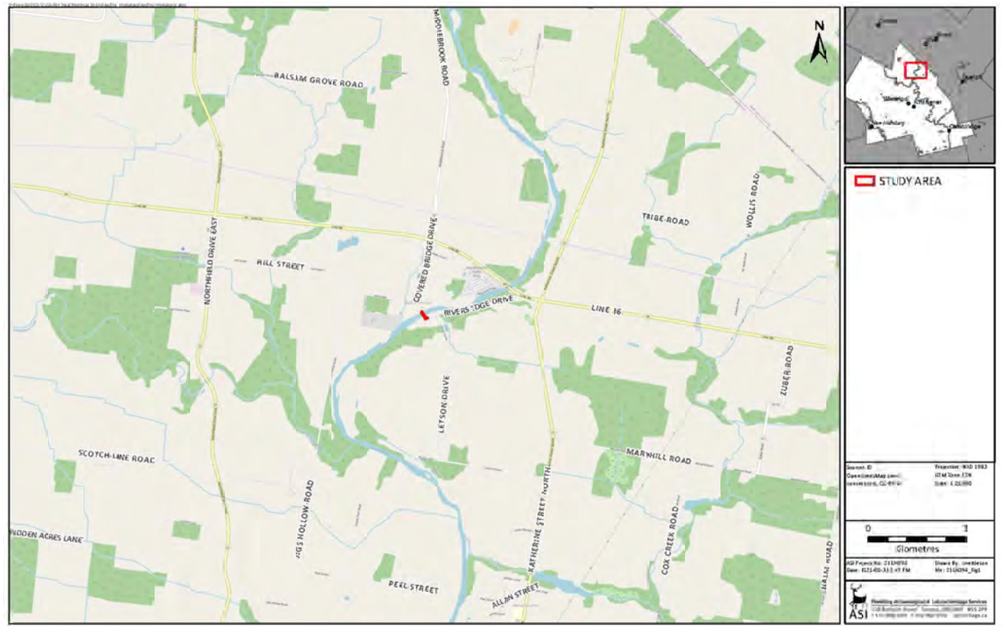


Figure 1: Location of Study Area

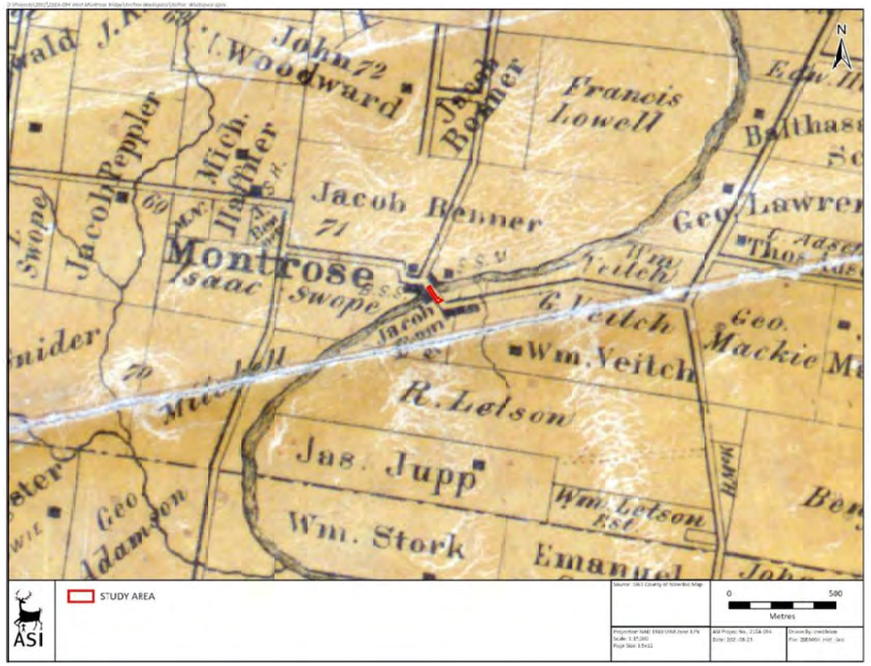


Figure 2: Study Area (Approximate Location) Overlaid on the 1861 County of Waterloo Map



Figure 3: Study Area (Approximate Location) Overlaid on the 1881 Illustrated Historical Atlas of Waterloo

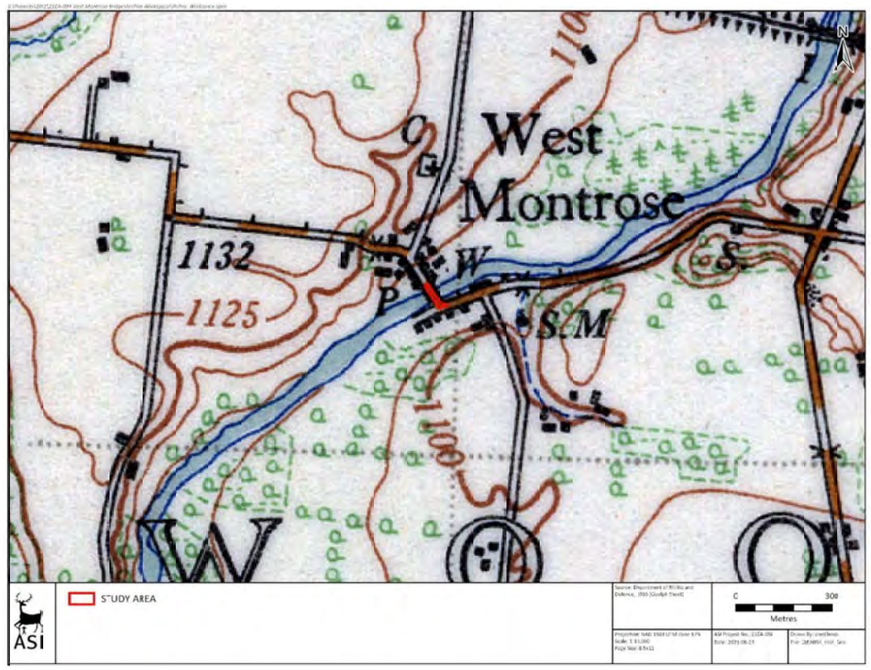


Figure 4: Study Area (Approximate Location) Overlaid on the 1935 NTS Guelph Sheet



Figure 5: Study Area (Approximate Location) Overlaid on the 1954 Aerial Photography

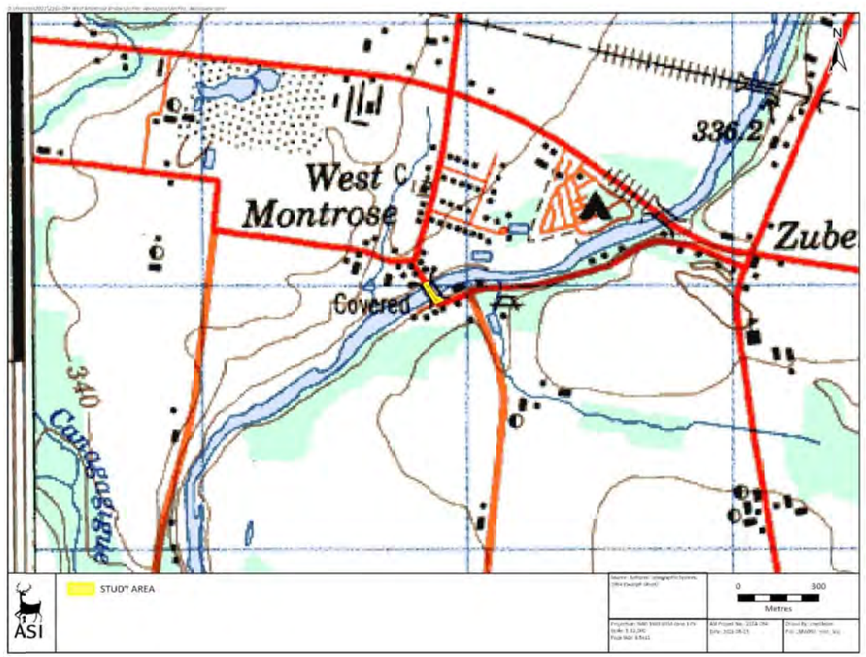


Figure 6: Study Area (Approximate Location) Overlaid on the 1994 Guelph Sheet



Figure 7: Study Area - Soil Drainage



Figure 8: Study Area - Surficial Geology



Figure 9: Results of the West Montrose Stage 1 Archaeological Assessment

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MEMORANDUM

FROM:	Doug Dixon, P.Eng. Senior Bridge Engineer Doug Dixon & Associates Inc.
TO:	Caitlin Lacy Lead Archaeologist Archaeological Services Inc.
DATE:	May 12, 2022
OUR FILE:	20-081 West Montrose Covered Bridge Rehabilitation
SUBJECT:	Previous Work within the Grand River under the West Montrose Covered Bridge
COPIES TO:	Michelle Pinto, P.Eng. – Region of Waterloo Kevin Li, EIT. – Doug Dixon & Associates

Introduction

Doug Dixon & Associates Inc. (DDA) was retained by the Region of Waterloo to undertake the rehabilitation design of the West Montrose Covered Bridge in the Township of Woolwich. The proposed rehabilitation included the installation of rock protections around the existing masonry pier.

Archaeological Services Inc. (ASI) was retained by the Team to perform an Archaeological Assessment of the bridge site in advance of the planned bridge rehabilitation. ASI prepared a Draft Stage 1 Archaeological Assessment, dated September 22, 2021. In the Draft Assessment, a marine archaeological assessment was recommended due to the proposed in-water work around the pier.

DDA has reviewed the conditions at the site and believes that a marine archaeological assessment is not necessary because of past disturbances on site. This memorandum provides evidence of past construction activities in the Grand Diver under the West Montrose Covered Bridge.

Original Bridge Pier

The West Montrose Covered Bridge was constructed in 1881. The original construction drawings and specifications indicated the installation of oak/rock elm piles underneath the timber piers (Figure 1).

Due to the era of construction, there are no construction records or photographs available. However, based on common construction practices of the late 1800s and early 1900s, DDA believes the timber piles were driven into the river bed by drop hammers on a crane. For the crane to access the center of the Grand River to drive the piles, a causeway would have had to be built. The crane would not have been situated on a barge because it would not have

provided sufficient stability to drive the timber piles. An earth dike was likely put in place around the pier to provide a dry working area for the workers.

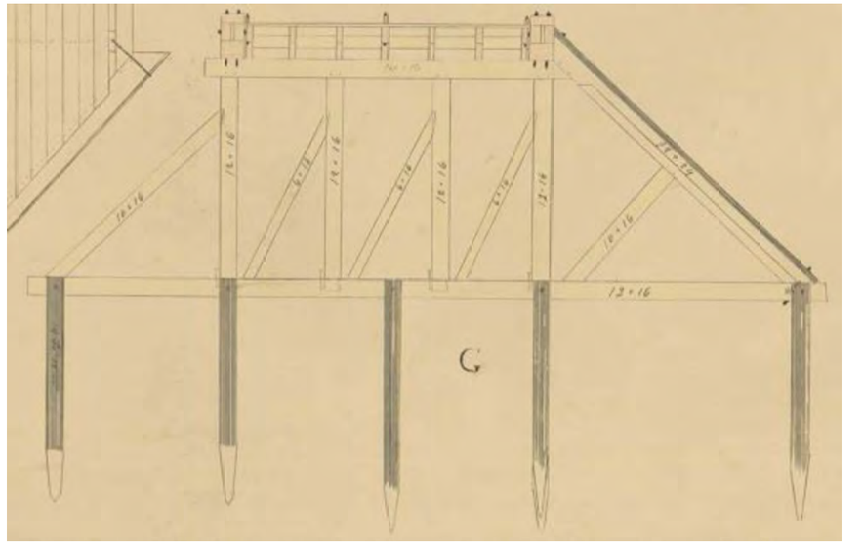


Figure 1 – Original drawing showing the timber pier.

Pier Replacement

According to archive records, the timber pier was undermined and the bridge acquired a noticeable tilt after a spring flood. To stabilize the bridge, construction work was undertaken to replace the timber pier with a masonry pier. Unfortunately, there were no records of when and how this work was undertaken. Historical records suggest this work was completed some time around the early 1900s but before the 1930s. The only evidence that this work happened is that the masonry pier is in place today (Figure 2).

To construct the new pier, workers would have had to set up a dry working area to place the masonry stones and apply mortars (Figure 3). This would once again involve the installation of a cofferdam (earth dike or others) and a causeway for access.

Other Pier Rehabilitation

There is evidence of differential settlement in the masonry pier. Evidence of stones and concrete to stabilize the masonry pier was noted on-site. This work, completed at an unknown date, likely entailed the same kind of construction protection and access requirement as noted before. Furthermore, existing rock protections can be observed around the existing pier, suggesting past disturbance in the river bed.

Conclusion

Based on the above, DDA believes there is significant evidence to suggest that past construction activities have disturbed the original river bed in the area of the pier.



Figure 2 – Masonry pier

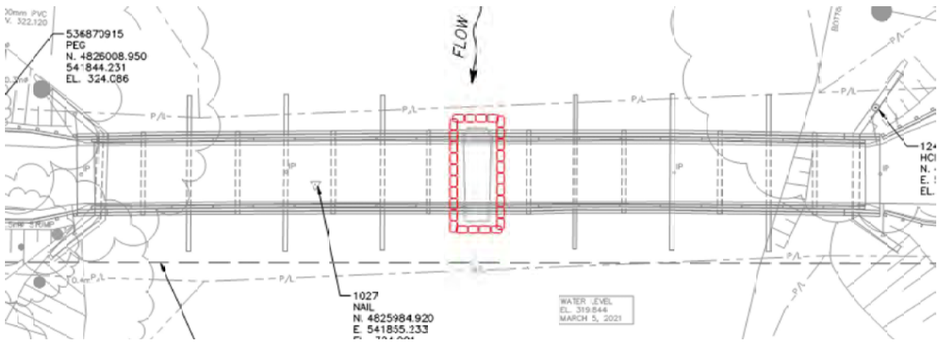


Figure 3 – Possible cofferdam area around the pier (shown in red) to facilitate pier reconstruction and rehabilitation

Appendix H

Structural Design Summary Report



ENTUITIVE

DESIGN SUMMARY REPORT

WEST MONTROSE COVERED BRIDGE

EN022-02331

FOR: REGION OF WATERLOO | **DATE:** AUGUST 7, 2024



ENTUITIVE

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Appendix A – Field Inspection Summary Report

Appendix B – Member IDs and Existing Condition Summary

Appendix C – Bridge Hydraulic Engineering Report

Appendix D – 2014 Preservation Plan by IBI Group

Project Name: West Montrose Covered Bridge
Project No: EN022-02331
Rev. 00
August 7, 2024

Appendix E – 2015 Roof Snow Load Calculations by RWDI

Appendix F – 2017 Inspection Report by Moses Structural Engineers

Appendix G – 2018 Structural Monitoring Report by Struct-Sure

Appendix H – 2019 Structural Assessment Options Report by Doug Dixon & Associates

Appendix I – 2020 Inspection Report by Doug Dixon & Associates

Appendix J – 2023 Value Engineering Report by BT Engineering

Appendix K – Renderings of Alternative A from PCC #2

Appendix L – Renderings of Alternative B from PCC #2

Appendix M – Description of Structural Alternatives for Evaluation

Appendix N – 2023 MATS Evaluation Report by BT Engineering

Appendix O – Preliminary General Arrangement Drawing of Preferred Rehabilitation Alternative (C2)

Appendix P – Renderings of Preferred Rehabilitation Alternative (C2)

Appendix Q – Preliminary Construction Laydown Area and Property Access Drawing

1. INTRODUCTION

Entuitive and its multi-faceted team of subconsultants ("we" and "our team") were retained by the Region of Waterloo (Region) in December 2022 to provide engineering consulting services for the "West Montrose Covered Bridge – Timber Truss Assessment and Design Assessment" project (ROW project no. 7626). The assignment is focused on rehabilitating the wood superstructure of the West Montrose Covered Bridge. Rehabilitation of the concrete abutments and masonry pier are not part of this assignment. The Region retained Doug Dixon & Associates to address that scope. Entuitive and the Region determined during the course of the assignment that the rehabilitated structure would be designed for a 50-year service life before occurrence of the next major rehabilitation.

The West Montrose Covered Bridge is a wood truss covered bridge structure crossing the Grand River in the unincorporated community of West Montrose, in the Township of Woolwich, in the Region of Waterloo, Ontario. A key plan of the bridge location is shown below in Figure 1. The bridge is the only remaining wood covered bridge in Ontario to carry vehicular traffic. It was designated under the Township of Woolwich By-Law Number 60-2007 to be of cultural heritage value or interest pursuant to the provisions of Section 29 of the Ontario Heritage Act, R.S.O. 1990, Chapter O.18 (IBI Group 2014).

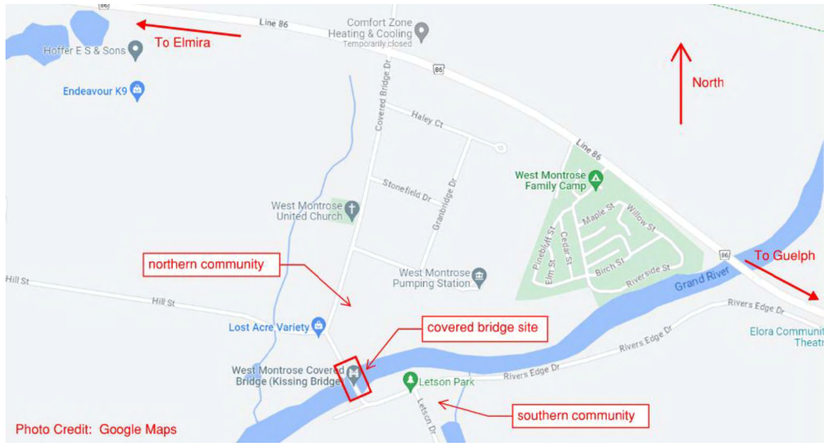


Figure 1 – Key Plan

The bridge was identified previously by others as needing structural rehabilitation. The purpose of Entuitive's assignment is to assess the physical condition of the existing structure by means of an arm's length visual inspection and non-destructive testing, to develop and evaluate rehabilitation alternatives, to recommend a preferred rehabilitation alternative, to undertake preliminary and detailed design for the preferred rehabilitation alternative, and to provide tendering and contract administration services for the ensuing construction contract (Region of Waterloo 2022). Public consultation with key project stakeholders is a key component of the assignment.

The focus of the project is a rehabilitation solution that preserves the heritage fabric of the structure. We have developed solutions that are focused on repairing defects in the least intrusive, reversible means possible instead of replacing the entire structure. Preservation of the appearance of the bridge is a very important design criterion.

The project kicked off in January 2023. The work to date has included a review of the background materials, performance of an arm's length visual inspection and non-destructive testing, performance of a structural evaluation to assess the load carrying capacity of the existing structure, development and evaluation of rehabilitation alternatives, and selection of the preferred rehabilitation alternative.

This Design Summary Report succeeds the Field Inspection Summary Report authored by our team in October 2023. The Field Inspection Summary Report focused on the findings of the arm's length visual inspection and non-destructive testing, as well as the initial structural evaluation. Those findings were used to develop rehabilitation alternatives for evaluation using the Multi-Attribute Trade-Off System. The development and evaluation of those alternatives, as well as the preliminary design of the preferred alternative are the focus of this Design Summary Report.

The Field Inspection Summary Report has been appended to this report in Appendix A.

2. THE EXISTING STRUCTURE

2.1 STRUCTURE OVERVIEW

The West Montrose Covered Bridge is a two-span wood through truss structure carrying a single lane of traffic over the Grand River along Covered Bridge Drive (see Figure 2). The bridge is in the centre of West Montrose, connecting the northern and southern parts of the community. The bridge has two equal spans of approximately 28.9m. The spans are simply-supported, except that the bottom chord members are continuous over the pier. The total bridge length is approximately 60.3m (198ft), including wood portal framing that extends beyond the truss supports. The traveled width inside the bridge is 4648mm (15'-3"). The existing wood trusses have been structurally augmented by installation of steel Bailey trusses circa 1965. The Bailey trusses are concealed behind white-coloured interior wood cladding.



Figure 2 – West Elevation View of Bridge

The bridge is currently posted for a 3t live load limit. As such, the bridge is generally subject to local and tourist traffic only. Commercial and through traffic make use of the nearby bridge carrying Regional Road 86 (Line 86) over the Grand River. This bridge is approximately 950m upstream from the covered bridge.

Refer to Section 2.3 of the Field Inspection Summary Report for a detailed description of the existing structure.

2.2 STRUCTURE HISTORY

The West Montrose Covered Bridge has a very storied history. Like many covered bridges, it is referred to as the "Kissing Bridge" due to the privacy afforded by the exterior cladding and roof.

The bridge was designed by John Bear in 1880. It was built in 1881 by John Bear and his brother, Benjamin. The bridge has undergone numerous documented and undocumented repairs since then. Major repairs and modifications include:

- Replacement of the wood pier with a masonry pier circa 1900
- Replacement of the wood crib abutments with concrete abutments (believed to have occurred sometime after the pier replacement)
- Original transverse plank deck replaced with nail-laminated deck circa 1954
- Major rehabilitation in 1959 including replacement of floor beams and needle beams, replacement of localized sections of the bottom chords, strengthening of the bottom chords by installation of longitudinal reinforcing rods, and repainting of the bridge
- Semi-retirement of the bridge in 1959 by construction of a new highway bridge to carry modern truck loading on the nearby Regional Road 86 (Line 86)
- Installation of steel Bailey trusses to supplement the wood trusses circa 1965
- Repainting of bridge in 1971
- Replacement of the roof in 1987
- Major rehabilitation in 1999 consisting of strengthening of the steel Bailey trusses, localized replacement of decayed segments of wood truss members, and replacement of the nail-laminated deck
- Repainting of bridge in 2004

The repairs and modifications to the bridge resulted in the full or partial replacement of many of the original wood members. Table 1 summarizes the known replacements:

Table 1 – Known Replacement of Original Wood Members

Wood Member	*Status as Original or Replacement Member*
Truss Top Chords and Lower Top Chords	Believed to be original
Truss Bottom Chords	Local segments have been replaced in 1933, 1959, and 1999.
Truss Diagonals and Lower Diagonals	Believed to be original except for local segments that were replaced to accommodate local bottom chord replacement
Wood Deck	Original transverse plank deck replaced with nail-laminated deck circa 1954. Deck replaced again in kind in 1999.
Stringers	Many original stringers are believed to remain. Additional lines of stringers have been added, likely when the new deck was installed circa 1954
Floor Beams and Needle Beams	No original members remain. Complete replacement occurred in 1959 with numerous individual members replaced since then
Tie Beams	Some original members remain
Vertical Posts	Believed to be original
Rafters and Roof Decking	No records available, but decking unlikely to be original given the structure's age
Exterior Cladding	Some original cladding remains
Interior Cladding	Photographic evidence suggests the present cladding is not original to the bridge. There is photographic evidence of interior cladding comprised of horizontal planks, which is believed to have been installed in the 1930s. We believe the present vertical plank cladding was installed at the same time as the steel Bailey trusses circa 1965

The bridge has a history of live load posting ranging from 2t to 5t. A structural evaluation of the Bailey trusses in 1997 by Giffels Associates Limited (subsequently IBI Group; now part of Arcadis) and subsequent major rehabilitation in 1999 resulted in a documented live load capacity of 8t with simultaneous snow loading on the roof. In recent years, we understand the bridge has remained posted for a 3t live load limit to discourage heavier vehicles from crossing the bridge.

The bridge was designed and built on the authority of the Woolwich Township Council in 1880-1881. The Ontario Department of Highways (predecessor to the present-day Ontario

Ministry of Transportation) assumed ownership of the bridge in 1937. The Region of Waterloo assumed ownership of the bridge in 1998 from the province.

The local community has played a significant role in the continued preservation and celebration of the bridge. For instance, the West Montrose Residents Association (also known as the "Bridge Keepers") act as advocates for preserving the bridge. They hold annual events that celebrate the bridge, such as an annual Christmas caroling event inside the bridge. Also, we understand that the local Mennonite community contributed the labour to rebuild the nail-laminated deck during the last major rehabilitation in 1999. The bridge is very much a destination for the local community, in addition to its initial function as a river crossing.

Refer to Section 2.4 of the Field Inspection Summary Report for a detailed history of the existing structure.

2.3 AVAILABLE BACKGROUND DOCUMENTS

The following background documents were made available to our technical team for review:

1) Drawings
    - Original bridge design drawings (no date or author provided but assumed to be by John Bear in 1880)
    - Bottom chord splice drawing by Ontario Department of Highways, dated August 1954
    - Steel Bailey truss drawing by Ontario Department of Highways, dated August 1966
    - Major rehabilitation tender drawings by IBI Group, dated September 1999
2) Specifications
    - Original bridge construction specifications (no date or author provided but assumed to be by John Bear in 1880)
3) Reports
    - West Montrose Covered Bridge Preservation Plan by IBI Group, dated April 2014
    - West Montrose Covered Bridge Snow Load Consultation by RWDI, dated January 2015
    - Conditions at West Montrose Covered Bridge by Moses Structural Engineers, dated November 2017
    - Structural Monitoring of West Montrose Covered Bridge by Struct-Sure Limited, dated April 2018
    - West Montrose Covered Bridge Structural Assessment of Options Report by Doug Dixon & Associates Inc., dated June 2019

- West Montrose Covered Bridge Detailed Inspection Report by Doug Dixon & Associates Inc., dated June 2020
- West Montrose Covered Bridge Value Engineering Report by BT Engineering Inc., dated May 15, 2023
- On-Site Observations and Non-Destructive Testing at West Montrose Covered Bridge, West Montrose, ON by Moses Structural Engineers, dated October 2023
- West Montrose Covered Bridge Field Inspection Summary Report by Entuitive, dated October 11, 2023
- West Montrose Covered Bridge [MATS] Analysis and Evaluation Report by BT Engineering Inc., dated November 23, 2023
- West Montrose Covered Bridge Rehabilitation Bridge Hydraulic Engineering Report by Sanchez Engineering Inc., dated December 2023

The existing bridge drawings can be found in Appendix A of the Field Inspection Summary Report. The original specifications can be found in Appendix B of that same report.

3. FIELD OBSERVATIONS AND INSPECTION FINDINGS

3.1 FIELD INSPECTIONS OVERVIEW

The field inspections of the existing bridge were conducted in two phases. The first phase of inspections occurred from Tuesday, February 21st, 2023 to Monday, February 27th, 2023, excluding the weekend days. The inspection was conducted from deck level by David Moses (P.Eng.), Marcel Hong (P.Eng.), and Mark Prescott of Moses Structural Engineers. Andrew Lehan (P.Eng.) from Entuitive was present for the first day of inspection.

The bridge was fully closed to traffic for the first inspection phase. Traffic control was provided by Theo Vandenberk Construction Inc. (Theo Vandenberk). Roadwork permits were obtained from both the Region of Waterloo and the Township of Woolwich. The interior cladding was removed in advance of the inspection by Theo Vandenberk to improve inspection access to the existing wood trusses and steel Bailey trusses (see Figure 3). It was restored upon completion of the inspection phase before the road was reopened to traffic.



Figure 3 – Interior Cladding Removed for First Inspection

The second phase of inspection occurred from Tuesday, June 13th, 2023 to Thursday, June 15th, 2023. The inspection was conducted from a floating work platform positioned beneath the bridge in the Grand River (see Figure 4). The platform was supplied and operated by Soderholm Maritime Services Inc. The inspection was completed by David Moses (P.Eng.), Marcel Hong (P.Eng.), and Mark Prescott of Moses Structural Engineers. The bridge remained open to traffic during the second inspection phase. The interior cladding was not removed.



Figure 4 – Floating Work Platform Used for On-Water Inspection

The scope of the inspection work consisted of the following:

- Arm's length visual inspection of the wood members, connections, and steel rods
- Resistance drilling measurements of the wood members using a 400mm long drilling rod to assess the likelihood of decay within a member
- Moisture content measurements of the wood members to assess the likelihood of decay within a member
- Removing small samples of the wood elements for species identification under microscope in a laboratory
- Visual grading of the in-situ wood members per the National Lumber Grades Authority's (NLGA) National Grading Rules for Canadian Lumber

Physical measurements of the existing bridge geometry were also taken during the inspections. The available drawings for the bridge show very few dimensions. A topographic survey and light detection and ranging (LiDAR) survey were also undertaken to further collect this geometric information. The surveying was completed by Callon Dietz Incorporated.

Refer to Sections 3.3 and 3.3 of the Field Inspection Summary Report for a detailed description of the inspection methodology and equipment, as well as the inspection access limitations.

3.2 KEY INSPECTION FINDINGS

Section 3.4 of the Field Inspection Summary Report presents a comprehensive summary of the findings of the field investigations. The following Table 2 summarizes the key inspection findings. The corresponding member IDs and an existing condition summary are appended in Appendix B. The inspection findings provided guidance on the useful capacity of the members for use in the structural load evaluation and durability assessment of the bridge.

Table 2 – Summary of Key Findings from Field Inspections

Component	*Key Findings*
Top Chord and Lower Top Chord Members	- Members were in fair condition due to checking - Outside face of members were tight to exterior cladding and could not be inspected - Minor damage due to trapped moisture from cladding is possible, but major repair or replacement are not expected and no reduction in capacity is necessary
Squash Blocks	- Squash blocks SQB1 and SQB2 have split in two and require replacement - No action for other squash blocks
Bottom Chords	- East bottom chord was in poor condition and should be replaced - West bottom chord was in fair condition but expected to progress to poor condition due to observed early onset decay within 50-year design life of rehabilitation and should thus be replaced at present
Diagonals	- Members were generally in good to fair condition due to checking - Replace end diagonals at pier due to decay and splitting - Repair missing portion of diagonal D9 in west truss if warranted by structural demand
Lower Diagonals	- Members were generally in fair condition due to checking and water staining - Members LD2W, LD3W, LD5E, LD6E, LD8E, and LD9W have all experienced section loss and may require repair or replacement if warranted by structural demand - Top end of member LD10 of the east truss was decayed and requires replacement or localized repair

Component (continued)	- *Key Findings (continued)*
Vertical Posts	- Members were generally in fair condition due to checking and wear - Replace members VP1E, VP2E, and VP7W because of splitting and notching at top ends
Tie Beams	- Members were generally in fair condition due to checking - Replace members CRB5, CRB13, and CRB17 due to decay at their ends - Replace member CRB11 due to large strength-reducing notch at east end
Nail-Laminated Deck	- Deck was generally in fair to poor condition due to decay of the soffit and fractures/splits of the laminations - Replace deck
Stringers	- Members were generally in poor condition due to excessively high moisture content (i.e. >30%), softness, decay, and splitting of notches at dapped ends - Replace all stringers
Floor Beams & Needle Beams	- Members were generally in fair to poor condition due to checking and decay - Replace all floor beams and needle beams
Exterior Cladding	- Exterior cladding was generally in poor condition due to decay, significant staining, and numerous holes - Replace all cladding
Interior Cladding	- Interior cladding was in fair condition, with some areas in poor condition due to repeated fastening and unfastening of the nailed connections to facilitate inspection of the wood and Bailey trusses
Roof Shingles	- Shingles not inspectable - Replace shingles
Roof Decking	- Planks generally in fair to poor condition due to significant water staining and numerous holes - Inspect up close during construction after removal of shingles and replace in kind as necessary

Component (continued)	- *Key Findings (continued)*
Roof Rafters	- Rafters generally in fair condition - Inspect up close during construction after removal of any decayed roof decking planks and replace in kind as necessary
Truss Vertical Rods	- Rods generally in fair to poor condition due to corrosion and pitting, with ends particularly in poor condition - Replace all rods with mild carbon steel rods of same appearance
Sway Bracing Rods	- Rods generally in fair to poor condition due to corrosion and poor seating - Replace all rods with mild carbon steel rods with improved detailing
Bottom Chord Longitudinal Reinforcing Rods	- Rods generally in poor condition because they have gone slack and are non-functioning - Remove from bridge permanently
Bottom Lateral Bracing Rods	- Rods generally in fair condition due to corrosion - Replace all rods with mild carbon steel rods
Bolsters at Abutments and Pier	- Bolsters in poor condition at south abutment - Bolsters in fair to poor condition at pier - Bolsters not inspectable at north abutment - Replace all bolsters with elastomeric bearing assemblies

The west bottom chord was indicated to be in fair condition in the Field Inspection Summary Report. Our inspection team reviewed this finding and provided further clarification after the publication of the Field Inspection Summary Report. The NDT results for this member indicate it to be in the early stages of decay at several locations. This decay could likely be arrested by reducing the member moisture content by protecting it with new exterior cladding. However, the bottom chords were found to have insufficient strength to support the 10t live load that was ultimately chosen as the live load design criterion for this project (see Section 4.6). For this reason, it is necessary to replace this member along with the east bottom chord, the latter of which was found to be currently in poor condition.

The existing wood members were sampled during the field inspection to enable identification of wood species via laboratory analysis. The members were also visually graded in

accordance with the NLGA's National Grading Rules for Canadian Lumber. The following Table 3 summarizes the member species and grades.

Table 3 – Wood Species and Grades

Member	*Species*	*Grade*
Top Chord (TC)	Eastern Hemlock	Select Structural
Lower Top Chord (LTC)	Red Pine	Select Structural
Squash Blocks	White Oak	N/A
Bottom Chord (LC)	Eastern Hemlock	Select Structural
Diagonals (D)	Red Pine/Eastern Hemlock	Select Structural
Lower Diagonal (LD)	Eastern White Pine	Select Structural
Floor Beams (FB)	Douglas Fir	Select Structural
Needle Beams (NB)	Douglas Fir	Select Structural
Stringers (S)	Eastern Hemlock	Select Structural
Nail-Laminated Deck	Spruce	Select Structural
Tie Beams (CRB)	Douglas Fir (original), SPF (assumed for replacements)	Select Structural
Vertical Posts	Eastern White Pine	Select Structural
Exterior Cladding	Eastern Hemlock	Select Structural
Curbs	Eastern Hemlock	Select Structural

4. STRUCTURAL EVALUATION

4.1 OVERVIEW

We performed a structural evaluation of the existing structure after completion of the field inspections. This "initial structural evaluation" was conducted in accordance with the CAN S6:19 Canadian Highway Bridge Design Code (CHBDC). The evaluation examined the existing wood structure acting without the steel Bailey trusses present. The intent was to determine the loading that could be supported by the original wood structure and to inform the development of the rehabilitation alternatives by identifying the weaker parts of the bridge.

Upon selection of the preferred rehabilitation alternative, the structural evaluation was refined to support the preliminary rehabilitation design.

A summary of the material properties, design live loads, other loads, load combinations, and demand-to-capacity (D/C) ratios is provided in the following sections. Refer to Sections 4.1 to 4.4 of the Field Inspection Summary Report for a detailed description of the structural analysis methodology, material properties, loads and load combinations, and member resistance assumptions used to complete the initial structural evaluation.

4.2 MATERIAL PROPERTIES

The following Table 4 summarizes the material properties used for the structural evaluation.

Both the Eastern Hemlock and Red Pine species fall under the Northern species combination for material properties, as published in the CHBDC and the CSA O86:19 Engineering Design in Wood standard (CSA O86). This species group has the lowest strength material properties and is thus an undesirable assumption. Higher strength material properties were determined for both Eastern Hemlock and Red Pine by comparison with the "Design Values for Wood Construction - National Design Specification (NDS) Supplement" published by the American Wood Council (AWC) (2018). Refer to Section 4.2 of the Field Inspection Summary Report for a more detailed explanation of how these higher strength material properties were derived.

Table 4 – Material Properties for Structural Evaluation (MPa)

Failure Mode	*Eastern Hemlock*	*Red Pine*	*White Pine*
Bending (f_b)	16.8	13.0	12.8
Shear (f_v)	1.2	1.2	1.0
Compression Parallel to Grain (f_c)	13.0	8.9	7.2
Compression Perpendicular to Grain (f_{cp})	4.6	5.3	3.5
Tension Parallel to Grain (f_t)	7.4	4.7	6.5
50th Percentile Elastic Modulus (E_{50})	10615	7190	8000
5th Percentile Elastic Modulus (E_{05})	7490	5100	5500

4.3 DESIGN LIVE LOADS

Development of the design live loads was an iterative process that evolved throughout the project.

For the initial structural evaluation, we determined D/C ratios for design live loads on a 1t incremental basis ranging from 3t to 15t, inclusive. This approach allowed our team to determine the level of intervention required for each 1t increment and to understand the "fuse points" within the system; that is, the design live load above which further intervention to the wood structure would be necessary.

The following subsections 4.3.1 and 4.3.2 explain the design live loads used for the initial structural evaluation and the preliminary design of the preferred rehabilitation alternative.

4.3.1. Initial Structural Evaluation

The initial structural evaluation was conducted after completion of the field inspections. Its purpose was to inform the development of structure alternatives by confirming the loading that could be supported by the original wood structure and by identifying the weaker parts of the bridge.

The geometry of the vehicular design live load used for the initial structural evaluation was that of the 3-axle CL3-625-ONT truck from CHBDC Figure A14.2.1 (see Figure 5).

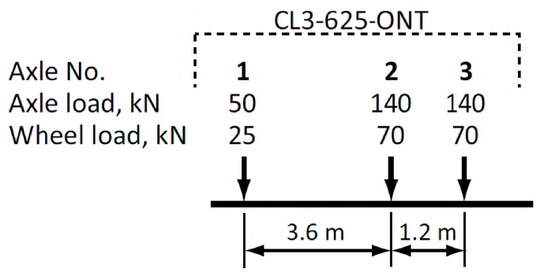


Figure 5 – CL3-625-ONT Truck Axle Arrangement (excerpt from CHBDC Figure 14.1) (CSA Group 2019)

The CL3-625-ONT truck represents the single-unit vehicles that are permitted to cross the covered bridge. The axle and wheel load magnitudes shown in Figure 5 are illustrative only and indicate relative loads (i.e. axle 1 carries 15% of total weight and axles 2 and 3 each carry 42.5% of total weight). The actual magnitudes used for the initial structural evaluation are shown below in Table 5.

Table 5 – Design Live Loads for Initial Structural Evaluation

Design Live Load Weight	*Axle 1 Weight*	*Axle 2 Weight*	*Axle 3 Weight*
3t	0.45t	1.27t	1.27t
4t	0.61t	1.70t	1.70t
5t	0.76t	2.12t	2.12t
6t	0.91t	2.55t	2.55t
7t	1.06t	2.97t	2.97t
8t	1.21t	3.39t	3.39t
9t	1.36t	3.82t	3.82t

Design Live Load Weight (continued)	*Axle 1 Weight (continued)*	*Axle 2 Weight (continued)*	*Axle 3 Weight (continued)*
10t	1.52t	4.24t	4.24t
11t	1.67t	4.67t	4.67t
12t	1.82t	5.09t	5.09t
13t	1.97t	5.52t	5.52t
14t	2.12t	5.94t	5.94t
15t	2.27t	6.36t	6.36t

The effects of the vehicular design live load were amplified by a dynamic load allowance (DLA) to capture the effects of dynamic vehicle-structure interaction. The DLA was determined in accordance CHBDC clause 3.8.4.5. A 30% reduction in DLA for wood components was assumed per CHBDC clause 3.8.4.5.4.

A single design lane was assumed for the evaluation because Covered Bridge Drive is a single lane road across the bridge. The current bridge has a lane width of about 4.3m. The rehabilitated bridge is expected to have a lane width of about 4.8m. A 3m wide truck width was assumed for the evaluation (see Figure 6). A wheel width of 0.25m and a wheel width of 0.6m were assumed for local effects.

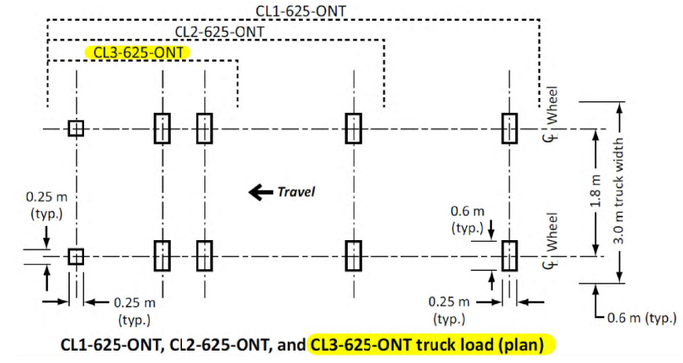


Figure 6 – CL3-625-ONT Truck Plan Layout (excerpt from CHBDC Figure A14.2.1) (CSA Group 2019)

When considering the load effects experienced by the wood trusses due to passage of the design truck (i.e. global effects), the truck was positioned so that the distance from the wheel centreline to the curb was 0.6m. This assumption implies a clear distance of 0.3m between the wheel and the curb, which represents the “shy distance”. The shy distance is the distance

from the edge of a lane to an obstacle beyond which a driver will not adjust their speed or path out of concern for potential collision with the obstacle. This assumption is per CHBDC clause 3.8.4.1.

CHBDC clause 14.9.1.5 affords the opportunity to increase the distance from the wheel centreline to the curb to 0.75m for lane widths greater than 3.6m. This opportunity was not taken. The covered bridge is posted for a 3t live load limit. Some of the overload vehicles envisioned by the design team is local farm equipment, the likes of which would operate at very low speeds (i.e. < 10km/hr). The shy distance decreases at low speeds due to drivers having a better sense of their surroundings. As such, it was decided to maintain a distance of 0.6m between the wheel centrelines and curb, consistent with CHBDC clause 3.8.4.1.

When considering the load effects experienced by the floor system (i.e. deck, stringers, floor beams, and needle beams) due to passage of the design truck (i.e. local effects), the truck was positioned so that the distance from the wheel centreline to the curb was 0.3m. This assumption implies no clear distance between the wheel and the curb. This assumption is per CHBDC clause 3.8.4.3.

Consideration was given to applying the pedestrian load per CHBDC clause 3.8.9. For the bridge's span lengths of 28.9m, this load would equate to a 4.0kPa uniform pressure applied over the entire travelled deck surface. While the covered bridge carries vehicular traffic, it also functions as a pedestrian bridge, particularly when tour buses visit the site. Preliminary consideration of the 4.0kPa pedestrian load suggested it was roughly equal to a design truck weighing about 8t to 10t depending on the element under consideration. The design team considered 4.0kPa applied over the entire travelled deck surface to be too conservative and not consistent with the pedestrian traffic known to be experienced on the bridge. The design team ultimately decided to forego further consideration of the pedestrian load until preliminary design, at which time the design vehicular live load would be decided, and the design pedestrian load could be more reasonably established.

4.3.2. Structural Evaluation for Preliminary Design

As noted below in Section 7.3, the design live load for the preferred rehabilitation alternative is a 10t design truck. The axle layout of this truck is noted above in Figure 6. The front axle weight is 1.52t and the rear two axle weights are each 4.24t.

The vehicular design live load prescribed by the CHBDC for evaluation of existing bridges consists of a truck load and a lane load. A modified lane load concept was used for the preliminary design. While the truck load is intended to represent the effect of single heavy vehicles moving at or near the roadway design speed, the lane load is intended to represent back-to-back lighter vehicles - with one heavier vehicle mixed in - all moving at very slow speeds to the point where dynamic effects are negligible (CSA Group 2019).

The CHBDC lane load is a uniformly distributed load (UDL) combined with the design truck not amplified by the DLA. The magnitude of the UDL is taken as 9, 8, or 7 kN/m for Class A, B, and C highways, respectively. Covered Bridge Drive is a Class C Highway per CHBDC Table 1.1. Thus, the lane load UDL would be 7 kN/m.

It was decided that the CHBDC lane load was not appropriate for the preliminary design. The covered bridge is signed for a 3t live load limit. The local community has historically exhibited strong support for this load limit and is assumed unlikely to violate it. Therefore, it is unlikely that an overload vehicle would be crossing the bridge at the same time as a series of small cars, which is what the lane load represents.

A uniform pressure of 2.4 kPa was assumed in lieu of the lane load. This assumption is consistent with Table 4.1.5.3 of Part 4 of the Ontario Building Code (O. Reg. 332/12) for garage structures supporting vehicles weighing no more than 4t. This condition is consistent with day-to-day bridge use, wherein multiple cars weighing 3t or less may follow one another across the bridge in close succession. This condition does not capture an overload situation.

Many members of the local Mennonite community use horse-drawn carriages as their primary means of transportation. We are aware of a weekly condition before and after church wherein a grouping of numerous, closely spaced, back-to-back, horse-drawn carriages cross the covered bridge. The horse and buggy combinations are not believed to exceed the 3t posted live load limit. Thus, this condition is covered by the 2.4kPa uniform live load used in lieu of the CHBDC lane load.

A 5kN load applied over a 0.1m by 0.1m footprint was considered to represent the local effect of a horse's hoof. This load was assumed per clause 6.5 of the recently published CSA S7:19 Pedestrian, Cycling, and Multiuse Bridge Design Guideline (CSA Group 2023).

The pedestrian live load used for the preliminary design was a uniform 4.0 kPa pressure across the full deck width over a deck length of 2.5m. This load was intended to represent an occupancy load of 70 persons, which was considered a realistic upper bound of the loading anticipated due to pedestrian congregations. The 70 persons assumption was based on our design team's understanding of the pedestrian loading experienced by the arrival of one large fully loaded tour bus or two fully loaded minibuses. The length of 2.5m was arrived at by assuming an average weight of 0.67kN (150lb) per person, a deck width of 4.8m, and a person density of six persons per square metre. The 2.5m loaded length was positioned at many points along the structure to capture the most severe effects. This maximizes the effect of the 70-person load.

We understand that there has been at least one proposal to host a dinner party within the bridge. A pedestrian live load of 2.4 kPa applied uniformly to the entire deck surface would be appropriate to design for this event, assuming that no dancing was permitted and that the dining tables remained in place throughout the course of the event. This loading is equivalent to roughly 3.6 persons per square metre weighing an average of 150lbs per person, which would equate to about 1000 persons on the entire bridge deck if no tables were present. That number of people is unrealistic for a dinner party because there would be tables and chairs present too. The 2.4 kPa load is the minimum loading for a dining area per Clause 4.1.5.6 of the Ontario Building Code (O. Reg. 332/12). As it turns out, this load has implicitly been addressed by means of the 2.4 kPa uniform pressure noted above to have been assumed in lieu of a lane load.

The live loads used for the detailed design will be the same live loads used for the preliminary design.

4.4 OTHER LOADS

The other loads considered for the structural evaluation included:

- Dead loads
- Superimposed dead loads
- Wind loads
- Snow loads
- Imposed deformations caused by thermal effects
- Flood loads

The following subsections explain the derivation of these loads. All loads were determined in accordance with the CAN S6:19 Canadian Highway Bridge Design Code (CHBDC) except where noted.

4.4.1. Dead Loads

The dead loads considered for the structural evaluation consisted of the self-weight of the superstructure members; that is, the wood elements comprising the trusses and floor system, and the steel hanger rods. The following unit weights were assumed per CHBDC Table 3.4:

Table 6 – Material Unit Weights for Structural Evaluation

Material	*Unit Weight*
Wood (all species)	6.0 kN/m^3
Steel	77.0 kN/m^3

The 6.0 kN/m^3 unit weight for wood is an upper bound, representing wood with a high moisture content.

As aforementioned, the initial structural evaluation did not consider the steel Bailey trusses to be present.

4.4.2. Superimposed Dead Loads

The superimposed dead loads considered for the structural evaluation consisted of the following:

- Tar and chip wearing surface (assumed 25mm thickness, unit weight = 23.5 kN/m^3)
- Roof shingles (assumed to be cedar shingles; unit pressure of 0.1 kPa)
- Roof decking (assumed 19mm thickness, unit weight = 6.0 kN/m^3)
- Rafters (assumed 44mm x 152mm cross-section, centre-to-centre spacing = 610mm, unit weight = 6.0 kN/m^3)

- Exterior cladding (assumed 22mm thickness, unit weight = 6.0 kN/m^3)
- Wood curbs and guardrails (assumed linear weight = 1.3 kN/m)

4.4.3. Wind Loads

Vertical and horizontal wind loads were calculated in accordance with CHBDC clause 3.10. The loads were based on a 370 Pa reference wind pressure for 1-in-50-year return period. The exposure coefficient was taken as 1.0 and the gust coefficient was taken as 2.0. Horizontal and vertical drag coefficients of 1.3 and 1.0 were assumed, respectively. The 1.3 horizontal drag coefficient was assumed recognizing the covered bridge has a lesser aspect ratio than typical bridges due to the height of its cladding and roof. The 1.3 value was calculated in accordance with Annex A3.2 of the CHBDC. It can similarly be calculated using Figure I-19 of Commentary I of the National Building Code of Canada (NBCC). The resulting horizontal and vertical wind pressures used for the structural evaluation were calculated to be 0.96 kPa and 0.74 kPa, respectively.

The vertical wind was considered to act both upwards and downwards. Both horizontal and vertical wind pressures were considered simultaneously per CHBDC clause 3.10.2. Possible eccentricity of the vertical wind pressure was considered by applying the resultant wind force at the windward quarter point of the bridge width per CHBDC clause 3.10.2.3.

The exterior cladding was assumed to be solid for the purposes of calculating drag forces due to wind. Wind on live load was precluded by the exterior cladding.

4.4.4. Snow Loads

Site specific snow loads were determined for the covered bridge in 2015 by RWDI for a 1-in-50-year return period. Balanced and unbalanced snow loads were determined (see Figure 7). The balanced snow load was determined to be 1.6 kPa applied uniformly over the entire roof. The unbalanced snow load was determined to be 2.1 kPa applied uniformly over the windward half of the roof and 0.5 kPa applied uniformly over the leeward half of the roof.

The snow loads were determined as follows:

- Ground snow load (S_s) determined to be 2.45 kPa using statistical analysis of 36 years of meteorological data from the Waterloo airport (winter 1973-1974 to winter 2013-2014) using the Fisher-Tippett Method (contrasted with S_s = 2.0 kPa per National Building Code of Canada 2010)
- Associated rain load (Sr) taken as 0.4 kPa per National Building Code of Canada 2010
- Product of basic roof snow factor (C_b) and wind exposure factor (C_w) taken as 0.60 per parametric assessment of roof size and exposure using finite area element method (contrasted with a product of 0.80 per National Building Code of Canada 2010)
- Roof slope factor taken as 1.0 (i.e. assumes no reduction in snow load due to snow sliding off roof)

- Importance factor of 1.0 assumed (appropriate because structure will not be used as post-disaster structure)

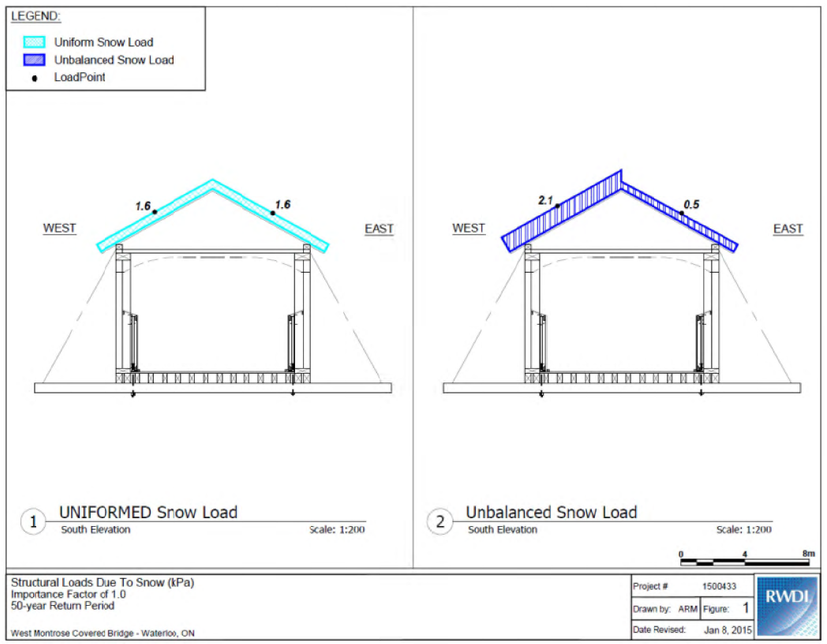


Figure 7 – Site Specific Balanced and Unbalanced Snow Loads (excerpt from RWDI 2015)

4.4.5. Imposed Deformations Caused by Thermal Effects

Linear thermal expansion and contraction were considered for the structural evaluation. The following coefficients of linear thermal expansion were assumed:

Table 7 – Coefficients of Linear Thermal Expansion for Structural Evaluation

Material	*Coefficient of Linear Thermal Expansion*
Wood (all species)	4.0×10^{-6}
Steel	12.0×10^{-6}

A thermal gradient was not considered through the depth of the structure, which is historically consistent for wood structures because wood has a lower thermal conductivity and is more thermally diffuse than traditional building materials like concrete and steel (Forest Products Laboratory 2010).

4.4.6. Hydraulic Loads

In 2023, the Region retained Sanchez Engineering Inc. (Sanchez) to undertake a hydraulic analysis of the Grand River at the covered bridge for the purpose of determining:

- the high-water level for floods of various return periods
- the hydraulic design criteria for evaluation of the bridge under flood loading resulting from partial inundation
- the corresponding hydraulic forces arising from flood conditions
- forces arising from ice in the river
- the effects of scour

The findings of the hydraulic analysis were presented in the "West Montrose Covered Bridge Rehabilitation – Bridge Hydraulic Engineering Report" by Sanchez, dated December 2023. That report has been appended in Appendix C.

The high-water levels and clearances to the underside of the floor/needle beams and truss bottom chords are presented in Table 8. The hydraulic analysis was completed well into the preliminary design process. At that time, it was known that the replacement floor/needle beams would be upsized from a 305mm x 305mm cross-section to a 406mm x 406mm cross-section. The larger cross-sectional size was assumed for the hydraulic analysis. As such, the undersides of the truss bottom chords were taken as 406mm higher than the underside of the floor beams/needle beams. Per the table, the wood trusses are not expected to be partially inundated for floods with returns periods less than Regional flood.

Table 8 – High-Water Levels and Vertical Clearances

Return Period	High Water Elevation	Vertical Clearance to	
		Underside of Floor/Needle Beams	Underside of Truss Bottom Chords
2 years	321.85m	1.337m	1.743m
5 years	322.27m	0.917m	1.323m
10 years	322.67m	0.517m	0.923m
25 years	322.97m	0.217m	0.623m
50 years	323.25m	-0.063m	0.343m
100 years	323.45m	-0.263m	0.143m
Regional Flood	324.26m	-1.073m	-0.667m

The MTO's "Highway Drainage Design Standard" was used to identify the design flow return period of 1-in-50 years. This standard indicates a desirable vertical clearance of at least 0.3m for the design flood. Per Table 8, this criterion is satisfied. However, given that the Region desires to keep the West Montrose Covered Bridge in service indefinitely, the project team decided to design for hydraulic loading resulting from passage of the Regional flood, acknowledging that the bridge cannot practically be raised any higher without severely complicating the bridge approach grades. Per Table 8, the wood trusses are expected to be partially inundated by 0.667m during the Regional flood, which will result in hydraulic forces acting on the bridge. The rehabilitation design considers the effects of these hydraulic forces by requiring installation of new bottom lateral bracing rods and new sway bracing rods to resist lateral loads due to hydraulic forces and wind.

Hydraulic forces acting on the partially inundated bridge were calculated per the Federal Highway Administration's "Hydrodynamic Forces on Inundated Bridge Decks" (Publication No. FHWA-HRT-09-028) document. The following forces were calculated:

- Hydrostatic force resulting from unbalanced water levels on the upstream and downstream faces of the bridge during partial inundation
- Hydrodynamic forces resulting from stream flow against the side of the bridge during partial inundation
- Hydrostatic uplift (i.e. buoyancy) acting on the underside of the partially inundated structure
- Hydrodynamic uplift and torsional moment resulting from stream flow against the side of the bridge during partial inundation

The static and dynamic forces were taken as additive. Their magnitudes are presented in Table 9.

Table 9 – Hydraulic Forces

Force	Direction	Magnitude
Hydrostatic Drag	Lateral	6.4kN/m
Hydrodynamic Drag	Lateral	11.4kN/m
Hydrostatic Uplift	Vertical	22.5kN/m
Hydrodynamic Uplift	Vertical	-0.14kN/m
Hydrodynamic Moment	Torsional	0.15kNm/m

The total lateral hydraulic load is the sum of hydrostatic and hydrodynamic drag forces. It is equal to 17.8kN/m.

The total vertical hydraulic load is the sum of hydrostatic and hydrodynamic uplift forces. It is equal to 22.4kN/m. Note that the dynamic component of this force has a negative sign and acts downwards, thereby counteracting the static uplift force.

Hydraulic loads acting on the pier and scour of the riverbed were not considered by our design team because the rehabilitation of the pier was outside our scope of our work and is the responsibility of Doug Dixon & Associates.

Per the hydraulics report, the high-water level during ice flow is believed to be about that of the 2-year flood, meaning that ice floes are always expected to clear the underside of the bridge. As such, ice loading was not considered for the structural evaluation.

4.5 PRIMARY LOAD COMBINATIONS

All loads and load combinations were determined in accordance with the CAN S6:19 Canadian Highway Bridge Design Code (CHBDC).

Special consideration was given to the possibility of snow acting on the roof simultaneously with heavy live load acting on the deck. The CHBDC does not provide guidance for this situation. The "Covered Bridges Manual" published by the United States Federal Highway Administration (2005) acknowledges that there is no published guidance on this topic, but that covered bridge experts believe that simultaneous loading by full snow load and full design live load to be highly unlikely. In light of this comment, snow load was considered to occur simultaneously with full design live load for the ULS 2 and ULS 3 load combinations, assuming a ULS load factor of 0.50 for the snow load. This approach is consistent with the MTO Structural Manual's recommendations for pedestrian bridges. An additional load combination was considered assuming a ULS load factor of 1.5 for the snow load, no live load on the bridge, and full ULS factored dead loads. This combination satisfies both MTO Structural Manual and the National Building Code of Canada.

4.6 DEMAND-TO-CAPACITY (D/C) RATIOS

The following Table 10 summarizes the D/C ratios determined from the initial structural evaluation.

Table 10 – Demand-to-Capacity (D/C) Ratios for Initial Structural Evaluation

Design Live Load Weight	Top Chord	Bottom Chord	Lower Top Chord	Main Diagonals		Lower Diagonals	
				1st	2nd/3rd	1st	2nd/3rd
3 t	30%	62%	41%	95%	32%	8%	3%
4 t	33%	68%	51%	105%	36%	9%	3%
5 t	36%	73%	61%	116%	40%	10%	3%
6 t	39%	80%	70%	130%	45%	11%	3%
7 t	42%	86%	80%	139%	50%	12%	3%
8 t	46%	92%	90%	154%	56%	14%	3%
9 t	49%	99%	100%	164%	61%	15%	3%
10 t	53%	106%	110%	178%	67%	17%	3%
11 t	56%	113%	121%	192%	73%	19%	3%
12 t	60%	120%	131%	207%	79%	21%	3%
13 t	64%	128%	141%	222%	86%	23%	3%
14 t	68%	136%	152%	238%	93%	25%	3%
15 t	72%	144%	162%	255%	100%	27%	3%

Table 10 shows that the bottom chords, lower top chords, and the end diagonals have the potential to be overstressed for the range of design live loads considered for the structural evaluation. The D/C ratio for the bottom chords exceeds 100% when a design live load greater than or equal to 10t is considered. The D/C ratio for the lower top chord exceeds 100% when a design live load greater than or equal to 9t is considered. The same is true for the end diagonals for a design live load greater than or equal to about 4t.

The D/C ratios have been reported for the wood members, not the member connections at the truss nodes and at splices. The connections tend to govern at about 75% of the member strengths, particularly for members with numerous fastener holes like the bottom chord members at splices. For instance, the bottom chord splice connections would likely be overstressed for a 6t design live load because the utilization is 80%, which is above the approximate 75% threshold.

Connection capacities were not evaluated for the structural evaluation, except for the bottom chord splice connections. That particular splice connection was evaluated to ensure that the new bottom chords could remain as sawn wood members (see Section 7.2). All other connections will be evaluated and strengthened as necessary during detailed design.

The D/C ratios for the floor beams, needle beams, stringers, NLT deck, and steel vertical rods were omitted from Table 10 because replacing these members was warranted due to their existing conditions. In replacing these members, it will be possible to increase their strength as needed by means of specifying stronger wood species and/or making permitted section size increases.

5. DEVELOPMENT OF REHABILITATION ALTERNATIVES

Numerous inspections, analyses, and studies were completed before our team joined the project, all of which influenced the rehabilitation alternatives that were ultimately evaluated by our team. This section explains the process by which the rehabilitation alternatives were developed.

5.1 INFLUENCE OF PRIOR WORKS

The bridge rehabilitation alternatives were influenced by prior engineering assignments for the bridge from the late 1990s onwards. Our project team studied the resulting background documents to inform the development of structural rehabilitation alternatives considered for our assignment. This section of the report explains the lead-up to the development of the alternatives presents in Section 5.6 of this report. The summaries presented herein are our interpretation of the background documents and their influence on the development of the rehabilitation alternatives.

The Region assumed ownership of the West Montrose Covered Bridge in 1998 from the Ontario Ministry of Transportation (MTO). Since then, the Region has undertaken several exercises to assess the condition of the bridge and to determine a suitable rehabilitation strategy.

In 1999, shortly after assuming ownership, the Region retained Giffels Associates Limited (Giffels; subsequently IBI Group; now part of Arcadis) to design a major rehabilitation of the bridge. This work followed the inspection and structural evaluation that Giffels had performed on the bridge on behalf of the MTO before ownership was transferred to the Region. To our knowledge, this exercise was the first time that the structural behaviour of the bridge was expressly investigated since the time of installing the steel Bailey trusses in 1965. It resulted in the determination that the Bailey trusses could support an 8t live load with simultaneous snow load on the roof and an 11t live load without any snow on the roof. No indication was given as to the capacity of the original wood trusses because the structural evaluation assumed the Bailey trusses to carry all gravity loads acting on the bridge.

Building on the late 1990's work, the Region retained IBI Group (formerly Giffels) in 2014 to complete a preservation plan for the bridge. That report has been appended in Appendix D. The plan investigated risks to the bridge and developed mitigation strategies for each risk. The investigated risks were:

- lightning strikes to the bridge
- inundation of the structure during flooding of the Grand River
- overloading by large snow accumulations on the roof
- overloading by passage of overweight vehicles
- collision by ice floes in the Grand River

- decay caused by animal waste accumulated on the wood members
- fire caused by arson
- defacement vandalism in the form of graffiti

The preservation plan proposed mitigation strategies for each of these risks. A 10-year capital plan and an on-going maintenance plan were developed. The Region has since implemented some of these mitigation strategies. Of importance, the preservation plan was the first known document to expressly consider the unique risks applicable to the West Montrose Covered Bridge. The plan helped inform the development of our rehabilitation alternatives as it pertained to the potential risks to the structure.

In 2015, IBI Group acted on behalf of the Region to determine site-specific snow loading for the bridge. IBI Group hired RWDI to determine this loading. Their work was based on a statistical analysis of 36 years of meteorological data from the Waterloo airport (winter 1973-1974 to winter 2013-2014). Full details of their work are explained in Section 4.4.4 of this report. RWDI's report has also been appended in Appendix E. Knowing the site-specific snow loading is very beneficial. It ensures a safe design against realistic snow accumulation conditions. It also prevents overdesign of the preferred rehabilitation alternative by precluding the use of non-site-specific snow loading calculated using general code equations.

The Region retained K. Smart Associates (KSA) in 2017 to investigate the existing condition and structural behaviour of the bridge. Moses Structural Engineers (MSE) was retained as a subconsultant to perform a detailed inspection of the wood members of the bridge. Their work consisted of:

- arm's length visual inspection of the wood members
- resistance drilling measurements of the wood members to assess the likelihood of decay within a member
- moisture content measurements of the wood members to assess the likelihood of decay within a member
- removing small samples of the wood elements for species identification under microscope in a laboratory
- visual grading of the in-situ wood members per the National Lumber Grades Authority's (NLGA) National Grading Rules for Canadian Lumber

The findings of the resulting "Conditions at West Montrose Covered Bridge" report by MSE were significant for the following reasons:

- They represented the first detailed investigation of the wood members by a wood materials expert since IBI's work in the late 1990's.
- They recommended replacement or remediation for many wood members, confirming that not all existing materials could be retained.

- They highlighted the inspection access limitations inherent to the bridge, with much of the floor system beneath the deck being not inspected due to a lack of access over the river.
- They represented the first comprehensive reporting of the species and grades of the existing wood members.

Anecdotal reports from the local community indicated that the bridge has been visibly deteriorating over the past few decades. MSE's report supports those anecdotes. MSE's report has been appended in Appendix F.

The second part of KSA's 2017 assignment was to assess the structural behaviour of the bridge by means of structural health monitoring. Struct-Sure Limited was retained as a subconsultant for this purpose. The bridge was outfitted with four fibre-optic strain sensors and a temperature sensor. One sensor was placed on the top chord of each steel Bailey truss and the lower top chord of each wood truss. Two live load tests were conducted in 2017; one in the winter and one in the summer to examine the impact of thermal deformations on live load distribution. The effect of changes in temperature was also examined. The following notable observations and conclusions were made by KSA:

- The wood trusses participate substantially with the steel Bailey trusses to resist live loads.
- There is unequal load sharing between the west and east wood trusses and Bailey trusses.
- Thermally induced stresses are much more significant in the wood trusses than stresses due to live load.
- The wood trusses and steel Bailey trusses are implicitly exhibiting translationally fixity at each abutment because of the large magnitude thermal restraint strains that were recorded.
- Vehicles of weight exceeding the posted 3t live load limit frequently crossed the bridge (45 overload crossings per month in the winter and 122 overload crossings per month in the summer).

The finding of high thermal stresses is surprising because the thermal conductivity and diffusivity of wood is quite low, to the point where thermal movements parallel to grain have historically been successfully ignored in wood structure designs.

Struct-Sure made the following recommendations:

- A structural analysis of the bridge should be undertaken to better understand its behaviour.
- A wood replacement program should be undertaken in accordance with the recommendations from MSE's 2017 inspection report.

- Further analysis should be undertaken to develop a means of relieving restraint of thermal movements in the wood trusses and Bailey trusses.

Struct-Sure's monitoring equipment was removed from the bridge at the end of the assignment and is thus no longer available to provide continuous monitoring data. Struct-Sure's monitoring report has been appended in Appendix G.

In response to Struct-Sure's recommendations, the Region retained Doug Dixon & Associates (DDA) in 2018 to perform a structural evaluation of the bridge, with a specific aim to evaluate the ability of the steel Bailey trusses to carry all gravity loads should the existing wood trusses deteriorate to the point where they are on longer functioning structurally. If the Bailey trusses were found to be deficient, then alternative structural concepts to support the full gravity loads were to be developed.

DDA's structural evaluation was presented in their June 2019 report entitled "West Montrose Covered Bridge Structural Assessment of Options Report". This report has been appended in Appendix H. The structural evaluation was conducted in accordance with the 2014 CHBDC. The wood trusses were assumed to have no stiffness, and were thus treated strictly as superimposed dead load, not as functioning structural elements. The east and west Bailey trusses were assumed to equally share applied gravity loads at the ultimate limit state. Ultimately, the Bailey trusses were found to not have sufficient capacity to resist all loads acting on the bridge should the wood trusses no longer have any structural capacity (see Figure 8).

Table 4: Capacity-to-Demand Ratio for Exisiting Two-Span Continuous SSR Bailey Truss

Load Combination	Moment		Shear		Axial
	0.4L	Pier	Abutment	Pier	Pier Vertical
	C/D Ratio	C/D Ratio	C/D Ratio	C/D Ratio	C/D Ratio
ULS1	1.96	**0.72**	1.21	**0.70**	**0.82**
ULS3-1	1.18	**0.55**	**0.81**	**0.50**	**0.59**
ULS3-2	1.12	**0.54**	**0.78**	**0.49**	**0.57**
ULS4-1	**0.73**	**0.36**	**0.52**	**0.32**	**0.37**
ULS4-2	1.26	**0.47**	**0.80**	**0.45**	**0.53**
ULS7	**0.87**	**0.44**	**0.62**	**0.39**	**0.45**
ULS9	2.53	**0.70**	1.41	**0.72**	**0.84**
Minimum	**0.73**	**0.36**	**0.52**	**0.32**	**0.37**
Result	**Insufficient Capacity**	**Insufficient Capacity**	**Insufficient Capacity**	**Insufficient Capacity**	**Insufficient Capacity**

Note: Bold indicates factored load exceeded capacity (i.e. failure is anticipated at ULS).

Figure 8 – Capacity-to-Demand Ratios for Steel Bailey Trusses per Structural Evaluation by DDA (excerpt from Structural Assessment of Options Report by DDA, 2018)

DDA developed three replacement alternatives for the Bailey trusses:

- Replacement with a double-single reinforced (DSR) modular truss system consisting of two planes of trusses on each side of the bridge. Both simply-supported and two-span continuous systems were considered. The use of Mabey-Johnson truss panels was also considered. Mabey-Johnson trusses are a more modern successor to Bailey trusses. Several compression chord bracing concepts were also considered. Insufficient capacity was found for all configurations, so this alternative was abandoned.
- Replacement with closed steel box girders, with one box girder on each side of the bridge (see Figure 9). A large aspect ratio was assumed to keep the girders narrow. This concept was found to be structurally feasible and was carried forward for costing. After discussions with the Region, this concept was refined to also include steel floor beams that would transfer loads from the deck directly into steel box girders, thus precluding the existing wood needle beams from having to transfer these loads.
- Replacement with prefabricated steel Pratt trusses, with one steel truss on each side of the bridge. The trusses were designed using tee sections for the chords and double-angle sections for the diagonals and verticals. An outrigger strut was designed to brace the truss top chords at every needle beam location. This brace would have to penetrate through the covered bridge exterior cladding to reach the needle beams and was identified to likely detract from the historic appearance of the bridge. This concept was found to be structurally feasible and was carried forward for costing.

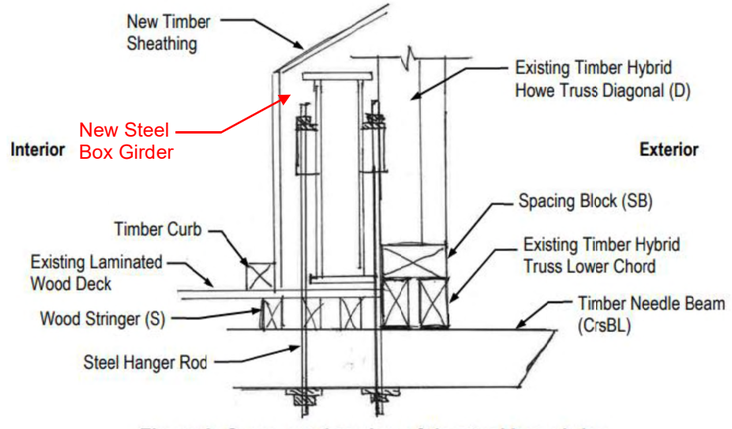


Figure 6: Cross-section view of the steel box girder

Figure 9 – Steel Box Girder Concept (modified excerpt from Structural Assessment of Options Report by DDA, 2018)

DDA intended for each of the three alternatives to take the place of the existing steel Bailey trusses behind the interior cladding. Minor adjustments in the width of the interior cladding were expected to accommodate the widths of the new trusses or box girders.

DDA identified the steel box girder alternative as the most preferable (see Figure 9). This alternative was evaluated during Entuitive's current assignment. It became known as Alternative A and is explained in further detail in Section 5.6.2 of this report.

DDA's 2019 report recommended an assessment of all existing wood elements to identify rehabilitation needs. The Region retained DDA in 2020 for this purpose. A visual inspection of the existing timber and steel elements was undertaken. The inspection was similar to MSE's 2017 inspection in that resistance drilling and moisture readings were taken for the wood elements. Like MSE in 2017, DDA in 2019 were limited to inspection of the bridge from deck level with no roof inspection and limited inspection of the floor system and underside of the bridge from the south abutment.

DDA's 2019 inspection findings were presented in their June 2020 report entitled "West Montrose Covered Bridge Detailed Inspection Report". This report has been appended in Appendix I. The report features detailed findings for the steel Bailey trusses, including the reporting of cross-section measurements for all elements, which is believed to be the first time in the bridge's history that that information had been officially documented. DDA made the following recommendations of note:

- Replace the existing shingles and roof sheathing boards.
- Replace or repair the existing squash blocks.
- Replace the exterior wood sheathing.
- Repair splits and check in the top chord and lower top chord members.
- Locally repair the diagonal and lower diagonal members that had deteriorated.
- Replace interior cladding (i.e. "splash panels") to accommodate new steel box girders (assuming the steel box girder alternative were to be carried forward).
- Replace the wood deck and stringers.
- Replace all floor beams and needle beams that were older than seven years (i.e. from before 2013).
- Further inspect the bottom chord and lower portions of the diagonal and lower diagonal members when better access is available.
- Repair the concrete abutments.

In addition to their inspection, DDA retained Complete Survey Solutions to perform a geodetic survey of the bridge in April 2020. The survey recorded both the vertical and lateral deflections of the bridge. DDA made the following observations from the survey results:

- The top of pier is higher than the tops of the abutments.
- The west wood truss is sitting lower than the east wood truss.
- The bridge was found to be laterally deflected (i.e. "sweeping") to the east.

- The pier appears to be settling to the east.

The previous studies and investigations reported in this section influenced the development of the alternatives developed for evaluation of the preferred rehabilitation concept. As aforementioned, the steel box girder concept developed by DDA in 2019 was carried forward for evaluation as "Alternative A".

5.2 SCHEDULE A+ ENVIRONMENTAL ASSESSMENT

Following their 2019 and 2020 assignments for the bridge, DDA subsequently worked with the Region to initiate a Schedule A+ Municipal Class Environmental Assessment (EA) for the purpose of rehabilitating the bridge. The steel box girder concept developed in 2019 (i.e. Alternative A) was introduced to the public as the preferred rehabilitation alternative at Public Consultation Centre #1 (PCC #1) in October 2021.

The public consultation that ensued resulted in the development of a second rehabilitation alternative that involved making the wooden trusses the primary load carrying members. This alternative became known as Alternative B. It focused on reinforcing the bridge by strengthening the wood truss chords by affixing fibre-reinforced polymer strips to them, and strengthening the wood truss diagonals by fastening wood reinforcing planks to them. This option included permanently removing the steel Bailey trusses. Alternative B was presented to the public as the preferred rehabilitation alternative at Public Consultation Centre #2 (PCC #2) in June 2022. Alternative B is explained in further detail in Section 5.6.3 of this report.

5.3 TIMBER TRUSS ASSESSMENT AND DESIGN ASSIGNMENT

Following PCC #2, the Region sought to retain an engineering firm experienced with wood structures and heritage structures to advance the bridge rehabilitation to completion, becoming what is the current "Timber Truss Assessment and Design Assignment" for which Entuitive's team was retained. A two-stage request for proposals was administered in fall 2022, with Entuitive's team selected to complete the assignment.

The RFP noted the following motivations:

- Gravity loads acting on the structure are being shared by the original wood trusses and the steel Bailey trusses.
- The wood trusses are continuing to deflect and are thus "shedding" load to the Bailey trusses.
- The Bailey trusses do not have sufficient capacity to support all gravity loads acting on the bridge and are thus at risk of collapse if the wood trusses shed too much of their load to the Bailey trusses.
- The Bailey trusses were manufactured in 1944 and cannot be readily strengthened to support all the gravity loads acting on the bridge.
- Restricting the bridge to pedestrian only traffic will not resolve the situation because a large group of pedestrians weighs as much or more as the vehicles that are permitted to cross the bridge.

- The bridge should undergo a major rehabilitation to assure safety of the structure and its users.

The scope of this assignment is to:

- Review all background materials.
- Perform an arm's length visual inspection and non-destructive testing for the bridge.
- Perform a structural evaluation to assess the load carrying capacity of the bridge.
- Develop and evaluate structural rehabilitation alternatives.
- Perform a Municipal Class Environmental Assessment, with the schedule to be determined by the project team.
- Recommend a preferred rehabilitation alternative to be advanced to detailed design.
- Complete detailed design of the preferred rehabilitation alternative.
- Provide tendering and contract administration services through the construction phase.

Our team joined the project in January 2023. Our team consisted of the following firms:

- Entuitive (Prime Consultant; expertise in bridge and construction engineering and wood structures)
- BT Engineering (expertise in project management, community consultation, environmental assessment, permitting, and value engineering)
- Moses Structural Engineers (wood structures expert)
- Wender Shearer (cultural heritage expert)
- Montogomery Sisam Architects (bridge architect)
- Callon Dietz (surveyor)

5.4 VALUE ENGINEERING WORKSHOP

Our team reviewed the background documents and performed the first of two bridge inspections (see Section 3) in winter 2023. The team then held a value engineering (VE) workshop on March 21, 2023. The workshop was held at Region's Operations Centre in Cambridge, Ontario. Steve Taylor from BT Engineering led the workshop. Mr. Taylor is an expert in value engineering and has been designated as a Certified Value Specialist – the highest designation from the Society of American Value Engineers.

In addition to our team, the workshop was attended by representatives from:

- The Region (bridge owner)
- The Township of Woolwich (local municipality in which bridge is located)
- The West Montrose Resident's Association (i.e. the "Bridge Keepers")

- Cambium Infrastructure Solutions Ltd. (bridge engineering consultant with considerable knowledge of the structure from previous employment at the Region)
- Doug Dixon & Associates (bridge engineering consultant with considerable knowledge of the structure from previous assignments; presently responsible for substructure and foundations rehabilitation)
- IBI Group (bridge engineering consultant with considerable knowledge of the structure from previous assignments)
- Sanchez Engineering (water resources engineer presently responsible for bridge hydraulics)
- Unterman McPhail Associates (cultural heritage expert responsible for completing the Heritage Impact Assessment for this bridge rehabilitation project)

The firms noted above collaborated alongside our team but were not part of our team. They were part of the overall project team assembled by the Region.

The purpose of the workshop was "to analyze functional requirements of the project, as well as generate, evaluate, and develop ideas for alternative value enhancements to move forward with this project. The exercise was for the VE workshop to review the project definition and to then question all previous decisions before carrying forward a short list of preliminary design approaches to consider in greater detail i.e., value proposals (either related to cost or performance) to improve the project within affordability constraints" (BT Engineering, 2023).

The VE workshop team undertook a quality modelling exercise to identify the areas of greatest concern and their relative priorities. A total of 18 criteria were established. A quality diagram (see Figure 10) was established to communicate their relative priority to the project. "X" symbols were marked on the circle for each criterion. Symbols at the outside of the circle represent the highest priority and symbols at the inside of the circle represent the lowest priority.

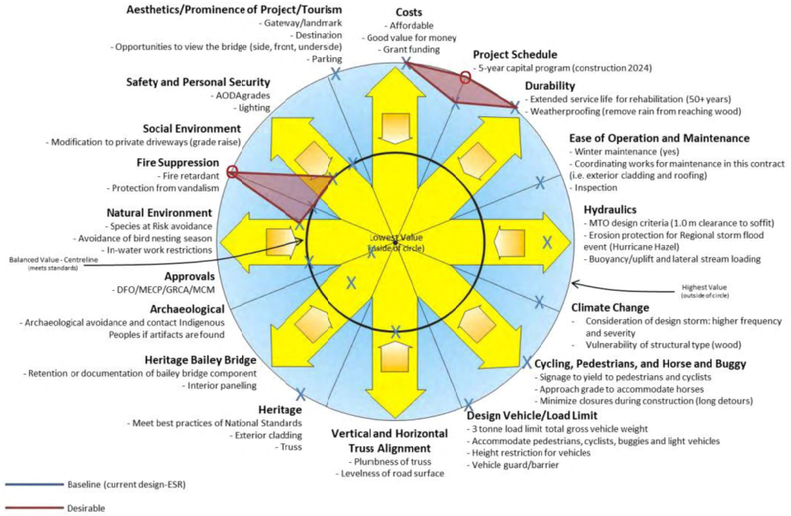


Figure 10 – Quality Model (excerpt from Value Engineering Report by BTE, 2023)

The VE workshop team also reviewed the functions of the bridge and its proposed rehabilitation by means of a functional analysis. They identified "preserve heritage" as the most basic function. The quality modelling and functional analysis enabled the team to better understand the project needs and the relative value of those needs. Those results were used to generate ideas that could add value to the project (i.e. "value proposals"). A total of 82 value proposals were generated. They were shortlisted down to 55 value proposals through a screening exercise that identified synonymous ideas.

The VE workshop also resulted in the following key recommendations:

- The bridge is to remain posted for the currently signed 3t live load limit.
- The rehabilitation design is to be based on a 5t design live load (eventually increased to 10t for the preferred rehabilitation alternative).
- The signage to restrict overheight and overweight vehicles is to be improved.
- The rehabilitation design is to consider flood loading acting on the bridge due to large storm events and/or improvements to the river hydraulics at the bridge to preclude or minimize such loading.
- The exterior cladding will be replaced if it is substantially deteriorated.

The VE workshop was documented in a Value Engineering Report by BTE. This report has been appended in Appendix J.

5.5 DEVELOPMENT OF ALTERNATIVE C

Our team sought to examine an alternative that relied only on the existing wood trusses to support the bridge. Even if strengthening were required, our team felt that the outcome would be more sympathetic to the original structural design than offered by Alternative A (i.e. steel box girders supporting bridge) and Alternative B (i.e. strengthening using modern fibre-reinforced polymers).

After reviewing the inspection results and completing the structural evaluation in summer 2023, our team came to understand that several members would require replacement (i.e. the bottom chords and the end diagonals at the piers) and some would require strengthening (i.e. the end diagonals at the abutments). It became clear that the member replacements and strengthening could be accomplished using higher strength wood solutions. Resulting from these findings, the design team developed Alternative C that was based on replacement and strengthening solutions using wood elements. Existing wood members that were found to require replacement due to their deteriorated conditions were envisioned to be replaced using wood members. If additional strength was required of those members, then the replacement members were envisioned to be of a higher strength than the existing members by either increasing member size or using higher strength timber materials. Similarly, existing wood members that were found to be understrength were envisioned to be strengthened using by fastening new wood elements onto the existing wood members. The addition of steel or fibre-reinforced polymer reinforcements was to be precluded.

Cultural heritage considerations were very important in developing Alternative C. Wendy Shearer, Entuitive's cultural heritage specialist, and Richard Unterman, the Region's cultural heritage specialist from previous assignments, were instrumental in that regard. The guiding document was the Standards and Guidelines for The Conservation of Historic Places in Canada by Parks Canada.

The bridge is an example of an "evolved structure"; that is, the bridge has evolved over time due to its various repairs, but it is still functioning as a covered bridge as intended by its builders. The bridge cannot be restored to its original state because the original design does not comply with the modern Canadian Highway Bridge Design Code; however, it can be conserved through satisfaction of the cultural heritage considerations outlined in the Standards and Guidelines for The Conservation of Historic Places in Canada document.

One of the overarching preservation principles is "reversibility". Reversibility aims to preserve the original heritage fabric of a structure by ensuring that evolutions to the structure be as reversible as possible so that the evolution can be reversed – if needed – without adversely impacting the structure's heritage significance. For example, reinforcing the bridge's existing wood members would be preferable to replacing them in order to maintain the historic original material. That approach is of course only possible when the existing members are not deteriorated to the extent that replacement is necessary.

The value engineering workshop established that the Region desired to keep the bridge posted for a 3t live load limit and that they wanted the design live load to be at least 5t. The

use of a heavier design live load for the bridge rehabilitation would provide greater safety against overload by passage of overweight vehicles, but it would also likely require more interventions to original wood structure. To investigate that impact, we determined demand-to-capacity ratios for design live loads on a 1t incremental basis ranging from 3t to 15t, inclusive. This approach allowed the design team to understand the "fuse points" within the system; that is, the design live load above which further intervention to the wood structure would be necessary.

The results of the incremental design live load analysis informed the definition of Alternative C. The team identified four "fuse points" based on design live loads of 6t, 8t, 10t, and 12t, becoming what are referred to as Alternatives C1, C2, C3, and C4, respectively. These alternatives are described in detail in Section 5.6.4.

5.6 REHABILITATION ALTERNATIVES FOR EVALUATION

This section of the report explains structural rehabilitation alternatives that were ultimately carried forward for evaluation. The development of these alternatives has been described previously in Sections 5.1 to 5.5.

5.6.1. Rehabilitation Items Common to All Alternatives

Alternatives A and B were created by others and presented to the public at PCC #1 and PCC #2. Entuitive's team further developed these alternatives so that they could be fairly evaluated against the Alternative C that we developed. After doing so, we realized that many rehabilitation items were common to all alternatives. The following list presents the common rehabilitation items:

- The truss bottom chord members will be replaced. The original descriptions of Alternatives A and B did not indicate bottom chord replacement. Alternative A did not address the bottom chords. The intent of Alternative B was to strengthen the bottom chords, but this alternative was developed before the condition of bottom chords could be established by arm's length inspection and non-destructive testing. Given the presently poor condition of the east bottom chord and the inability of both bottom chords to support the 10t design live load, it was determined that the bottom chords would require replacement for all alternatives.
- The existing steel Bailey trusses and their hanger system will be permanently removed.
- The existing steel hanger rods comprising the truss verticals will be replaced.
- The existing external sway bracing rods will be replaced.
- The floor system (deck, stringers, floor beams and needle beams) will be replaced.
- The deck will be paved with a tar-and-chip wearing surface.
- The non-functioning bottom chord longitudinal reinforcing rods will be permanently removed.

- The existing roof shingles and exterior cladding will be replaced to protect the wood superstructure from direct precipitation.
- The existing window louvres that are part of the exterior cladding will be replaced.
- The existing roof decking, rafters, and tie-beams will be replaced on a member-by-member basis. An inspection of these elements will occur at the outset of construction when they can be better accessed after removal of the shingles and cladding.
- The existing wood curbs will be removed and replaced with new wood curbs (for all alternatives) and guardrails (for Alternative B & C only).
- The vertical sag currently exhibited by the bridge will be at the very least reduced, if not eliminated. To do so, the bridge will be temporarily supported by jacking beams to remove the sag, at which time the joints will be re-fitted to reduce or eliminate the sag. It may not be possible to fully eliminate the sag because of the geometry of the existing joints and because time-dependent deflections due to wood creep will still occur after rehabilitation.
- The bottom lateral bracing rods will be replaced.
- The wood bolsters at the pier and abutments will be replaced with new elastomeric bearing assemblies.
- All burnt out light bulbs inside the bridge will be replaced.
- The centre masonry pier will be repointed (scope of Doug Dixon & Associates).
- The concrete abutments will be patch repaired (scope of Doug Dixon & Associates).
- Scour protection will be placed at the pier and abutments (scope of Doug Dixon & Associates).
- A height restriction bar will be installed on the north approach and the guiderails will be narrowed on the south approach to restrict oversized vehicles from crossing the bridge.

5.6.2. Alternative A

Alternative A was developed in 2019 by Doug Dixon & Associates and was presented to the public as the preferred rehabilitation alternative at PCC #1 in October 2021.

The primary features of Alternative A are replacing the existing steel Bailey trusses with new steel box girders and replacing the existing sawn wood floor beams with steel floor beams. The Bailey trusses were installed within the bridge in the mid-1960's. Bailey trusses were abundant in the decades following the Second World War. At that time, they were a convenient means of strengthening the original wood trusses. The steel box girders are the modern-day analogue of the Bailey trusses. Thus, Alternative A represents a continuation of the bridge's current configuration, wherein the primary load carrying material is steel, not

wood. The wood trusses would remain as a secondary structure and as ornamentation. The box girders proposed for Alternative A were proportioned to support 15t of live load.

The bridge would look very similar to its existing state if Alternative A were implemented because the interior white cladding would be replaced in kind. This interior cladding would have to be wider than the existing cladding because the box girders would be wider than the existing Bailey trusses. The road width would be slightly narrower as a result.

Refer to Appendix K for renderings of Alternative A that were prepared for PCC #2 by Doug Dixon & Associates.

5.6.3. Alternative B

Alternative B was developed after PCC #1 in response to public objection against the new steel box girders proposed for Alternative A. It was presented as the preferred alternative at PCC #2 in June 2022. We understand that the development of Alternative B was informed by some recent rehabilitation techniques used for wood covered bridges in the Maritime provinces, specifically the Milkish Inlet No. 1 Covered Bridge.

The primary feature of Alternative B is the strengthening of the existing wood trusses by bonding fibre-reinforced polymer strips to the underside of the bottom chord members. Additional reinforcement of the truss diagonals was also proposed, in the form of fastening new wood elements to the existing wood members. The intent of this strengthening was to enable the wood trusses to support the entire weight of the bridge such that the steel Bailey trusses could be permanently removed.

A notable concern about Alternative B was the effect of the bottom chord FRP reinforcement on the vertical position of the bridge and the exterior cladding height. The reinforcement was intended to be affixed to the underside of the bottom chord. The exact thickness of reinforcement was not established by detailed calculations, but it was estimated to be in the range of 80mm to 300mm depending on the design criteria. The West Montrose Covered bridge has a unique configuration of its floor beams and needle beams. These beams are positioned below the truss bottom chords. Most covered bridges feature these beams across the tops of their bottom chords. With these beams on the underside of the bottom chords at West Montrose, any reinforcing on the underside of the bottom chords would have to be fitted between the chords and floor/needle beams to be continuous. To do so, either the floor/needle beams would have to be lowered down by a distance equal to the reinforcement thickness or the trusses would have to be raised up by a distance equal to the reinforcement thickness. Both scenarios were found to be problematic. Lowering the floor/needle beams would increase the flood risk. Raising the trusses would affect the grades on the bridge approaches, which was found to be unfeasible. Furthermore, the addition of the bottom chord reinforcement would result in the exterior cladding having to be increased in height by the reinforcement thickness. This last issue was resolved once it was concluded that the exterior cladding would be entirely replaced due to its deteriorated condition. Nonetheless, the geometric challenges resulting from the bottom chord reinforcement and the lack of reversibility made this alternative less appealing.

Modular deck panels comprised of glued-laminated (glulam) timber were proposed for Alternative B. The existing bridge deck has been a nail-laminated wood deck since the 1950's. Nail-laminated decks have performed satisfactorily on lower volume roads but have tended to deteriorate under the action of higher traffic volumes. Glulam decks have performed better under higher traffic volumes. After liaising with the public, specifically the West Montrose Resident's Association (i.e. the "Bridge Keepers"), we became aware of strong public preference against the use of glulam in the rehabilitated structure. For this reason, and because Covered Bridge Drive experiences low traffic volumes, our team decided to substitute the glulam deck with a nail-laminated deck.

Alternative B was ultimately found to not be feasible because of the deteriorated condition of the east bottom chord member identified during the bridge inspections. This bottom chord member was too deteriorated to justify bonding on new reinforcement. Alternative B was still evaluated alongside Alternatives A and C for completeness..

Refer to Appendix L for renderings of Alternative B that were prepared for PCC #2 by Doug Dixon & Associates.

5.6.4. Alternative C

Alternative C is a family of related alternatives globally referred to as Alternative C. When we joined the project after PCC #2, we wanted to investigate the possibility of rehabilitating the bridge by removing the steel Bailey trusses and strengthening the existing wood trusses using materials sympathetic to the original construction. That outcome would revert the bridge back to its original form; that is, a bridge where the primary load-carrying material is wood.

By conducting our structural evaluation using a 1t incremental design live load, with live loads ranging from 3t to 12t inclusive, we were able to determine the live load thresholds beyond which further intervention to the existing bridge would be required. We used this exercise to develop Alternatives C1 to C4. Alternative C1 was designed for a 12t live load. Alternative C2 was designed for a 10t live load. And Alternatives C3 and C4 were designed for 8t and 6t live loads, respectively.

The primary features of Alternative C consist of:

- replacing the bottom chord members
- reinforcing the end diagonals at the abutments by fastening new wood planks to the existing diagonal members
- reinforcing the first interior diagonals by fastening new wood planks to the existing diagonal members (Alternative C1 only)
- making the top chord and lower top chord members composite
- replacing the steel hanger rods
- replacing the floor system (deck, stringers, floor beams, and needle beams)

  permanent removal of the steel Bailey trusses

- permanent removal of the interior cladding except at the ends of the bridge to protect the ends of the bridge from driving snow and rain

An elevation view used to communicate the development of Alternative C is shown in Figure 11. Renderings of Alternative C2 are shown in Appendix P. Renderings were not prepared for Alternatives C1, C3, and C4, but they would have appeared like those for Alternative C2.

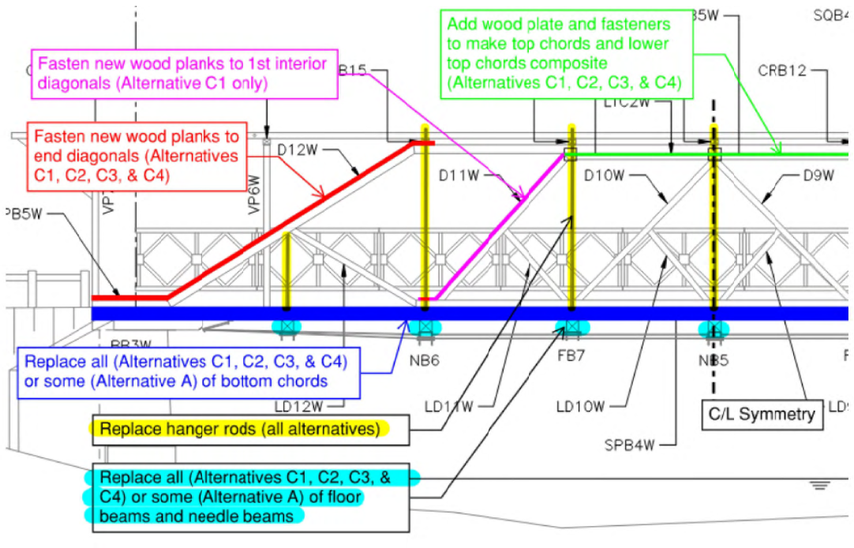


Figure 11 – Elevation View of Alternative C during Development

6. EVALUATION OF REHABILITATION ALTERNATIVES

This section of the report explains the evaluation procedure by which the preferred rehabilitation alternative was selected. Appendix N includes a side-by-side detailed summary of the Alternatives A, B, and C that were subject to the evaluation process.

6.1 MULTI-ATTRIBUTE TRADE-OFF SYSTEM

The "Multi-Attribute Trade-Off System" (MATS) was used to evaluate the proposed rehabilitation alternatives. This system makes use of the "weighted additive method", which is a double-weighted quantitative method of evaluation. The methodology is consistent with the Ministry of Environment, Conservation, and Park's practices for evaluating numerous and complex alternatives. Both the MECP's Guidelines on Environmental Assessment Planning and Approval and the Environmental Assessment Act feature "accountability" and "traceability" as key principles. Using a MATS evaluation satisfies those principles.

The MATS evaluation was performed by a Technical Advisory Committee (TAC). This team represented the subject matter experts for the project.

The TAC established global factors that represented broad categories that captured the major project concerns. Four global factors were established:

- Heritage
- Structure
- Social Environment
- Cost

The TAC then established sub-factors for each global factor, with each sub-factor representing a specific issue related to a global factor. Care was taken to screen out non-distinct factors and factors that did not provide a meaningful difference between alternatives. The sub-factors used for the evaluation are shown in Table 11.

Table 11 – Global Factors and Sub-Factors for MATS Evaluation

Global Factor	*Sub-Factor*
Heritage	Visual Character – Reinforcing/Replacing Members
	Visual Character – Views to the Bridge from Banks of Grand River
	Retain Original Bridge Dimensions
	Flexibility for Interior Cladding Dimensions
	Level of Intervention (Reversibility)
	Visibility of Original Truss Structure
	Floor System
Structural	Vehicle Loading
Social Environment	Ability to Accommodate Large Gatherings/Special Events
	Construction Duration
Cost	Capital Cost
	Durability
	Construction Risk

A "social utility function" was developed for each sub-factor to measure the attractiveness of each alternative as it related to that sub-factor. Each social utility function was assigned a dimensionless score ranging from 0 to 1. The relationship between a score and social utility was measured assuming a linear function for each sub-factor. The social utility functions were defined by relevant subject matter experts on the TAC.

Double-weighting was achieved by having each TAC member assign a weighting for each sub-factor and each global factor. The sum of the weights assigned for the sub-factors added to 100% for all of the sub-factors within one global factor. Similarly, the sum of the weights assigned to the global factors added to 100%. This process allowed each member of the TAC to provide a professional judgement on the importance of each global factor and sub-factor. The double-weighting assigned by each TAC member was then aggregated to identify the preferred alternative.

The TAC for the West Montrose project met in person on September 7, 2023 to conduct the MATS evaluation. The meeting was held at the Region's Operations Centre in Cambridge, Ontario. The meeting was led by Steve Taylor from BT Engineering.

6.2 EVALUATION RESULTS & SENSITIVITY ANALYSIS

The TAC met virtually on September 14, 2023 to review the evaluation results and the impact of a sensitivity analysis on the outcome of the evaluation. The aggregated average weightings for the global factors and sub-factors are shown in Figure 12.

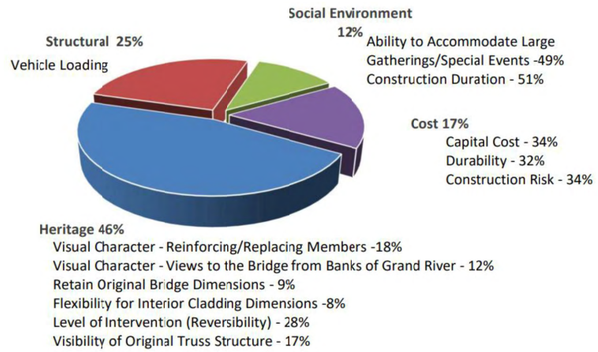


Figure 12 – Average Global Factor and Sub-Factor Weightings (excerpt from Analysis and Evaluation Report by BT Engineering, 2023)

The weightings were such that Alternative C2 was the highest scoring alternative. The average scores for each alternative are presented in Figure 13.

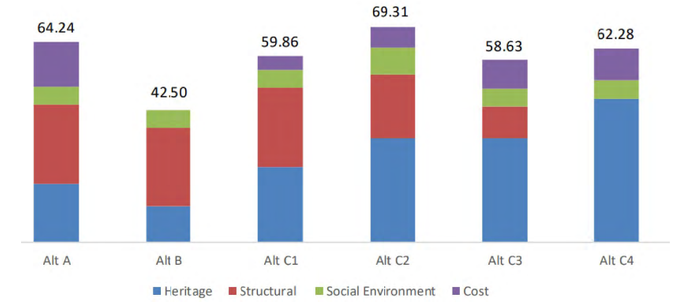


Figure 13 – Average Global Factor and Sub-Factor Weightings (excerpt from Analysis and Evaluation Report by BT Engineering, 2023)

The global factors, sub-factors, social utility functions, and weightings are a matter of professional judgement and subject to the personal experiences of the TAC members. Consequently, a sensitivity analysis was conducted to examine the effect of varying the weightings. The sensitivity analysis considered the effect of both the highest and lowest assigned weighting for the global factors. The highest weighting was taken as the highest weight assigned by any TAC member. Similarly, the lowest weighting was taken as the lowest weight assigned by any TAC member. The results of this analysis are shown below in Figure 14. The integers in the table represent the relative scoring of each alternative, with a score of 1 being most preferable and a score of 6 being least preferable.

		Alt A	Alt B	Alt C1	Alt C2	Alt C3	Alt C4
FACTORS	WEIGHT	64.24	42.50	59.86	69.31	58.63	62.28
TAC Weights		2	6	4	1	5	3
Heritage	High	5	6	4	2	3	1
	Low	1	6	5	3	4	2
Structural	High	1	4	2	3	6	5
	Low	4	6	5	2	3	1
Social Environment	High	2	6	5	3	4	1
	Low	1	6	5	3	4	2
Cost	High	1	6	5	3	4	2
	Low	2	6	4	3	5	1

Figure 14 – Sensitivity Analysis Results (excerpt from Analysis and Evaluation Report by BT Engineering, 2023)

The scoring of alternatives using the average weights indicated Alternative C2 to be most preferable. The sensitivity analysis indicated Alternative A to be most preferable when the structural and cost global factors were most valued and the heritage and social environment factors global factors were least valued. Similarly, the sensitivity analysis indicated Alternative

C4 to be most preferable when the heritage and social environment global factors were most valued and the structural and cost factors global factored were least valued. These results indicate that there are trade-offs for Alternative C2 relative to the other options.

After reviewing the results and the sensitivity analysis, the TAC decided that the average weightings provide the best overall alternative and thus recommended that Alternative C2 be carried forward as the preferred rehabilitation alternative.

The MATS evaluation process was documented in the "Analysis and Evaluation Report" by BTE. This report has been appended in Appendix N.

7. PREFERRED REHABILITATION ALTERNATIVE

Alternative C2 was selected by the design team as the preferred rehabilitation alternative following the MATS Evaluation process. This section of the report explains the preliminary design of this alternative. Feedback from the elevated environmental assessment (see Section 7.1) and other stakeholder liaisons (see Section 7.2) were helpful in refining Alternative C2 beyond its definition at the time of the MATS evaluation in September 2023.

7.1 SCHEDULE C ENVIRONMENTAL ASSESSMENT

As noted in Section 5.2, the Region began the project as a Schedule A+ Municipal Class Environmental Assessment (EA) for the bridge rehabilitation before our team joined the project. The Region retained Doug Dixon & Associates to conduct the EA. The EA featured two Public Consultation Centres (PCC). The first PCC (PCC #1) was conducted in October 2021, at which time Alternative A was presented to the public as the preferred rehabilitation alternative. The second PCC (PCC #2) was conducted in June 2022, at which time Alternative B was presented to the public as the preferred rehabilitation alternative.

Part of our assignment was to determine whether the Schedule A+ Municipal Class EA required reassessment based on the project development. After completing the MATS evaluation and selecting the preferred rehabilitation alternative, we recommended that the EA be elevated from Schedule A+ to Schedule C because of the impact to the heritage attributes and because of the magnitude of the project cost.

The Schedule C EA is on-going at the time of this report. An Environmental Study Report is currently being drafted. It will be posted for public review and comment upon completion.

The project team held a third PCC on November 22, 2023 (PCC #3). Alternative C2 was presented to the public as the preferred rehabilitation alternative. The PCC was held near the bridge at the West Montrose United Church. It was hosted by the Region and was attended by members of Entuitive and BTE, as well as the project's cultural heritage specialists – Wendy Shearer and Richard Unterman.

The Region solicited public feedback regarding the preferred alternative via an online survey posted on the Region's Engage website for the project (https://www.engagewr.ca/west-montrose). The survey was open from November 22 to December 17. The results of the feedback are currently being incorporated into the ESR as part of the Schedule C EA. They were used to inform the preliminary design.

7.2 OTHER STAKEHOLDER LIASONS

Our team met with the West Montrose Resident's Association (i.e. the "Bridge Keepers") on October 19, 2023 to discuss the results of the MATS evaluation and present Alternative C2 as the preferred rehabilitation alternative. The meeting was held in the Township of Woolwich's Council Chambers in Elmira, Ontario. Andrew Lehan from Entuitive, Steve Taylor from BT Engineering, and our cultural heritage specialist Wendy Shearer represented our team at the meeting, along with Region staff.

The Bridge Keepers are a very important stakeholder. We wanted to gain consensus on the preferred alternative and solicit feedback to inform the preliminary design. Their critical feedback was that glued-laminated timber (glulam) and other engineered wood products would not be a welcome addition to the bridge. Their preference for replacing deficient sawn wood members with glulam was instead to replace with sawn wood members of larger size and/or a stronger wood species, although the size of the sawn wood alternative is typically larger.. Up to receiving their feedback, our team had proposed to use glulam to replace the bottom chords, floor beams, and needle beams. After receiving this feedback, we adjusted the preliminary design to make use of sawn wood elements only.

Andrew Lehan from Entuitive and Steve Taylor from BT Engineering also met with the Township of Woolwich's Heritage Committee on November 8, 2023. The committee was generally in support of Alternative C2; however, they wanted our team to consider permanently closing the bridge to vehicular traffic to prolong the life of the structure. The Region included a question about this possibility in the online survey for the public consultation that occurred after PCC #3 in November 2023. Based on public feedback, the design team is currently proceeding based on the bridge remaining open to traffic.

Closing the bridge to vehicular traffic would not result in a significant delay to vehicular traffic. Allowing only horses and buggies to continue to cross the covered bridge would necessitate installing a controlled access gate structure, as using only signage to restrict the bridge to horse and buggy traffic has the potential to be disregarded by drivers. Such disregard implies the need to design for a vehicular live load anyway. The design team did not find a suitable means of providing the controlled access gate at this location for horse and buggy traffic. Therefore, the design is proceeding as originally intended, with the covered bridge being rehabilitated to remain open to vehicles not exceeding 3t in weight.

7.3 STRUCTURAL DESIGN CRITERIA

The structural design criteria used for the preliminary design of Alternative C2 are as follows in Table 12. The criteria were established by our team in conjunction with the Region, the other members of the project team that weren't part of Entuitive's team, and through liaison with the public.

Table 12 – Structural Design Criteria

Design Criteria	*Requirement*
Service Life of Rehabilitation	50 years
Posted Vehicle Height Restriction	<3.0 m
Posted Vehicular Live Load	3 tonnes
Design Vehicular Live Load	(a) 10 tonne CL3-625-ONT truck (b) 2.4 kPa lane load without design truck present
Design Vehicle Axle Load	42 kN per axle (two axles spaced 1.2m apart)
Design Vehicle Wheel Load	21 kN applied over 0.25m x 0.6m footprint
Design Pedestrian Live Load	4.0 kPa over the full deck width for a length of 2.5m (assumed to represent 70 persons)
Design Wind Load	1-in-50-year wind
Design Snow Load	(a) 1.6 kPa balanced loading (b) 2.1 kPa (windward half) + 0.5 kPa (leeward half) unbalanced loading
Design Flood Load	Regional storm event
Design Equestrian Load	5 kN applied over 0.1m x 0.1m footprint (local effect consideration for floor system only)
Design Guardrail Load	Test Level 1
Wood Replacement & Strengthening Material	Sawn wood (glulam and other engineered wood products not permitted)

7.4 DESIGN FEATURES

This section of the report explains the various design features of Alternative C2. Preliminary general arrangement drawings have been appended in Appendix O. Renderings of Alternative C2 have been appended in Appendix P.

7.4.1. Wood Trusses Repairs

The existing wood trusses will be repaired to support the entire weight of the bridge. The steel Bailey trusses will be permanently removed. The intended truss repairs are summarized in Table 13.

Table 13 – Wood Truss Repairs for Alternative C2

Truss Element	*Repair Description*
Top Chords and Lower Top Chords	Make composite by adding wood plate in between top chord and lower top chord members and fasten together
Bottom Chord	Replace with new sawn wood Douglas Fir members
End Diagonals at Abutments	Strengthen by fastening on new sawn wood planks
End Diagonals at Piers	Replace with new sawn wood Douglas Fir members
All Diagonals and Lower Diagonals at Bottom Chords	Adapt ends to receive replacement bottom chord members
Lower Diagonal Member LD10	Locally replace upper end of member due to decay
Steel Hanger Rods	Replace with new steel hanger rods

7.4.2. New Floor System

The existing floor system will be removed and replaced in its entirety due to its poor condition. The new floor system will be comprised entirely of sawn wood elements. Glulam and other engineered wood products will not be used. The intended new floor system is summarized in Table 14.

Table 14 – New Floor System for Alternative C2

Floor System Element	*Description*
Deck	Replace existing nail-laminated deck in kind
Stringers	Replace existing sawn wood stringers in kind
Floor Beams	Replace existing sawn wood floor beams in kind but with larger 16” x 16” cross-section (existing floor beams have 12” x 12” cross-section)
Needle Beams	Replace existing sawn wood needle beams in kind but with larger 16” x 16” cross-section (existing needle beams have 12” x 12” cross-section)

A larger cross-section is needed for the new floor beams and needle beams. The existing beams have a 12” x 12” cross-section. The new beams will have a 16” x 16” cross-section to satisfy the bridge code strength requirements.

7.4.3. New Lateral System

The lateral system in the existing bridge is comprised of the sway bracing and bottom lateral bracing. All the bracing will be replaced in kind with new steel threaded rods.

New top lateral bracing will be added at the top chord level of the wood trusses. This bracing will be comprised of sawn wood members. This bracing will stabilize the top chords against buckling and reduce the potential for racking of the structure (i.e. the tendency for the structure to become out-of-square and lean to one side). It will also result in the top chords of the gravity trusses resisting lateral loads primarily in tension and compression by virtue of a plan truss formed by these chords and the new top lateral bracing.

7.4.4. New Roof

The roof shingles will be replaced. The new shingles will be either asphalt shingles or cedar shakes and will be determined during detailed design.

The roof decking boards will be replaced on a board-by-board basis as a function of their existing condition. An inspection is proposed to be performed after removal of the existing shingles. Many of the decking boards are expected to require replacement. Any decking boards requiring replacement will be replaced in kind with 19mm thick sawn lumber.

The roof rafters will also be replaced on a board-by-board basis as a function of their existing condition. They will be inspected at the same time as the roof decking boards. Some of the rafters are assumed to require replacement. Any rafters requiring replacement will be replaced in kind using sawn lumber.

7.4.5. New Exterior Cladding

The exterior cladding boards will be removed and replaced in kind. The original cladding made use of tongue-and-groove connections between adjacent cladding boards. Much of this cladding was replaced at unknown times throughout the bridge's life. The replacement cladding was installed without tongue-and-groove connections and made use of battens to close the gaps between adjacent cladding boards. The new cladding is proposed to be of board and batten construction because it is easier to replace single boards over time than boards connected by tongue-and-groove connections.

7.4.6. New Interior Cladding

The interior white cladding will be removed. New interior cladding will be installed, but only for a short distance from the ends of the bridge. The intent of the new interior cladding is to protect the end regions of the wood trusses from driving precipitation and splash from vehicles, and to pay homage to the designated heritage attribute. The new cladding will be comprised of sawn wood boards painted white to be sympathetic to the existing cladding.

7.4.7. New Wearing Surface

A tar-and-chip wearing surface will be installed on the new nail-laminated wood deck. This wearing surface will protect the new deck and provide friction to ensure sufficient traction for bridge users.

There were many public requests to use a wood plank wearing surface instead of the proposed tar-and-chip wearing surface. The project team does not support the use of a wood plank deck due to concerns about insufficient friction and the resulting increased likelihood for accidents on the bridge.

7.4.8. New Curbs & Guardrails

The existing bridge curbs will be removed with the existing nail-laminated deck. New curbs and guardrails will be installed to protect the wood trusses from impacts by errant vehicles. The guardrails are proposed to be designed for Test Level 1 loading – the lowest magnitude guardrail design loading in the bridge code – because of the slower driving speeds in the bridge and because of the lower traffic volumes along Covered Bridge Drive.

7.4.9. New Bearing Assemblies

The existing wood trusses are supported on wood bolsters at the pier and abutments. These bolters are in a severe environment with respect to durability because they are resting directly on the concrete abutments and masonry pier. This damp environment is favourable for the onset of decay in the bolsters. Therefore, the bolsters will be replaced with new elastomeric bearing assemblies to improve long-term durability. The new bearings will create separation between the wood trusses and the tops of the concrete abutments and masonry pier to help ensure that water is not wicked from these surfaces into the wood truss members. The new bearings will also afford more reliable translational and rotational flexibility to the wood trusses at their supports.

Each bearing assembly will consist of a laminated elastomeric bearing and a steel shoe plate. The shoe plate will be affixed to the underside of the bottom chord members to anchor the assembly. Vertical rods will be drilled into the tops of the abutments and pier to restrain lateral movements.

A single line of two bearings will be installed at each abutment. Two lines of two bearings will be installed at the pier, one line for each truss span.

7.4.10. Approach to Rack Correction

The existing wood trusses are out-of-plumb (i.e. "racking") and are visibly leaning to the east. The approach to correcting the racking will be to plumb the wood trusses when completing the superstructure repairs. The new top lateral bracing described above in section 7.4.3 will provide new lateral stiffness that will reduce the likelihood of future racking.

7.4.11. Durability

The durability of the bridge will be greatly improved by replacing the roof and exterior cladding. These elements are the "raincoat" for the structure, protecting the load-bearing wood trusses from direct precipitation.

As a second means of protection, all new wood components will be pressure treated with a wood preservative to reduce the likelihood of decay by fungus or insect attack.

The exact wood preservatives will be identified during detailed design. They will comply with CSA O80 for use category 4.1. It is expected that the new heavy timber truss elements will be treated with an oil-borne preservative to maintain their dimensional stability and minimize the likelihood of significant checking. It is expected that all new dimension lumber for the nail-laminated deck, cladding, and roof will be treated with a water-borne preservative. All

wood members will be specified to be mechanically incised to increase the depth of penetration into their cores.

The contractor will be mandated to complete as much cutting and drilling of new wood members as possible before pressure treating the wood. We expect that some field modifications to the new wood members will be required, which could expose untreated wood that is below the depth of the preservative penetration. A field-applied wood preservative will be specified to be applied in these scenarios.

The National Society for the Preservation of Covered Bridges has recommended to our team that all the existing wood members be sprayed in-situ with a wood preservative. This approach would increase the durability of these members. Our team will investigate this possibility during detailed design. This approach would require approval from the Grand River Conservation Authority because of the risk of excess spray infiltrating the river.

New hardware and metalwork in contact with preservative treated wood must be hot-dipped galvanized to prevent corrosion per CHBDC clause 9.17.11. Galvanizing the threaded rods comprising the sway bracing, bottom lateral bracing, and truss verticals will notably alter the appearance of these elements relative to their current rusted steel appearance. An alternative to galvanizing would be to provide some sacrificial thickness for corrosion by slightly oversizing these members. Doing so would allow the use of weathering steel for the threaded rods, which would more closely match the existing appearance of the rods. The expected oversize is an increase in rod diameter of about 6mm. The resulting difference in diameter will not be perceivable when viewed from either shore of the river.

7.4.12. Paint

The existing exterior cladding is painted red. The new cladding will be painted the same colour. The colour will be established by paint matching.

7.4.13. Fire Protection

Fire is a significant risk to the structure, particularly the thinner wood elements (e.g. exterior cladding) that can be more easily ignited. A fire retardant that limits flame spread will be sprayed onto the existing wood elements in-situ. The new wood elements will be treated with a fire retardant before arriving on site.

The exact fire retardant product has not been established. It is necessary to ensure the selected product does not have any negative interactions with the selected wood preservative(s) and the product does not have any harmful impacts to the environment. Entuitive's in-house fire engineering service has been engaged to assist in this regard.

7.4.14. Anti-Graffiti Coating

Our team has been requested to examine anti-graffiti coatings to help protect the bridge aesthetic against defacement vandalism. Such a coating would be sprayed onto the wood members. It would make easier the removal of paint from the wood members. There are several products available for this purpose. The specific product to be used will be established during detailed design. It is necessary to ensure the selected product does not

have any negative interactions with the selected wood preservative(s) and fire protection chemicals.

7.4.15. Substructure & Foundations

The existing abutments and pier are anticipated to require repairs. We understand these repairs will consist of concrete patch repairs, the placement of scour protection, and repointing of the masonry pier, as a minimum. These repairs are being designed by Doug Dixon & Associates and are not within Entuitive's scope. These repairs will, however, be included in the same construction tender package as Entuitive's scope.

7.4.16. Discouraging Passage by Overweight Vehicles

The bridge is currently posted for a 3t live load limit. This posting will be maintained for the rehabilitated structure. Despite ample signage on the bridge approaches, there is a long history of overweight vehicles crossing the bridge. The 2017 structural monitoring by Struct-Sure noted these crossings as an on-going problem. West Montrose residents have reported these crossings anecdotally. In the worst cases, overloads resulted in failure of a floor beam or needle beam, forcing a bridge closure until the failed member could be replaced.

Physical barriers will be added at the bridge to physically impede overweight vehicles from reaching the bridge. For covered bridges, these barriers have traditionally been in the form of overhead height restrictor bars. Overweight vehicles have tended to be taller vehicles. Thus, restricting the bridge to lower height vehicles is a proxy for restricting the vehicle weight. This approach is not perfect means of stopping all overweight vehicles, but it has proven effective at many other covered bridge sites.

Overhead height restrictor bars can be effective physical barriers but are also often thought to detract from the appearance of the bridge. The public has communicated this concern for the West Montrose Covered Bridge.

The overhead height restrictor bars for the rehabilitation bridge are being examined through the Schedule C EA that is currently on-going. At present, the design team is working towards precluding an overhead height restrictor bar at the south end of the bridge by instead modifying the intersection of Covered Bridge Drive and Rivers Edge Drive such that large vehicles will not be able to turn into the bridge. The modification is proposed by means of narrowing the guiderails along Covered Bridge Drive and extending them further south. This approach is not possible at the north end of the bridge and thus an overhead height restrictor bar is expected at this location.

7.5 ANTICIPATED CONSTRUCTION STAGING AND SEQUENCING

Covered bridges have commonly been rehabilitated by relieving the wood trusses of load so that wood members can be repaired or replaced. Relieving them of load has typically been accomplished by temporarily supporting them using a pair of jacking beams. The most recent rehabilitation of the West Montrose Covered Bridge in 1999 was completed this way (see Figure 15). We anticipate the successful contractor for the upcoming rehabilitation to also adopt this methodology.



Figure 15 – 1999 Rehabilitation Showing Jacking Beams Comprised of Mabey-Johnson Trusses (Photo Credit: Ted Brumfitt of IBI Group)

The jacking beams are flexural members. For many covered bridge rehabilitation projects, contractors have made use of temporary modular bridges for this purpose. Examples include Bailey trusses and Mabey-Johnson trusses. We are aware of one instance where a contractor used glued-laminated timber for the jacking beams.

Our requirement will be for the jacking beams to be founded on top of the abutments and piers. Doing so will keep their supports out of the river and thereby minimize risk of damage by flooding. We anticipate the jacking beams will not be continuous across the pier, but this configuration is not a requirement.

A temporary floor system will need to be installed below the existing trusses. This floor system will act as a work platform and will be used to support the truss members. It is anticipated that this platform will be comprised of plywood panels supported by stringers. The stringers are anticipated to be supported by floor beams that would be oriented transverse to the bridge span. These floor beams are usually steel I-beams. We anticipate the floor beams to be suspended from the jacking beams using threaded rods. We do not anticipate the contractor needing to install any falsework in the river to support the temporary floor system.

We anticipate that the temporary floor system will be designed to support mechanized equipment, in addition to workers and materials. We anticipate the contractor to use a combination of telehandlers, lifts, and carry deck cranes (see Figure 16) to lift new and

removed materials into and out of place. We anticipate all equipment to be positioned between the existing wood trusses when operating for the superstructure repairs.



Figure 16 – Broderson IC-35 Carry-Deck Crane (Photo Credit: Broderson Manufacturing Corp.)

The temporary floor system will be positioned below the trusses, meaning that it will be at greater risk of becoming inundated in a flood than the permanent structure. This situation would put the permanent structure at great risk if the temporary platform were to become damaged during a flood. One means of alleviating this risk would be to temporarily raise the entire structure for the duration of the truss repairs. The distance raised should be such that the underside of the temporary floor system is not lower than the existing bridge soffit. In doing so, the flood risk to the temporary works would be no more than that for the permanent structure. To accomplish this temporary raising of the permanent bridge, we anticipate that the contractor would set the jacking beams up higher than otherwise needed using temporary pedestals installed on the abutments and pier. We anticipate the temporary pedestals to consist of steel cribs or weldments. Upon completion of the truss repairs, the wood trusses would be lowered down to their permanent seats on the abutment and piers.

Raising the bridge also facilitates repairs to the top of the piers and abutment seat, and is likely required for that purpose as well.

We anticipate that the contractor will need temporary access onto private properties at both ends of the bridge. We anticipate this access will be necessary to repair the abutments and piers, as well as install scour protection. The contractor could also use this access to help install the temporary works for the wood superstructure rehabilitation. We anticipate the contractor will operate equipment on this private property (e.g. excavators) in support of the repairs to the abutments and pier, and the installation of the scour protection. We have appended a Preliminary Construction Laydown Area and Property Access drawing in Appendix Q to demonstrate our estimate of the anticipated private property access needs during construction.

An overhead wire crosses the river alongside the west edge of the bridge. This wire is not anticipated to preclude any of the proposed works, but its presence may slow the speed of production. The 1999 bridge rehabilitation involved removing and reinstating segments of exterior cladding on the west side of the bridge, which serves as a demonstration to the feasibility of working successfully and safely alongside this wire.

We anticipate the general order of work to be as follows:

- Mobilization and site set-up.
- Close Covered Bridge Drive.
- Install the temporary works and temporarily support the existing bridge.
- Complete the following removals:
    - Remove the existing shingles and deteriorated roof decking and rafters.
    - Remove the exterior and interior cladding.
    - Remove the existing floor system (nail-laminated deck, stringers, floor beams, and needle beams).
    - Remove the existing sway bracing and associated hardware.
    - Remove the existing truss hanger rods and associated hardware
    - Remove the existing steel rods and associated hardware under the deck (longitudinal bottom chord reinforcing rods, bottom lateral bracing rods, and bailey truss hangers).
    - Removed the existing steel Bailey trusses.
    - Remove the wood truss members that are indicated for replacement.
- Complete the following wood truss repairs:
    - Replace the bottom chord members.
    - Locally replace or adjust the bottom ends of the diagonal and lower diagonal members as necessary to connect with new bottom chords. Adjustments are preferred over local replacements.
    - Replace the end diagonals at the piers.
    - Reinforce the end diagonals at the abutments.
    - Reinforce the top chords and lower top chords by making them composite.
- Construct the new wood floor system:
    - Install the new floor beams and needle beams.
    - Install the new bottom lateral bracing.
    - Install the new stringers.

    - Install the new nail-laminated deck.
    - Install the new curbs and guardrails.
- Construct the new roof:
    - Replace all the deteriorated roof decking and rafters.
    - Install the new shingles.
- Install the new exterior cladding.
- Construct the new interior cladding at ends of bridge only.
- Lower the existing bridge from its temporary supports and transfer loads to permanent structure.
- Remove the temporary works.
- Pave the deck with a new tar and chip wearing surface
- Construct any improvements to bridge approaches, including an overhead height restrictor on the north approach and narrowing of the road on the south approach.
- Restoration and grading.
- Demobilize.

We anticipate that the bridge rehabilitation will be completed in a single construction season from April 1st to December 1st.

The construction methodology described in this section is Entuitive's opinion only. The successful contractor will have freedom to propose alternate methodologies subject to approval by the Contract Administrator.

7.6 CONSTRUCTION COST ESTIMATE

A construction cost estimate was completed for Alternative C2. The estimated cost is $6,058,000. The estimate has a tolerance of +/-20%. The repairs to the abutment and pier have not been included because that scope of work is the responsibility of Doug Dixon & Associates. Design and contract administration costs have also not been included.

Item Group	Description	Unit	Quantity	Unit Price	Total Price
General	Mobilization/Demobilization	LS	1	$ 40,000	$ 40,000
General	Bonding and Insurance	LS	1	$ 30,000	$ 30,000
General	As-Built Drawings and Data	LS	1	$ 10,000	$ 10,000
General	Contractor Layout	LS	1	$ 20,000	$ 20,000
General	Site Offices	LS	1	$ 30,000	$ 30,000
General	Protection of Utilities	LS	1	$ 10,000	$ 10,000
General	Traffic Control	LS	1	$ 25,000	$ 25,000
General	Provisional Pedestrian Access	LS	1	$ 50,000	$ 50,000
General	Environmental Protection	LS	1	$ 25,000	$ 25,000
General	Construction Engineering	LS	1	$ 100,000	$ 100,000
Structural	Temporary Works	LS	1	$1,000,000	$1,000,000
Structural	Disposal of Removals	LS	1	$ 40,000	$ 40,000
Structural	New Wood Materials & Fasteners (Supply, Treatment, and Delivery)	LS	1	$ 750,000	$ 750,000
Structural	New Steel Materials (Supply and Delivery)	LS	1	$ 50,000	$ 50,000
Structural	New Roof (Supply and Delivery)	LS	1	$ 50,000	$ 50,000
Structural	New Bearings (Supply)	LS	1	$ 30,000	$ 30,000
Structural	Labour & Equipment for Superstructure Repairs	LS	1	$2,400,000	$2,400,000
				Sub-Total	$4,660,000
				Contingency (30%)	$1,398,000
				Total	$6,058,000

8. CLOSURE

This report represents the conclusion of the preliminary design phase of the project. The findings of this report will be used to inform the detailed rehabilitation design.

This report was authored by Entuitive. The field inspection findings that were summarized from the Field Inspection Summary Report were the work of David Moses, P.Eng., from Moses Structural Engineers (Entuitive's subconsultant).



Andrew Lehan, P.Eng., M.A.Sc.
Associate, Entuitive



Stephen Brown, P.Eng., P.E., M.Eng.
Technical Advisor, Entuitive

9. REFERENCES

American Wood Council. 2018. *National Design Specification (NDS) Supplement: Design Values for Wood Construction 2018 Edition*. American Wood Council, Leesburg, Virginia.

BT Engineering Inc. 2023. *West Montrose Covered Bridge Value Engineering Report*. BT Engineering Inc., London, Ontario.

CSA Group. 2019. *CSA O86:19 Engineering Design in Wood*. CSA Group, Toronto, Ontario.

CSA Group. 2019. *CSA S6:19 Canadian Highway Bridge Design Code*. CSA Group, Toronto, Ontario.

CSA Group. 2019. *CSA S6.1:19 Commentary on CSA S6:19, Canadian Highway Bridge Design Code*. CSA Group, Toronto, Ontario.

CSA Group. 2023. *CSA S7:23 Pedestrian, Cycling, and Multiuse Bridge Design Guideline*. CSA Group, Toronto, Ontario.

Doug Dixon & Associates Inc. 2019. *West Montrose Covered Bridge Structural Assessment of Options Report*. Doug Dixon & Associates Inc., Brampton, Ontario.

Doug Dixon & Associates Inc. 2020. *West Montrose Covered Bridge Detailed Inspection Report*. Doug Dixon & Associates Inc., Brampton, Ontario.

Entuitive. 2023. *West Montrose Covered Bridge – Field Inspection Summary Report*. Entuitive, Toronto, Ontario.

Forest Products Laboratory (2010). *Wood Handbook – Wood as an Engineering Material. General Technical Report FPL-GTR-190*. Madison, WI: United States Department of Agriculture, Forest Service, Forest Products Laboratory.

IBI Group. 2014. *West Montrose Covered Bridge Preservation Plan*. IBI Group, Waterloo, Ontario.

Moses Structural Engineers Inc. 2017. *Conditions at West Montrose Covered Bridge*. Moses Structural Engineers Inc., Toronto, Ontario.

Moses Structural Engineers Inc. 2023. *On-site Observations and Non-destructive Testing at West Montrose Covered Bridge, West Montrose, ON*. Moses Structural Engineers Inc., Toronto, Ontario.

National Research Council. 2020. *National Building Code of Canada 2020 Volume I*. National Research Council, Ottawa, Ontario.

Ontario Building Code, O Reg. 332/12, s.4.1.5.3(1)

Ontario Ministry of Transportation. 2008. *Highway Drainage Design Standards*. Ontario Ministry of Transportation, Toronto, Ontario.

Region of Waterloo. 2022. *Request for Proposal – Consulting Services, C2022-34 West Montrose Covered Bridge – Timber Truss Assessment and Design Assignment, Project No. 7626*. Region of Waterloo, Waterloo, Ontario.

RWDI. 2015. *West Montrose Covered Bridge Snow Load Consultation*. RWDI, Guelph, Ontario.

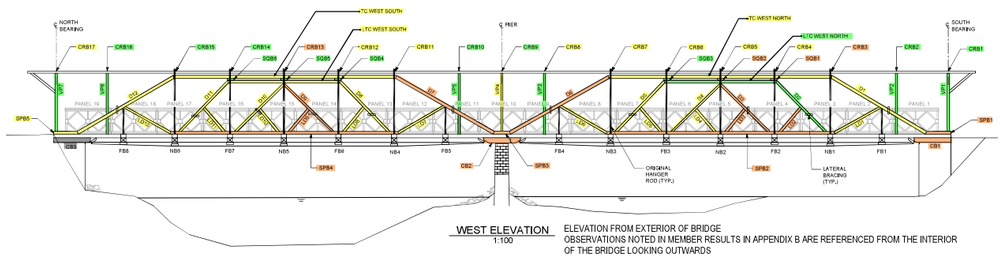
Struct-Sure Limited. 2018. *Structural Monitoring of West Montrose Covered Bridge*. Structure-Sure Limited, Kitchener, Ontario.

APPENDIX A
FIELD INSPECTION SUMMARY REPORT

Available Upon Request

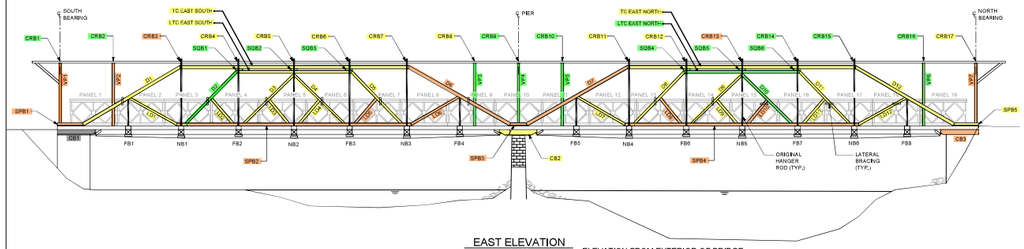
APPENDIX B
MEMBER IDS AND EXISTING CONDITIONS SUMMARY

BRIDGE DWG. EXCERPT FROM "WEST MONTROSE BRIDGE - DETAILED INSPECTION REPORT" BY DOUG DIXON & ASSOCIATES DATED JUNE 9, 2020



WEST ELEVATION
1:100

ELEVATION FROM EXTERIOR OF BRIDGE
OBSERVATIONS NOTED IN MEMBER RESULTS IN APPENDIX B ARE REFERENCED FROM THE INTERIOR OF THE BRIDGE LOOKING OUTWARDS



EAST ELEVATION
1:100

ELEVATION FROM EXTERIOR OF BRIDGE
OBSERVATIONS NOTED IN MEMBER RESULTS IN APPENDIX B ARE REFERENCED FROM THE INTERIOR OF THE BRIDGE LOOKING OUTWARDS

NOTE:
* refer to S100 and S101 for existing conditions of LC, STR, FB & NB.

EXISTING CONDITIONS

N/A
Member was not inspected either due to limited access or similar members previously inspected adequately represents the existing conditions.

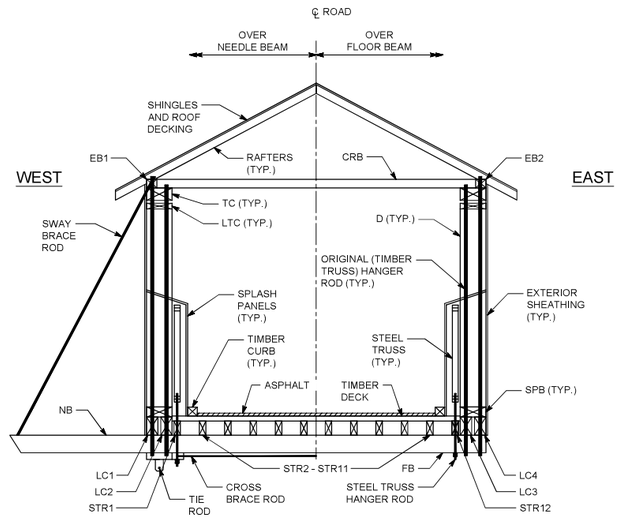
POOR
Severe deterioration.

FAIR
Minor deterioration. Member is still serviceable.

GOOD
No comments from visual review and resistograph readings. Expected MC%.

moses structural engineers
366 Adelaide St. West, Suite 804
Toronto, Ontario, M5V 1R7
Tel 416 255 3337
info@mosesstructures.com

Project:
WEST MONTROSE BRIDGE
WEST MONTROSE, ON
Project No:
22.124
Date: JUNE 2023
Scale: AS NOTED
Drawn By: MH
Checked By: DM
Drawing Title:
ELEVATIONS
Drawing No:
S200

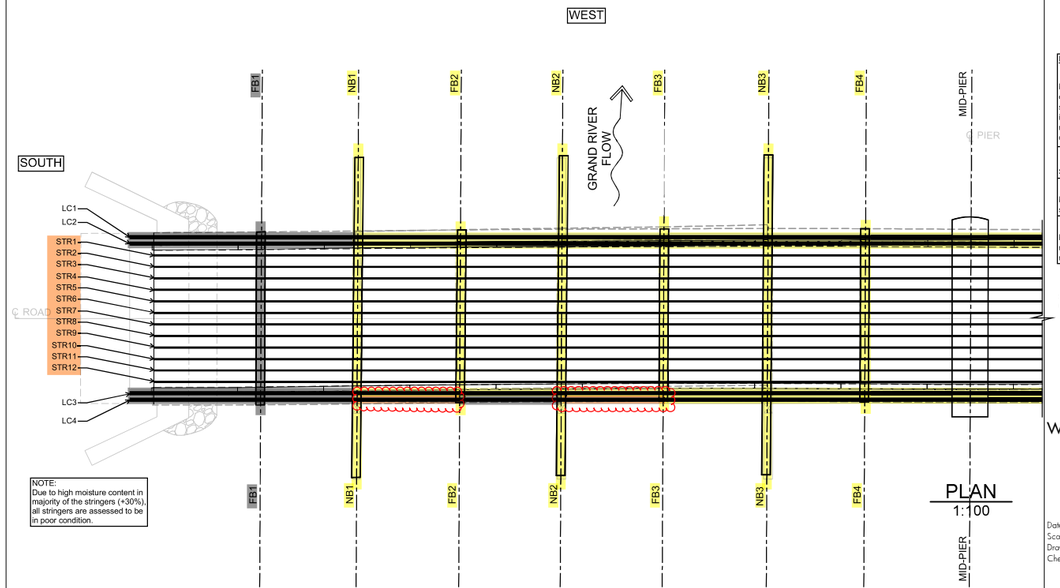


TYPICAL SECTION
1:50

moses structural engineers
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Toronto, Ontario, M5V 1R7
Tel 416 255 3337
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Project:
WEST MONTROSE BRIDGE
WEST MONTROSE, ON
Project No:
22.124
Date: JUNE 2023
Scale: AS NOTED
Drawn By: MH
Checked By: DM
Drawing Title:
ELEVATIONS
Drawing No:
S201

BRIDGE DWG. EXCERPT FROM "WEST MONTROSE BRIDGE - DETAILED INSPECTION REPORT" BY DOUG DIXON & ASSOCIATES DATED JUNE 9, 2020



PLAN
1:100

moses structural engineers
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Tel: 416 255 3337
info@mosesstructures.com

EXISTING CONDITIONS

N/A
Member was not inspected either due to limited access or similar members previously inspected adequately represents the existing conditions.

POOR
Severe deterioration.

FAIR
Minor deterioration. Member is still serviceable.

GOOD
No comments from visual review and resistograph readings. Expected MC%.

Project:
WEST MONTROSE BRIDGE
WEST MONTROSE, ON

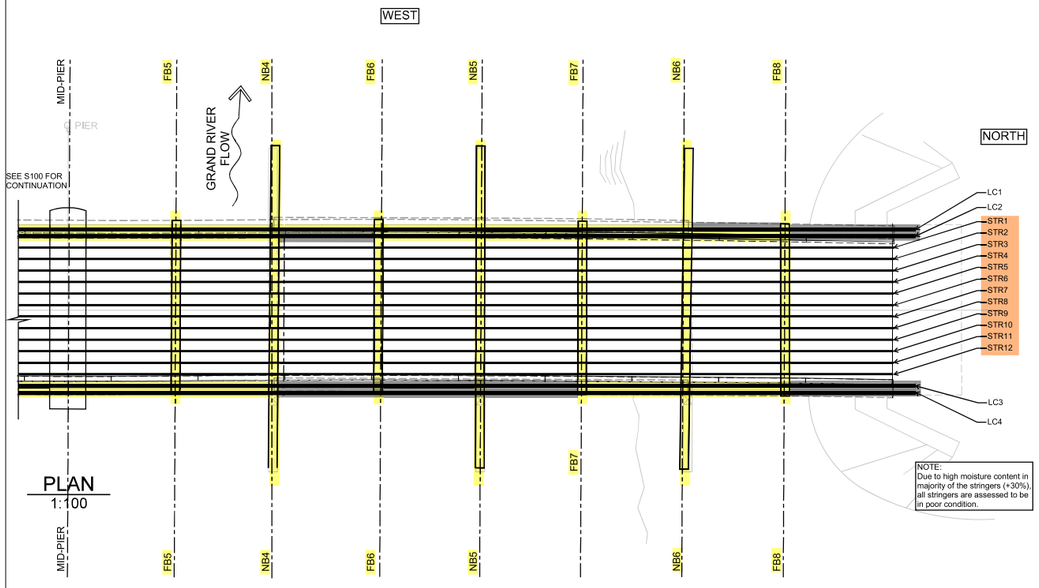
Project No:
22.124

Date: JUNE 2023
Scale: AS NOTED
Drawn By: MH
Checked By: DM

Drawing Title:
BRIDGE DECK PLAN

Drawing No:
S100

BRIDGE DWG. EXCERPT FROM "WEST MONTROSE BRIDGE - DETAILED INSPECTION REPORT" BY DOUG DIXON & ASSOCIATES DATED JUNE 9, 2020



PLAN
1:100

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Toronto, Ontario, M5V 1R7
Tel: 416 255 3337
info@mosesstructures.com

EXISTING CONDITIONS

N/A
Member was not inspected either due to limited access or similar members previously inspected adequately represents the existing conditions.

POOR
Severe deterioration.

FAIR
Minor deterioration. Member is still serviceable.

GOOD
No comments from visual review and resistograph readings. Expected MC%.

Project:
WEST MONTROSE BRIDGE
WEST MONTROSE, ON

Project No:
22.124

Date: JUNE 2023
Scale: AS NOTED
Drawn By: MH
Checked By: DM

Drawing Title:
BRIDGE DECK PLAN

Drawing No:
S101

APPENDIX C
BRIDGE HYDRAULIC ENGINEERING REPORT

Available Upon Request

APPENDIX D
2014 PRESERVATION PLAN BY IBI GROUP

Available Upon Request

APPENDIX E
2015 ROOF SNOW LOAD CALCULATIONS BY RWDI

West Montrose Covered Bridge

West Montrose, ON

Snow Loading Consultation

RWDI #1500433
January 9, 2015

SUBMITTED TO

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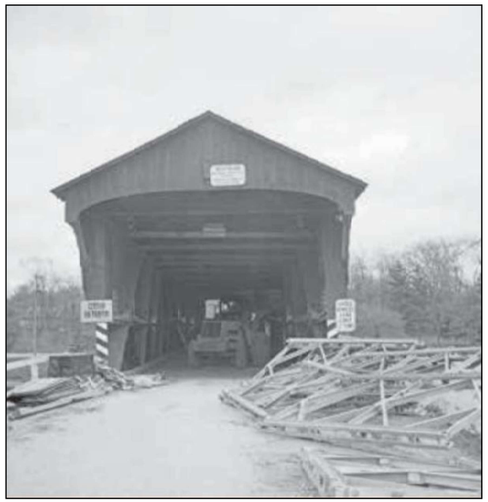


Image courtesy of University of Waterloo Library, K-W Record Negative Collection.

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by **IBI** Group Waterloo to assess the design roof snow loads for the historical West Montrose Covered Bridge, located in West Montrose, ON.

The assessment is based on:

- analytical calculations using the National Building Code of Canada (NBCC) 2010;
- regional meteorological information for the West Montrose area from the Waterloo International Airport and surrounding meteorological stations;
- A parametric assessment of the Covered Bridge, using representative wind flows and thermal characteristics to simulate the general conditions of the structure; and,
- RWDI's experience in snow research and consultation.

The following sections describe the various portions of the assessment. Snow loading conditions are discussed in conjunction with the recommendations of the NBCC2010.

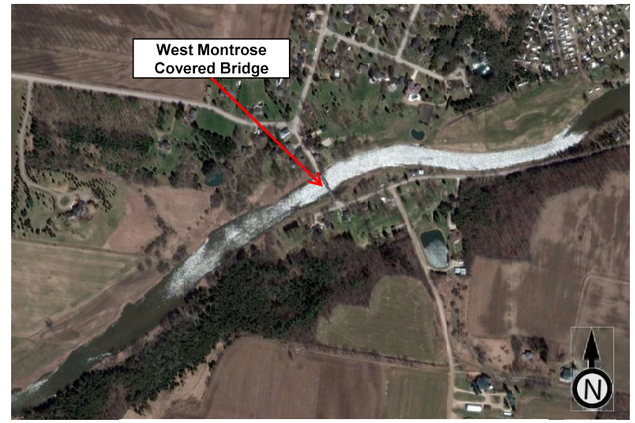


Image 1: Aerial View of West Montrose Covered Bridge Site

2. PROJECT DESCRIPTION

The existing West Montrose Covered Bridge is a historical structure crossing the Grand River in West Montrose. The roof of the bridge is approximately 62 m in length, and 14 m in width. An elevation and section of the bridge are shown in Image 2 below.

The surrounding terrain is generally comprised of open farm fields, although the river and bridge is sited within the river valley and surrounding trees.

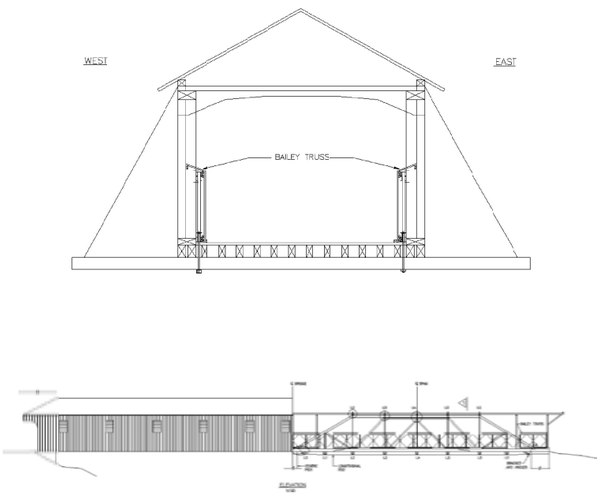
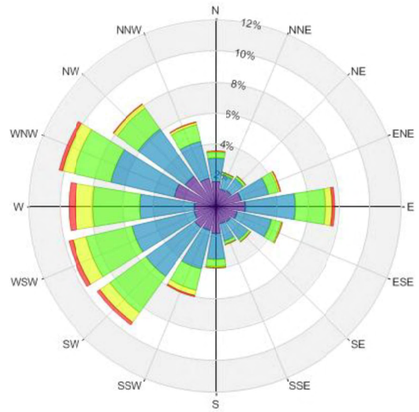


Image 2: Site Plan

3. METEOROLOGICAL DATA

The long-term weather data recorded at the Waterloo International Airport for the period of 1973 through 2014 were analyzed to determine the prevailing wind directions during the winter months. The wind rose below indicates that winds are predominately from the south through northwest directions during the winter, with less frequent winds from the northeast quadrant. Strong winds above 30 kph are most often from the southwest through northwest, and east directions.



Winter
(November - April)

Image 3: Directional Distribution (%) of Winds (Blowing From) Waterloo International Airport (1973 through 2014).

4. WIND AND SNOW CLIMATE

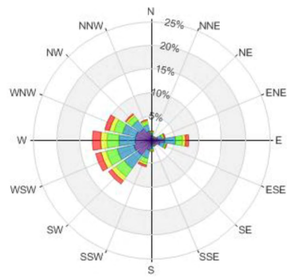
The meteorological information were also analyzed to determine the prevailing wind directions that would be associated with drifting snow at the project site. The following analyses of the winter winds determined the predominant direction and frequency of winds that are associated with drifting snow:

- winter winds greater than 15 kph;
- winter winds greater than 15 kph with snowfall; and
- winter winds with blowing snow events.

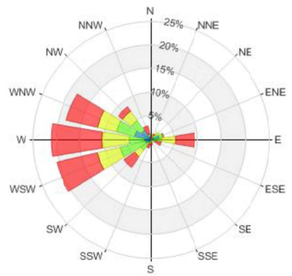
The movement of drifting snow at wind speeds less than 15 kph is negligible so this threshold wind speed was used to determine the predominant wind directions that could potentially create snow drifting problems around the study site.

The 15 kph wind speed is measured at the weather station anemometer, which is typically located on a mast approximately 10 m above the ground. Winter winds with blowing snow represent higher wind speeds often associated with storm events and significant drifting.

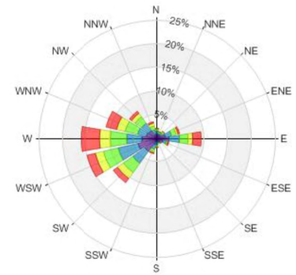
The wind roses at right show the results of these analyses. The analyses of the winds greater than 15 kph with snowfall (middle right) indicate that the predominant winds are from the southwest through northwest and east directions. The blowing snow events are presented in the wind rose (bottom), and show that the predominant directions are similar, coming from the west-southwest through west-northwest and east directions.



Winter Winds >15 km/h



Blowing Snow Events



Winds During Snowfall > 15 km/h

Percentage of Snow over All Winds: 8.6%

Wind Speed km/h	Probability (%) Winter Winds	During Snowfall	Blowing Snow
16-20	33.1	28.5	2.2
21-25	25.0	23.0	11.4
26-30	14.6	19.2	23.2
31-35	6.7	11.0	23.6
>35	6.4	12.9	39.5

Image 4: Directional Distribution (%) of Winds (Blowing From) Waterloo International Airport (1973 through 2014).

5. METHODOLOGY – PARAMETRIC ASSESSMENT

To provide greater refinement to the roof snow loads, RWDI used a modified form of the Finite Area Element (FAE) method, which uses a detailed computer simulation of the hour-by-hour deposition, drifting and melting of snow on a typical commercial building roof. The absorption of rain and melt water into the snowpack is also considered. Entire winters are simulated on an hour-by-hour basis, including the cumulative effects of successive storms, drifting events and melting periods.

The FAE method was initially developed in 1986 by RWDI and has been applied to a large number of major structures in Canada and the United States, and in research funded by the National Research Council of Canada to develop improved snow load provisions for the 1995 and 2005 editions of the NBCC. A more complete description of the complete FAE method for determining roof snow loads can be provided if required by the design team.

The parametric analysis model used in this investigation represents a typical long span roof.

This typical building allows investigation into the effects of roof size and thermal characteristics in order to provide information upon which to draw conclusions regarding the various portions of the proposed building. In this way, it provides an overview of how the local wind climate and directionality influences the accumulations of snow loads.

The following discussions focus on the NBCC2010 recommendations for the derivation of design snow loads and how the FAE techniques can be used to refine the design loading for the West Montrose Covered Bridge.

As per Section 4.1.6.2 of the NBCC2010, the design roof snow load can be derived as:

$$S = I_s[S_s(C_b C_w C_s C_a) + S_r]$$

Each of the factors in this loading derivation are discussed in the following sections.

5.1 Ground Snow Load - S_s

Hourly and daily meteorological data, including wind speed, direction, temperature, rainfall, snowfall and cloud cover, recorded at the Waterloo International Airport were consolidated to produce a weather data set that covered 36 years, beginning with the winter of 1973-74 through to the winter of 2013-14. To determine the applicability of these data and to allow fine tuning of the FAE procedure, it was desirable to first simulate the ground snow loads using the FAE procedure for each of these winters and to perform an extreme value analysis to determine a 50-year ground snow load by FAE method. This information is valuable for comparison with design values published in the applicable building codes.

The accumulation and depletion of the snow load in the modeled ground patch was simulated for the 36 winters. It can be seen from these computed values presented in Image 5 on Page 6 that the highest ground snow accumulations peaked at 2.109 kPa on March 14, 2014. The precipitation and snowfall events leading to this peak accumulation are shown in Image 6.

It should be noted that, based on Table C2 of the NBCC2010, the 1 in 50 year snow load is S_s – 2.0 kPa, S_r – 0.4 kPa, for a combined ground snow load of 2.4 kPa. An extreme-value statistical analysis performed by RWDI of the weather records spanning a 36 year period of record using the Fisher-Tippett method yielded a 50-year snow load of 2.45 kPa as shown in Image 5. Comparing the maximum ground snow load values from the NBCC2010 to those produced by the FAE methodology show good agreement.

Year	Max Date	Max (kPa)	Max/50.0 yr	Year	Max Date	Max (kPa)	Max/50.0 yr
2014	14-Mar	2.109	0.862	2002	21-Jan	0.763	0.312
2001	18-Mar	2.015	0.824	1975	12-Mar	0.757	0.310
1978	31-Mar	1.958	0.800	1980	10-Mar	0.708	0.290
1986	10-Mar	1.639	0.670	1981	10-Feb	0.705	0.288
1984	16-Mar	1.586	0.648	2013	7-Mar	0.705	0.288
2008	31-Mar	1.540	0.630	2010	26-Feb	0.680	0.278
1982	13-Mar	1.526	0.624	1996	16-Jan	0.677	0.277
1987	6-Mar	1.478	0.604	2011	13-Feb	0.669	0.274
1976	8-Feb	1.435	0.587	2005	2-Mar	0.604	0.247
1979	3-Mar	1.327	0.543	1990	17-Jan	0.556	0.227
1977	4-Mar	1.226	0.501	1991	1-Feb	0.551	0.225
1985	21-Feb	1.168	0.478	1988	21-Feb	0.523	0.214
1974	26-Jan	1.113	0.455	2006	11-Jan	0.517	0.211
1994	19-Feb	1.037	0.424	1989	10-Mar	0.462	0.189
2009	7-Feb	1.017	0.416	1995	7-Mar	0.456	0.187
1999	23-Jan	1.012	0.414	1998	30-Jan	0.393	0.161
1992	28-Feb	0.869	0.355	1983	11-Feb	0.234	0.096
2007	10-Mar	0.795	0.325	2012	1-Jan	0.186	0.076

Return Period	FT1 (kPa)	FT2 (kPa)	Linear Log(kPa)	Log Normal(kPa)	Return Ratio
5.0 yr	1.39	1.32	1.35	1.40	0.57
10.0 yr	1.72	1.88	1.75	1.83	0.70
30.0 yr	2.22	3.21	2.37	2.56	0.91
50.0 yr	2.45	4.10	2.67	2.93	1.00
100.0 yr	2.75	5.70	3.06	3.46	1.13
Ratio-50.0 yr	2.45	4.10	2.67	2.93	
Ground Snow	1.00	1.00	1.00	1.00	

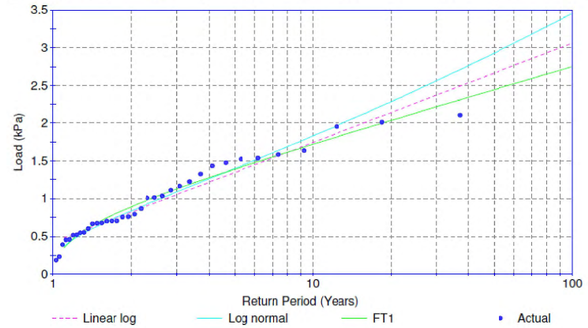


Image 5 – Ground Snow Calibration for Data Recorded at Waterloo International Airport (1973 through 2014).

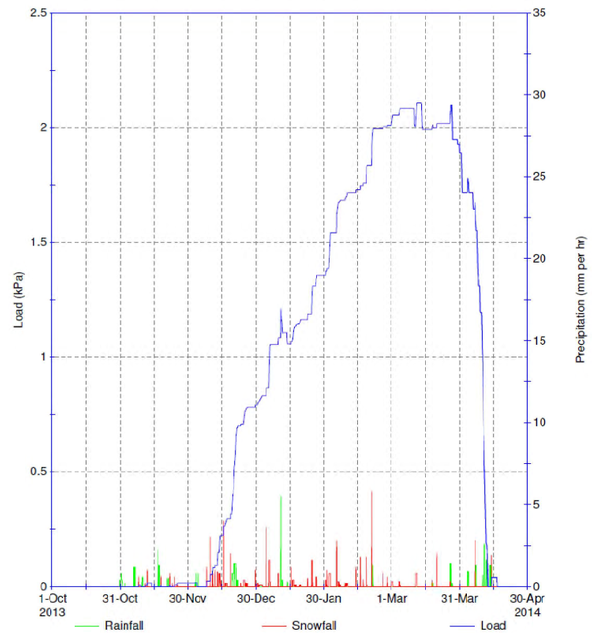


Image 6 – Example Time History of the Ground Snow Load (Winter of 2013).

5.2 Ground to Roof Ratio (C_b) and Exposure Factor (C_w)

When considering snow accumulations on a roof, it is important to understand the relationship of the amount of snow residing on a roof to that on the ground. In the NBCC, this is characterized through the combination of a basic ground to roof ratio and the wind exposure factor. The basic ground to roof ratio accounts for the fact that some snow will be shed from a roof structure due to the building aerodynamics and is assumed to be 0.8 in the code, which can be appropriate for many design applications. However, as the size of a roof decreases, snow that has accumulated on the roof can be more easy scoured by winds.

The NBCC2010 recommends a wind exposure factor of 1.0, as stated in Section 4.1.6.2. This factor allows for a reduction in snow load due to increased scouring for areas that are well exposed to approaching winds. However, given the surroundings of this site, the assumption of C_w = 1.0 is appropriate.

The effect of the roof size and exposure was parametrically assessed for the covered bridge using the FAE methodology. The result of this analysis showed the combined effects of basic ground to roof ratio and exposure factors to be equivalent to $C_b C_w$ = 0.6 as opposed to the C_b = 0.8 and C_w = 1.0 recommended by the NBCC.

5.3 Effects of Sliding – C_s

In general, less snow will accumulate on steep roofs than on flat and moderately sloped roofs due to sliding, creep, improved melt water drainage and saltation processes. The NBCC provides provisions for sliding in the form of a sliding coefficient, Cs, which is dependent on the slope of the surface and the material properties. A smooth, slippery surface will shed snow accumulations more reliably that a roughened surface. Slippery surfaces include metal, slate, and bituminous, rubber and plastic membranes with a smooth surface. Common roof surfaces that do not readily permit sliding include asphalt shingles, and roofs that include snow retention devices. To RWDI's knowledge, the West Montrose Covered Bridge uses asphalt shingles, and therefore a Cs = 1 is recommended by the NBCC2010.

5.4 Importance/ Safety Factor

In RWDI's opinion, the West Montrose Covered Bridge does not require an importance factor above 1.0 as this structure will not be used as a post-disaster structure. Any additional factors should be applied by the design team as they see fit.

6. STRUCTURAL LOADS DUE TO SNOW

6.1 Distributed Load for Design of Primary Structure Including Foundations - No Slippery Roof Redistribution

The left load case presented in Image 6 represents a recommended design loading pattern considering the scenario in which the 50-year design snow is accumulated uniformly over the course of a design winter.

6.2 Unbalanced Load Distribution

The structural snow loads shown in the right load case in Image 8 accounts for the 50-year design snow unbalanced loading that can occur as a result of snow being blown from one roof onto the leeward side.

There is the potential that this unbalance could be exaggerated by the effects of snow sliding from the roof surfaces. However, as the roof is currently comprised of asphalt shingles, sliding is not expected to be a significant concern. The loading magnitudes may need to be revisited if a different roofing system is used that will significantly reduce the effective coefficient of friction of the roof surfaces.

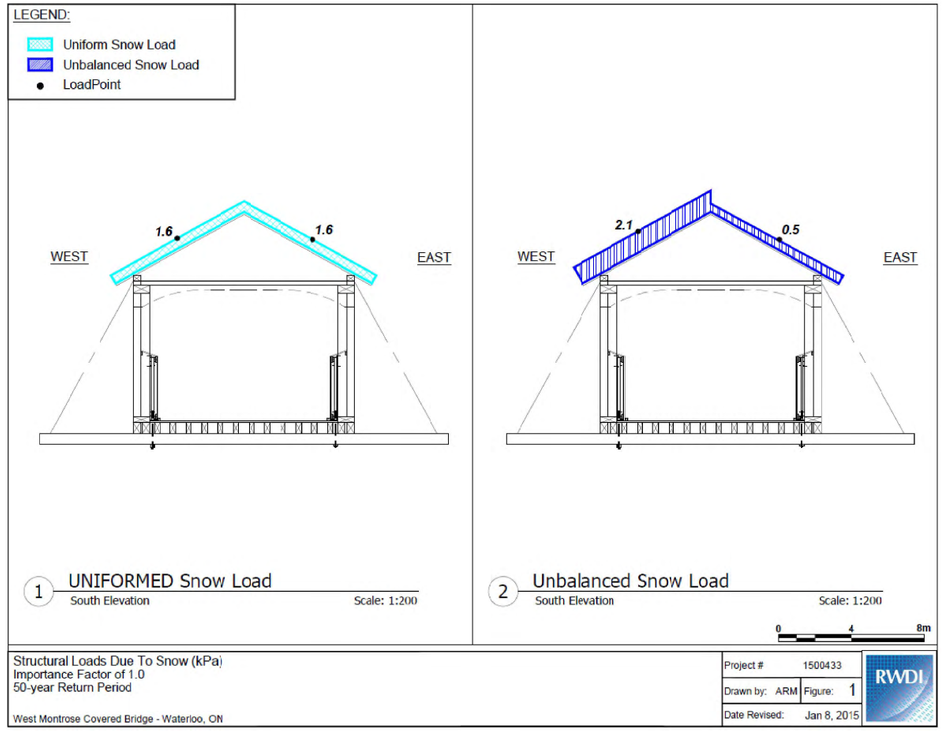


Image 7 – Distributed Loads for Design of Primary Structure Including Foundations (Left) and Unbalanced Load (Right).

7. APPLICABILITY OF RESULTS

The recommended snow loads presented in this report are based on the existing geometry and design drawings provided to RWDI as listed in Appendix A. The snow loads determined by this snow study and the associated analysis are applicable to the particular building configuration and surroundings tested.

These recommendations for roof snow loads are formulated based on the peak simulated load patterns, interpreted appropriately to account for alternate localized distributions driven by aerodynamics and limits in smaller step regions due also to aerodynamics. The loads provided in these figures are for a 50-year return period and should be used in the same way as loads calculated by the NBCC-2010. **There are no specific importance, safety or load combination factors included, i.e., for presentation purposes here, we have assumed that these factors are 1.0.** Any additional factors should be applied at the discretion of the structural engineer.

It should be noted that snow loading of any roof can be sensitive to changes in building materials and operation that are possible during the life of the building. These could be, for example, construction of other adjacent buildings; replacement of roofing material on sloped surfaces; increasing insulation value; lowering of internal temperature; clogging or re-routing of roof drainage systems or failures or discontinuation of heat tracing systems. Buildings codes and standards address the uncertainties regarding these potential loading changes in simplified ways through the normal use of load factors. It is the responsibility of the structural engineer to assess the appropriateness of the code load factor for the present design situation and to scale the loads given in this report accordingly.

In the event of any significant changes to the design, construction or operation of the building or addition of surroundings in the future, RWDI could provide an assessment of their impact on the design loads included in this report. It is the responsibility of others to contact RWDI to initiate this process.

APPENDIX F
2017 INSPECTION REPORT BY MOSES STRUCTURAL ENGINEERS

Available Upon Request

APPENDIX G
2018 STRUCTURAL MONITORING REPORT BY STRUCT-SURE

Available Upon Request

APPENDIX H
2019 STRUCTURAL ASSESSMENT OF OPTIONS REPORT BY DOUG DIXON & ASSOCIATES

Available Upon Request

APPENDIX I
2020 INSPECTION REPORT BY DOUG DIXON & ASSOCIATES

Available Upon Request

APPENDIX J
2023 VALUE ENGINEERING REPORT BY BT ENGINEERING

Available Upon Request

APPENDIX K
RENDERINGS OF ALTERNATIVE A FROM PCC #2

Available Upon Request

APPENDIX L
RENDERINGS OF ALTERNATIVE B FROM PCC #2

Available Upon Request

APPENDIX M
DESCRIPTION OF STRUCTURAL ALTERNATIVES FOR EVALUATION

Structural Alternatives for Evaluation

Alternative	A	C1	C2	C3	C4
Description	Strengthen bridge by addition of two new steel box girders to replace the Bailey trusses	Strengthen bridge by repairs to specific wood truss members. Distinguishing factor for all Alternative C sub-alternatives is the design vehicular live load and corresponding strengthening needs.			
Design Vehicular Live Load	15 tonnes	12 tonnes	10 tonnes	8 tonnes	6 tonnes
Posted Vehicular Load Limit	3 tonnes				
Design Pedestrian Live Load	To be determined; will be back-calculated based on strength resulting from strengthening to carry design vehicular live load				
Primary Structural System	New steel girders	Existing wood trusses			
Bailey Bridge	Replaced by steel girders	Permanently removed			
Roof	Replace in kind (i.e. cedar shingles underlain by wood planks and rafters)				
Exterior Cladding	Replace with new sawn wood planks with battens				
Interior Cladding	Replace	Permanently remove			
Curbs/Barriers	None	New sawn wood curbs with scuppers and wood guardrail			
Wearing Surface	New 25mm asphalt + waterproofing	Replace in kind (i.e. tar and chip surface)			
Deck	New orthotropic steel deck	Replace in kind (i.e. nail-laminated wood deck)			
Stringers	New steel stringers	Replace in kind (i.e. sawn wood stringers)			
Floor Beams	New steel floor beams	New 16”x16” sawn wood floor beams			
Needle Beams	Replace in kind (i.e. sawn timbers)	New 16”x16” sawn wood floor beams			
Top Chord	No action*				
Lower Top Chord	No action*	Make composite with top chord by adding wood plate between top chord and lower top chord and fastening together			No action*
Bottom Chord	Localized replacement at decayed sections	Replace with new sawn wood bottom chord			

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West Montrose Covered Bridge – Structural Alternatives for Evaluation
November 2023

End Diagonals at Abutments	No action*	Repair by fastening on new 4-1/2” (102mm) thick wood plank to increase member cross-section	Repair by fastening on new 4” (89mm) thick wood plank to increase member cross-section	Repair by fastening on new 3” (64mm) thick wood plank to increase member cross-section	
End Diagonals at Piers	Replace in kind (i.e. sawn wood)	Replace in kind (i.e. sawn wood) and strengthen fastening on new wood plank to increase member cross-section			
Interior Diagonals	No action*	Repair by fastening on new 2” (38mm) thick wood plank to increase member cross-section	No action*	No action*	No action*
Lower Diagonals	No action*				
Hanger Rods	Replace with new steel rods and hollow pipes	Replace in kind (i.e. steel threaded rods)			
Sway Bracing	Replace in kind (i.e. steel threaded rods)				
Top Lateral (Overhead) Bracing	May be required	Add new steel threaded rods with turnbuckles or solid sawn timbers (choice to be based on detailed connection design) to form lateral truss in plane of top chords			
Bottom Lateral Bracing	Replace in kind (i.e. steel threaded rods with turnbuckles)				
Bolster Beams	Replace in kind (i.e. sawn timber)	Replace with elastomeric bearings on concrete pedestals (more durable than replacing in kind, but less sympathetic to heritage)			
Repair Strategy for Checks and Splits in Existing Wood Members	Inject with epoxy resin and reinforce with screws				
Approach to Sag Correction	No action	Reduce sag by unloading structure and refitting truss joints			
Approach to Rack (i.e. cross-section out-of-square) Correction	No action	Eliminate racking by means of replumbing trusses. Additional means of rack prevention will be investigated including replacement of tie beams at top chord level and/or installation of ship’s knees (some ship’s knees already exist). New top lateral (overhead) bracing will help as well.			
Fire protection	Apply fire-retardant to all existing wood surfaces; apply pressure-impregnated fire retardant to all new cladding and roof elements				
Wood Preservative	Incise and pressure-treat all new cladding and roof elements with permissible wood preservative (likely water-borne preservative)				

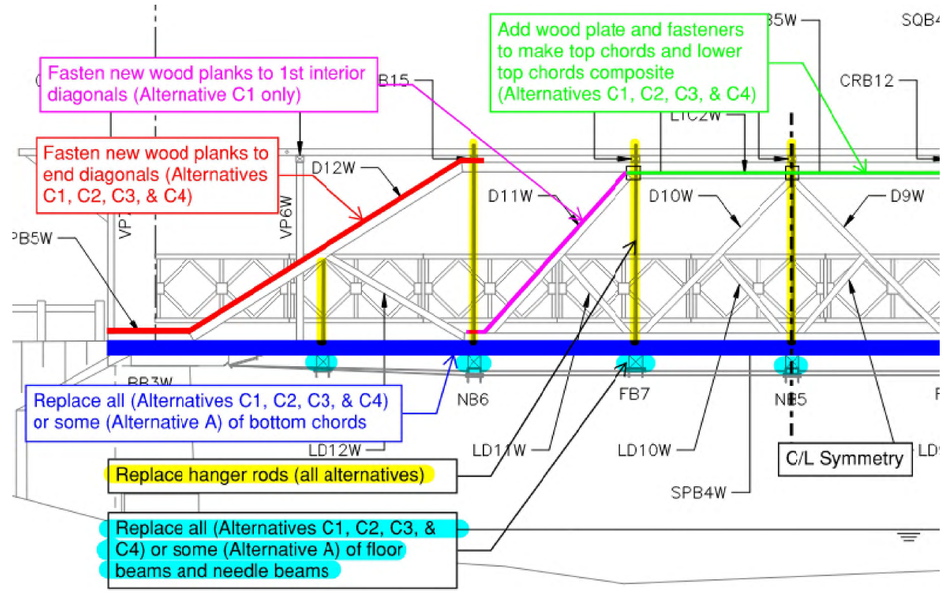
Paint	To match existing colour	
% of Vehicular Live Load Carried by Existing Wood Trusses	0%	100%
% of Existing Wood Trusses Remaining	+/- 60-70%**	+/- 60%

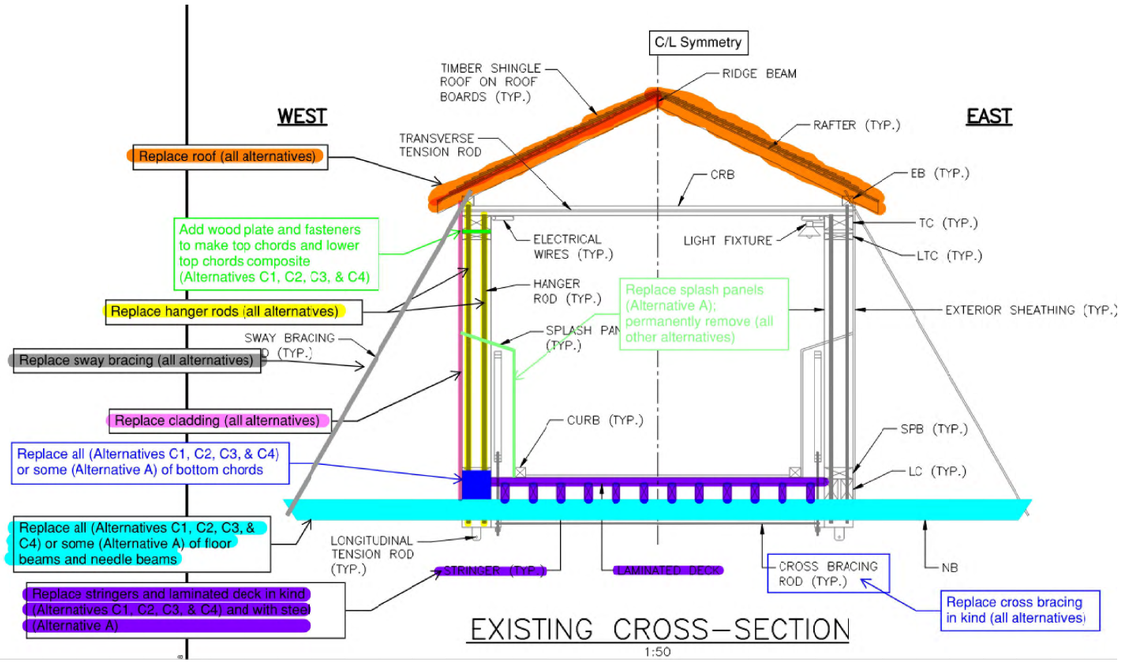
*No action means no remediation beyond injecting and reinforcing checks and splits
**Alternative A does not rely on the existing wood trusses to carry vehicular live load despite retaining potentially more of the existing wood trusses

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West Montrose Covered Bridge – Structural Alternatives for Evaluation
November 2023

Examples of Anticipated Repairs





EXISTING CROSS–SECTION
1:50

APPENDIX N
2023 MATS EVALUATION REPORT BY BT ENGINEERING

Available Upon Request

APPENDIX O
PRELIMINARY GENERAL ARRANGEMENT DRAWINGS OF PREFERRED REHABILITATION ALTERNATIVE (C2)

Available Upon Request

APPENDIX P
RENDERINGS OF PREFERRED REHABILITATION ALTERNATIVE (C2)

Available Upon Request

APPENDIX Q
PRELIMINARY CONSTRUCTION LAYDOWN AREA AND PROPERTY ACCESS DRAWING

Available Upon Request

Appendix I

Geotechnical Investigation Report

DRAFT
GEOTECHNICAL INVESTIGATION
WEST MONTROSE COVERED BRIDGE
WEST MONTROSE

for

THE REGIONAL MUNICIPALITY OF WATERLOO

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1 cc: The Regional Municipality of Waterloo
1 cc: PML Kitchener

PML Ref.: 23KF020
Report: 1
September 22, 2023

Peto MacCallum Ltd.
CONSULTING ENGINEERS

September 22, 2023

PML Ref.: 23KF020
Report: 1

Ms. Michelle Pinto, P.Eng., MBA
The Regional Municipality of Waterloo
Transp. & Environ. Services,
Design & Construction
150 Frederick Street, 6rh Floor
Kitchener, Ontario
N2G 4J3

Dear Ms. Pinto

DRAFT Geotechnical Investigation
West Montrose Covered Bridge
West Montrose, Ontario

We are pleased to present the results of our recent geotechnical investigation for the above referenced project.

It is understood that the Region of Waterloo is planning structural repairs to maintain the existing covered bridge, in West Montrose. Peto MacCallum Ltd (PML) was retained to conduct a geotechnical investigation at the site, and based on the findings we have prepared this engineering report with engineering recommendations relating to retrofit the bridge foundations with micro-piles, including excavations, backfilling, and pavement restoration.

The subsurface stratigraphy encountered at the site generally comprises surficial pavement structure and fill, over dense non-cohesive sand and gravel / sandy silt / sand, over very dense / hard silt till, over very dense gravelly sand, over bedrock. The ground water conditions encountered in the near surface sand and gravel soils reflect the water levels in the Grand River; however, artesian pressure was encountered in the bedrock layers underlying the till.

Structural retrofit of the exiting bridge foundations utilizing micro-piles founded in the overburden soils is considered feasible at the site. Micro-piles could also be installed into the underlying bedrock, but will be complicated by the artesian pressures, and therefore is generally not recommended. Regardless, installation of the micro piles will likely extend below the river water level, and require extensive surface water and ground water control during construction such that a further hydrogeological investigation is recommended for permit to take water (PTTW) or environmental activity and sector registry (EASR) application.

We trust that this report is sufficient for your immediate needs, should you have any questions please do not hesitate to contact our office.

Sincerely

Peto MacCallum Ltd.

William Loghrin, P.Eng.
Manager, Engineering Services

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Figure 5 – Bedrock Core Photographs
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Appendix A – Statement of Limitations

1. INTRODUCTION

Peto MacCallum Ltd. (PML) is pleased to report the results of the geotechnical investigation recently completed at the above noted project site. Authorization to proceed with this assignment was provided by Region of Waterloo Purchase Order 274267.

The purpose of this investigation was to explore the subsurface soil and ground water conditions at the site. Based on this information, geotechnical recommendations for micro-pile installations for foundation retrofit will be provided together with recommendations for excavations, backfilling, and pavement restoration.

The comments and recommendations provided in this report are based on the site conditions at the time of the investigation, and are applicable only to the planned works as addressed in the report. Any changes in the plans will require review by PML to assess the validity of the report, and may require modified recommendations, additional investigation and/or analysis.

2. EXISTING FOUNDATIONS

It is understood that the West Montrose covered bridge was constructed in the 1880's. Based on the construction records provided with the proposal request, the records specify the following: Approximate length 198 feet (60.4 m), 20 feet (6.1 m) wide and the deck 13 feet (4.0 m) from the low water mark. The abutment foundation was to have four bed timbers placed 2 feet (0.6 m) below the low water mark. The approaches (abutments) supported on driven timber piles advanced to a depth of 12 feet (3.7 m), presumably below the bed timbers. The centre pier was to be supported on timber piles advanced with a one-ton hammer to depth of 12 feet (3.7 m) or a set of ¼ inch, unfortunately the hammer drop height or energy value was not been provided. The original specifications called for wooden plank facings on both the abutment and pier.

The bridge and its foundations have undergone restoration (presumably multiple times) over the past 140 years. Records of the restoration work have not been provided. However, based on visual inspection, the abutments currently comprise case-in-place concrete and the centre pier has quarry stone facing with a cast-in-place concrete cap. Moreover, the quarry stone on the upstream side of

the centre pier is showing signs of settlement. The centre pier is generally missing mortar between the stones, from about 3.6 m depth below the deck to the water line.

3. SITE PHYSIOGRAPHY AND BEDROCK

As noted by Chapman and Putnam, The Physiography of Southern Ontario, Second Edition, the site is located in a spillway containing the current route of the Grand River, and is fringed by drumlinized till plans. A spillway is a natural drainage channel cut by water from melting glaciers or ice fields. A typical spillway is a broad trough floored wholly or in part by gravel beds at one or more levels. After the glaciers receded the spillway at the site has become the current valley for the Grand River.

Bedrock mapping of the site published by the Ontario Department of Northern Development and Mines, Map 2544, indicates sandstone, shale, dolostone, and siltstone bedrock materials of the Guelph Formation, Middle and Lower Silurian period.

Bedrock topography mapping publish by the Ontario Geological Survey, Preliminary Map P2224 identifies bedrock at elevation 974 and 1002 feet (approximate elevation 296.9 and 305.4) north and south of the river, respectively. For reference the Grand River water level was at about elevation 319.6 during the investigation.

4. INVESTIGATION

The fieldwork for the geotechnical investigation was conducted between July 18 and August 18, 2023. The investigation comprised a total of seven boreholes, at the locations shown on the appended Borehole Location Plan, Drawing 1. Boreholes 1 and 3 were at the south and north approaches, advanced to 25.3 m and 18.4 m depths, respectively. Borehole 2 was advanced at the centre pier of the bridge to 25.1 m depth. Boreholes 1A and 1B were advanced behind the south abutment and into the south abutment wall, to 4.6 m and 1.6 m depths, respectively. Boreholes 3A and 3B were advanced behind the north abutment and through the north abutment wall to 4.6 m and 5.1 m depths, respectively.

Borehole 3 was advanced using CME-75 truck mounted drill rig, and Boreholes 1 and 2 were advanced with a Simco track mounted drill rig. The drill rigs were fitted with continuous flight hollow stem augers, along with washboring using diamond tipped N casing, and automatic hammer. Boreholes 1A, 1B, 2, 3A and 3B were advanced into the near surface bridge structural elements and backfill soils using construction coring equipment, and ramsounder automatic hammer. The drilling equipment was operated by specialist drilling contractors. The work was carried out under full-time supervision of a PML engineering staff member who directed the drilling and sampling operations, documented the soil stratigraphy, monitored ground water conditions and processed the recovered samples.

The borehole locations were programmed through consultation with the client, and established in the field by PML. The boreholes were surveyed by PML using a Sokkia GCX3 GNSS Receiver.

Representative samples of the overburden were secured from the boreholes at regular intervals of depth. Standard penetration tests (SPT) were carried out in conjunction with the sampling operations using a conventional split spoon sampler. The bedrock was cored at two borehole locations using an N sized core barrel. Ground water observations were carried out in the open boreholes during and after completion of drilling.

Upon completion, the boreholes below the centre pier and abutments were sealed with Portland cement grout and bentonite, in accordance with the O. Reg 903, as amended. The bridge pier and abutments themselves were filled using red tinted flowable grout, Quikrete Non-Shrink Precision Grout (No.1585), and imported coarse aggregate.

All of the recovered samples were returned to PML's laboratory for detailed visual examination, classification and routine moisture content determinations. The laboratory testing also included particle size distribution analyses on four samples of the major soil types encountered. Compressive strength testing was conducted on two samples of the existing bridge abutment concrete, and compressive strength testing was also conducted on four bedrock core samples.

The scope of work for this study did not include the observation, recording or assessment of the environmental conditions of the soil, bedrock and ground water on the site. If excess materials

requiring off site disposal are generated during construction, laboratory analysis will be required to determine the chemical properties of the material and evaluate options for off site disposal.

5. SUMMARIZED FINDINGS

Reference is made to the appended Log of Borehole sheets for details of the field work including soil descriptions, inferred soil stratigraphy, SPT N values, rock quality designation (RQD), concrete and bedrock strength measurements, ground water observations and laboratory moisture content determinations.

Due to the soil sampling procedures and the limited size of samples, the depth/elevation demarcations on the borehole logs must be viewed as “transitional” zones, and cannot be construed as exact geologic boundaries between layers.

The general subsurface stratigraphy encountered at the site comprised surficial pavement structure and fill soils, over non-cohesive sand and gravel / sandy silt / sand, over silt till, over non-cohesive gravelly sand, over bedrock.

5.1 Abutments

Boreholes 1A, 1B, 3A and 3B were advanced behind and into the existing abutments. Boreholes 1A and 3A were advanced approximately 0.5 m behind the concrete abutment face and encountered pavement structure over fill soils, to a typical 4.6 m depth (further notes on the fill encountered are noted in the sections below). Borehole 1B was advanced into the south abutment wall (about 0.2 m from the face), but was terminated due to core refusal on a boulder or steel. Borehole 3B penetrated through the 5.1 m tall north abutment, with split spoon refusal encountered on very dense sand and gravel at 5.1 m.

The south abutment wall comprised Portland cement with coarse aggregate (up to cobble and boulder size) along with infrequent rebar pieces. The north abutment wall comprised Portland cement, with a maximum aggregate ranging to cobble sized. Reference is given to the appended Figure 1 showing the concrete cores recovered from the abutments. Compressive strength tests of

concrete cores recovered from boreholes 1B and 3B were 36.7 and 22.0 MPa, with densities of 2,431 and 2,249 kg/m^3, respectively.

5.2 Centre Pier

Borehole 2 was advanced through the deck and centre pier of the bridge. The deck comprised 30 mm of bituminous asphalt surface treatment, over 90 mm of wooden decking, on 250 mm tall joists, supported by the centre pier. The pier comprised a cast-in-place concrete cap from 0.37 to 2.1 m depth; over large quarried dolostone boulders (likely the backside of the stone pier facing) and Portland cement mortar extending from 2.1 to 2.8 m depth; over Portland cement concrete containing large cobbles and boulders, from 2.8 to 3.5 m depth; over sandy gravelly cobbles and boulders (the stonework below the waterline) extending to 6.7 m depth.

The pier was penetrated to a depth of 3.5 m using construction coring equipment, where coring was terminated due to the presence of cobble/boulder infill materials. Reference is given to Figure 1 showing the recovered cores from the upper part of the pier, at Borehole 2. Borehole 2 was advanced further through the pier using the Simco drillrig and wash boring with diamond tipped casing N casing, and encountered uncemented sandy cobbles and boulders from 3.5 m to 6.7 m depth. The bottom of the bridge pier was established based on the change in casing advance rate, wash conditions, and drop-in wash water usage rate.

The extensive loss of wash water return, total consumption water during the N casing advance, and quantity of grout and cementing materials consumed upon completion of drilling, indicates that the portion of the bridge pier below 3.5 m is very permeable (possibly with large voids); which is likely due to a lack of mortar / cemented infill between the stonework below the waterline.

5.3 Pavement Structure / Fill / Silt

A surficial pavement structure was encountered at the bridge abutments and approaches, in Boreholes 1, 1A, 3 and 3A, and extended to between 25 and 380 mm depth. The pavement components comprised 25 to 75 mm of surface treatment / asphalt, over granular base / subbase (where encountered).

The pavement structure at the approaches was underlain by fill, which extended to between 3.5 to 4.6 m depth in Boreholes 1, 1A, 3 and 3A. The fill varied in composition from sand and gravel to silty sand. The fill also contained occasional cobbles, boulders, inclusions of organics, inclusions of topsoil, wood pieces, and coal pieces. The fill was very loose to compact with SPT N values ranging from 0 to 26 blows per 0.3 m penetration of the split spoon sampler. The fill was moist to wet with laboratory moisture contents ranging from 3 to 62%.

A localized silt layer (possible fill) was encountered below the fill in Borehole 1, and extended to 4.3 m depth. The silt was loose, and moist to wet with a moisture content of 35%.

5.4 Sand and Gravel /Sandy Silt / Sand

Sand and gravel / sandy silt / sand was encountered below the fill, bridge foundations and silt layer in Boreholes 1, 2, 3, and 3B. The sand and gravel / sandy silt / sand layers extended to between 8.7 and 9.4 m depth (elevation 314.8 to 315.5) in Boreholes 1, 2 and 3. The sand and gravel contained cobbles and boulders. The sand and gravel / sandy silt / sand was compact to very dense with SPT N values ranging from 12 to greater than 50 blows per 0.3 m penetration. The sand and gravel / sandy silt / sand was saturated with moisture contents ranging from 10 to 32%. Reference is given to the appended Figure 2 showing the results of particle size distribution analyses conducted on samples of the sand and gravel. It should be noted that the split spoon sampling procedure excludes particles larger than 38 mm.

5.5 Till

Silt till was encountered underlying the sand and gravel / sandy silt / sand in Boreholes 1, 2 and 3, and extended from 8.7 9.4 m depth (elevation 314.8 to 315.5) and extended to between 16.8 and 19.7 m depth (elevation 304.1 and 307.5). The till typically comprised low plastic clayey silt, and to a lesser extent non plastic silt with sandy silt layers. The till was typically very dense / hard with SPT N values ranging from 39 to greater than 50 blows per 0.3 m penetration of the split spoon sampler. The till was moist to wet / drier than plastic limit (DTPL) with moisture contents ranging from 7 to 17%. Reference is given to the appended Figure 3 showing the results of particle size distribution analysis conducted on a sample of the till.

5.6 Gravelly Sand / Cobbles and Boulders

A deposit of gravelly sand transitioning to cobbles and boulders was encountered below the till in boreholes 2 and 3, and extended to 19.8 and 18.4 m depth (elevation 304.5 and 305.8), respectively. The gravelly sand was very dense with SPT N values greater than 50 blows per 0.3 m penetration. The gravelly sand was saturated with moisture content of 12%. Reference is given to Figure 4 for the results of a particle size analysis on a sample of the gravelly sand.

5.7 Bedrock

Bedrock was contacted in Boreholes 1 and 2 below 19.7 and 19.8 m depth (elevation 304.1 and 304.5), respectively. The bedrock was cored in Borehole 1 and 2 to the 25.3 and 25.1 m termination depths (elevation 298.5 and 299.2), respectively. The bedrock comprised light grey dolostone, interbedded with shale, siltstone, and sandstone. The RQD ranged from 0 to 13% from the recovered cores. Reference is given to the appended Figure 5 showing the bedrock cores. The compressive strength of the four bedrock samples tested ranged from 67.0 to 100.9 MPa. Reference is given to the Log of Borehole sheets for details of the bedrock core analysis and compressive strength results.

5.8 Ground Water

During drilling, free water seepage was observed below 3.5 to 4.6 m depth in the boreholes, in the saturated sand / sandy silt / sand soils. Upon completion of auger drilling in Borehole 3, free water was observed at 5 m depth in the uncased borehole. The free water observed in the boreholes reflects the Grand River water level (elevation 319.6), and the ground water level in the near surface overburden soils.

Artesian ground water conditions were observed during coring of the bedrock in Boreholes 1 and 2. The stabilized artesian head was monitored in the cased Borehole 1 between August 11 and 14, 2023, and was found to be about 2 m above road grade and 6.2 m above the Grand River level (about elevation 325.8). The artesian conditions reflect the deeper ground water level found in the

granular soils and bedrock which is present below the relatively impermeable and confining silt till deposit.

6. DISCUSSION AND RECOMMENDATIONS

In general, the subsurface soil stratigraphy at the site comprises near surface fill, over a water bearing sand and gravel / sandy silt / sand, over clayey silt till, over a deeper sand and gravel deposit, over dolostone bedrock. The near surface ground water level generally matches the water level of the Grand River, while the deeper hydraulicly confined bedrock deposits are under a significant artesian pressure, with hydraulic head approximately 5 to 6 m above the river water level.

Cognizant of the very dense and bouldery conditions of the near surface soils, it is envisaged that the wooden pile foundations detailed in the historical specifications were very likely to have encountered shallow refusal on the coarse granular soils of the river bed. Even with relatively modern construction piling equipment, installation of a deep foundation system comprising driven wooden piles installed to the typical 3.7 m depth (as per the 1880 specifications) through very dense sand and gravel would not be recommended. If the piles were installed, they would likely have terminated at a shallow depth, and the piles and timber bed would function as a large irregular footing on a very dense sand and gravel subgrade (not a deep foundation system). Therefore, the bulk of the foundation loads were/are very likely supported effectively on a shallow strip or pad foundation. Initially, the footing would likely have comprised an irregular timber pile stubs and the wooden timber beds resting on the very dense sand and gravel river bed. The subsequent historical retrofits / repairs involving placement of concrete and masonry stones replacing or supporting the wooden structure would also function as a shallow footing founded on the very dense sand and gravel subgrade soils.

The very dense sand and gravel soils found at the level of the river bottom are capable of supporting relatively heavily loaded footings, and properly constructed footings could be designed to support bearing pressures in the order of 400 kPa at serviceability limit states (SLS) and 600 kPa at ultimate limit sates (ULS); however, footings are susceptible to scour from the river. The settlement of the stone work on the upstream side of the bridge pier is attributed to scour from the river. Regardless

of the bearing pressures which can be supported by the onsite soil, it is recommended that the bridge foundations be retrofitted to provide protection from scour.

Consideration could be given to underpinning the existing foundations (below the scour depth). However, underpinning would require extensive excavation support and ground water control over a relatively long period of time to maintain a safe and adequately dry work area, which might not be preferable from a cost perspective. Similarly, installation of deep foundation systems such as driven piles or caissons will require prohibitive special measures to manage the soil and artesian ground water conditions. Micro-piles founded in the very dense / hard over burden soils or underlying bedrock will be less intrusive into the water bearing soil and rock (when compared to the other methods), and therefor may be considered to support the bridge and provide uplift resistances.

6.1 Mico-Piles

A micro-pile is constructed by drilling a small diameter borehole typically less than 300 mm. Reinforcement steel is placed in the drilled shaft followed by tremie grouting. Micro-piles achieve their load carrying capacity from the bond between the grout in the micro-pile and the surrounding soil / rock. Due to the method of installation, minimal ground water control requirements are required for their construction.

Where micro-piles are planned for the foundation construction / retrofit they can be extended into the coarse water bearing sand and gravel deposits of the river, and if necessary, the confined aquifer in the bedrock. However, the micro-pile system must also provide permanent means to prevent upward seepage of the artesian ground water during construction and in the long term. Cognizant of the subsurface soil and ground water conditions, consideration should be given to using micro-piles installed in the overburden soils to retrofit the bridge foundations for axial compression and uplift resistance. Installation of the micro-piles into the underlying bedrock will encounter the hydraulic pressure and flow of the artesian aquifer in the bedrock, which will require additional means to control seepage. Therefore, while micro-pile installation into the underlying bedrock is technically possible, it is generally not recommended given the additional complications of sealing and long-term ground water control.

It should be noted that the mobilized capacity of micro-piles is heavily dependent on the contractor and the actual procedures used to install the micro-pile. Capacities should be confirmed by load tests, and load tests are essential to verify the capacities that can be achieved.

Micro-pile systems are typically available as a proprietary product. The names of local distributors / installers can be provided if required. Detailed design services are typically included with the product. PML should review the micro-pile contractors stamped shop drawings for conformance with geotechnical requirements.

The axial compression and uplift capacity of micro-piles is provided by bond stress developed along the grouted shaft, over the bond length portion of the micro-pile advanced into soil / bedrock, and the reinforcement bar placed in the casing. The following soil and bedrock parameters may be used for preliminary design of micro-piles.

LOCATION	STRATA	MINIMUM DEPTH (Maximum Elevation)	GROUT TO GROUND BOND (KPa)
Borehole 1	Very dense sand and gravel / hard clayey silt till	4.5 (319.3)	75
Borehole 2	Very dense sand and gravel / hard clayey silt till	6.9 (317.4)	
Borehole 3	Compact to dense sand and gravel / hard clayey silt till	5.3 (318.9)	
Borehole 1	Dolostone Bedrock	19.9 (303.9)	1,000
Borehole 2	Dolostone Bedrock	20.0 (304.3)	

An appropriate factor of safety must be used for design. A typical minimum bond length of 3.0 m should be used to develop capacity. These parameters are for preliminary planning purposes only and should be reviewed based on actual construction equipment. The structural capability of individual micro-piles must be verified by field load tests during construction.

Settlement of the micro-piles when the foundation load is applied should be less than 10 mm. This does not include the elastic settlement of the micro-pile.

Details of the extent of micro-pile installations have yet to be established. However, the envisaged micro-pile foundation system would comprise grouping of piles diverging at various angles and resembling tree roots to provide the required axial and lateral load resistances.

At the abutments, the micro-piles are envisaged to terminate in a grade beam below or behind the existing abutment. If a new abutment is required, then micro piles could be used to support a new abutment.

At the centre pier, depending on the amount of reinforcement needed, consideration can be given to installing the micro-piles through the existing concrete, masonry and boulder elements into to the underlying soil and bedrock deposits. If it is not practical to install the required number of micro-piles through the pier, then consideration must be given to installing micro piles with a grade beam under/around the existing pier (below the river water level), or as part of a new replacement of the centre pier. Further discussion is provided in the excavations section.

It is noted that with installations through the existing abutments or centre pier there is significant risk that the micro-pile drilling equipment could be obstructed by uncemented boulders and components in the abutment and pier. During the investigation at the pier, it was found that the masonry structure was not hydraulically secure, and this will require careful consideration for micro-pile installations through the pier. Any grouting or cement placement into the existing concrete/masonry elements will require additional measures to contain unwanted seepage out of the structure. Construction of containment measures around the pier could require extending a coffer dam for a work area below the river water level, and extensive water diversion and dewatering measures will be required, and further reference is given in the excavations section.

6.2 Excavations

The excavations for the micro-pile installations at the abutments and centre pier are expected to typically extend to a maximum 6 m depth below the bridge deck, through variable loose to compact

fill and into water bearing coarse cohesionless soil, which are classified as Type 3 materials as defined in the Occupational Health and Safety Act (OHSA), providing adequate ground water control is achieved. Excavations within Type 3 soil that are to be entered by workers, may not be steeper than one horizontal to one vertical (1H:1V) from the base of the excavation. Workers should not enter an unprotected excavation if there is evidence of ongoing ground water seepage in the banks.

Foundations of heavily loaded/settlement sensitive structures and/or utilities located within close proximity to the excavation may require underpinning to preserve the integrity of these structures. Further comments and general recommendations in this regard are presented on Figure 6.

It should be noted that, under the Ontario Water Resources Act, the Water Taking and Transfer Regulation 387/04, a Permit to Take Water (PTTW) from the Ministry of Environment, Conservation, and Parks (MECP) is required if the dewatering discharge is greater than 50,000 L/day. In accordance with the above noted regulatory requirements and in compliance with the MECP's PTTW Manual (April 2005), an application should be filed to the MECP for the subject property construction dewatering PTTW, if the dewatering discharge is greater than 400,000 L/day, or about 4.6 L/S. If the dewatering discharge is between 50,000 L/day (or about 0.6 L/S) and 400,000 L/day (or about 4.6 L/S) dewatering activities need to be registered on the Environmental Activity and Sector Registry (EASR). Upon request, PML would be pleased to assist with this process.

Excavations for the recommended micro-pile foundation retrofit construction are expected to extend to a maximum 6 m in areas. A PTTW would not be required for localized excavations which do not extend below the ground water / river level provided construction dewatering rates do not exceed 50,000 L/day. However, if extensive excavations below the ground water level / river level are expected for micro pile grade beam installations and/or abutment reconstruction, the work would generally be expected to have dewatering rates in excess of 50,000 L/day, and a PTTW registered or EASR will be required along with a supportive hydrogeological investigation.

Extensive surface water control measures including sandbagging and installation of cofferdam structures would be required for any excavation in the Grand River. Extensive dewatering from inside cofferdam areas including seepage from the excavation base might also require a PTTW in addition to of surface water diversion permits.

Regardless of the dewatering method chosen, the hydraulic head and ground water inflow must be properly controlled to ensure stable and safe excavation and to facilitate construction. The design of the dewatering system should be left to the contractor's discretion, and the system should meet a performance specification to maintain and control ground water at least 0.30 m below the excavation base level, in order to provide a stable excavation base throughout construction.

It is recommended that test pits be carried out during the tendering stage of the project in order that prospective contractors may familiarize themselves with soil and ground water conditions. The dewatering requirements should also be established by the contractor in the context of a performance specification.

6.3 Backfilling

Backfill should be placed in accordance with the Ontario Provincial Standard Specifications (OPSS) OPSS.MUNI 902. The backfill should be placed in 300 mm maximum lifts and compacted to at least 95% Standard Proctor Maximum Dry Density (SPMDD), as verified by in-situ density testing.

The backfill adjacent to the structure should comprise free draining granular material such as OPSS Granular B Type I. Subject to inspection and testing at time of construction, it is generally expected that the bulk of the soil excavated from behind the abutments will be too silty for reuse as Granular B. Similarly, materials containing topsoil and/or organic matter should not be used as backfill. The use of wet backfill material should be specifically avoided within the top 1 m of backfill below the pavement subgrade level, to help maintain stable subgrade conditions for pavement construction.

The structure must be designed to support the stress imposed by roadway traffic and the overlying fill as well as to resist the unbalanced lateral earth pressure and compaction pressure imposed by the backfill adjacent to the abutment walls.

The lateral earth and water pressure, P (kPa), may be computed using the equivalent fluid pressure method presented in Section 6.12 of the Canadian Highway Bridge Design Code (CHBDC), CAN/CSA-S6-19, November 2019, or employing the following equation.

$$P = K(\gamma h + q) + C_p$$

where
- P = total lateral pressure at depth h (m) below ground surface (kPa)
- K = lateral earth pressure coefficient of compacted backfill
- h = depth below grade (m) at which lateral pressure is calculated
- γ = unit weight of compacted sand and gravel backfill
- q = vertical stress at depth h due to surcharge loads (kPa)
- C_p = compaction pressure (refer to clause 6.12.3 of CHBDC)

For walls restrained at the top, the total lateral compaction pressure may be computed as 12 kPa added at the backfill surface, reducing linearly to 0 kPa at a depth of 1.7 m, plus a further lateral surcharge of 0.15 times the at-rest lateral pressure added over the full backfilled height of the wall.

Appropriate factors of safety must be used in the design.

The following design parameters may be assumed for granular backfill materials compacted to 95% SPMDD:

PARAMETER	OPSS GRANULAR A	OPSS GRANULAR B TYPE I
Angle of Internal Friction (degrees)	35	32
Unit Weight (kN/m^3)	23	21
Coefficient of Active Earth Pressure (K_a)	0.27	0.31
Coefficient of Earth Pressure at Rest (K_o)	0.43	0.47
Coefficient of Passive Earth Pressure (K_p)	3.70	3.23

Some on-site materials such as the existing pavement structure could be considered for re-use as backfill, subject to inspection and approval during construction; however, material described as silty on the appended borehole logs will generally not be free draining and compactible to 95% SPMDD and should be segregated and allocated to areas where post construction settlement would not present a concern.

Existing fill soils should not be re-used as backfill. On-site topsoil and other deleterious materials should be used for landscaping purposes only. Care must be taken to minimize mixing of suitable fill soils with other deleterious materials. Laboratory testing will also be required to determine the soil properties and conformity with specifications.

6.4 Pavement Reinstatement

Based on the anticipated traffic volumes and frost susceptibility of the anticipated subgrade soils to be encountered at the site, the following pavement design is recommended for reinstatement of the approaches:

HL 3 Surface Asphalt	40 mm
HL 8 Binder Asphalt	60 mm
Granular A Base Course	150 mm
Granular B Subbase Course	300 mm

The pavement materials should conform to current OPSS and municipal specifications. The Granular A base and Granular B subbase courses should be placed in 150 mm thick lifts and compacted to a minimum of 100% SPMDD, and asphalt should be placed to a minimum of 92% of the material's maximum relative density (MRD). Reference is made to OPSS 310.

The pavement design considers that the construction will be carried out during the drier time of the year and that the subgrade is stable, as determined by proof-rolling inspected by PML personnel. If the subgrade is wet and unstable, additional granular subbase material will be required.

It should be noted that the subgrade will lose its strength if allowed to become wet due to surface water or during freezing and thawing periods. Therefore, drainage of the granular courses and subgrade becomes very essential, which can be provided by extending the granular courses out to the face of the embankment slopes.

It is recommended that at the transition zones, the subgrade level of the new pavement sections and existing pavement section should match, if possible, to avoid any problems of differential frost

heaving of the subgrade. Alternatively, frost tapering of the subgrade at 10H:1V would be recommended.

During construction, testing should be conducted to confirm the gradation and compactibility characteristics of the granular base and subbase materials.

Proofrolling procedures and the placement and compaction of all the fill and granular materials for the pavement construction and backfilling at the site should be inspected on a continuous basis by PML technicians.

7. CLOSURE

We trust the information presented in this report is sufficient for your immediate requirements. If you have any questions or require further information, please do not hesitate to contact our office.

Sincerely

Peto MacCallum Ltd.

William Loghrin, P.Eng.
Manager, Engineering Services

Gerry Mitchell, MEng. P.Eng.
Senior Consultant



Photograph 1: Borehole 1B, Depth 0 to1.6 m



Photograph 2: Borehole 2, Depth: 0.37 to 3.5 m

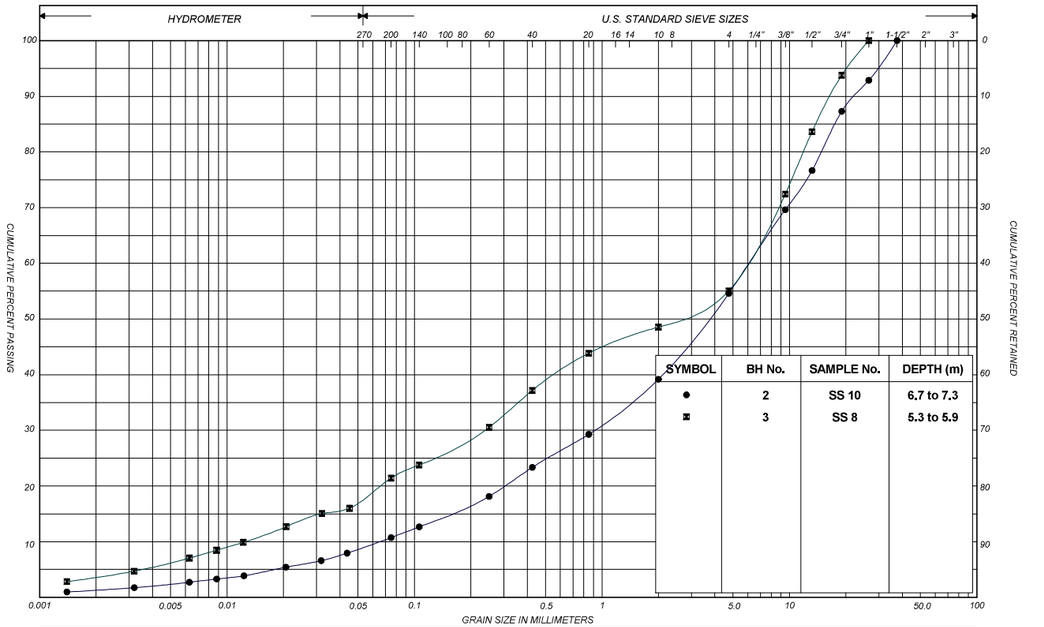


Photograph 3: Borehole 3B, Depth 0 to 5.1 m

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PROJECT NO. 23KF020
FIGURE NO. 2

PARTICLE SIZE DISTRIBUTION CHART



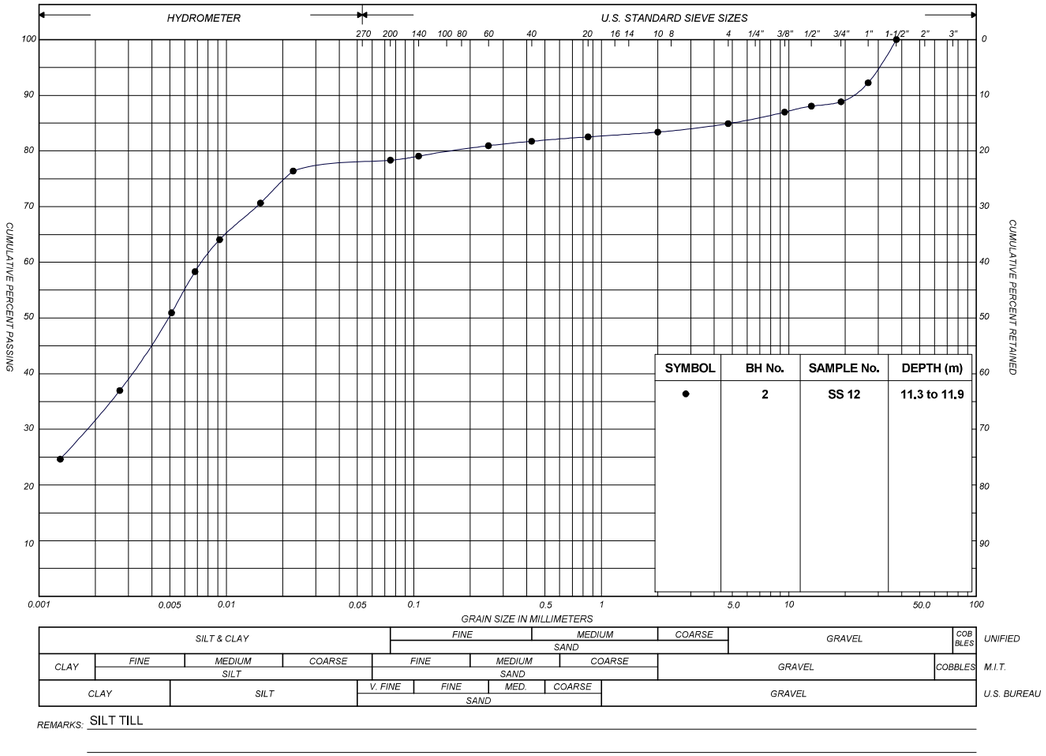
SILT & CLAY			FINE		MEDIUM		COARSE	GRAVEL		COBBLES	UNIFIED
			SAND								
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL			COBBLES	M.I.T.
	SILT			SAND							
CLAY	SILT		V. FINE	FINE	MED.	COARSE	GRAVEL				U.S. BUREAU
			SAND								

REMARKS: SAND AND GRAVEL

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PARTICLE SIZE DISTRIBUTION CHART

PROJECT NO. 23KF020
FIGURE NO. 3



SYMBOL	BH No.	SAMPLE No.	DEPTH (m)
●	2	SS 12	11.3 to 11.9

SILT & CLAY			FINE		MEDIUM		COARSE	GRAVEL		COB BLES	UNIFIED
			SAND								
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL			COBBLES	M.I.T.
	SILT			SAND							
CLAY	SILT			V. FINE	FINE	MED.	COARSE	GRAVEL			U.S. BUREAU
				SAND							

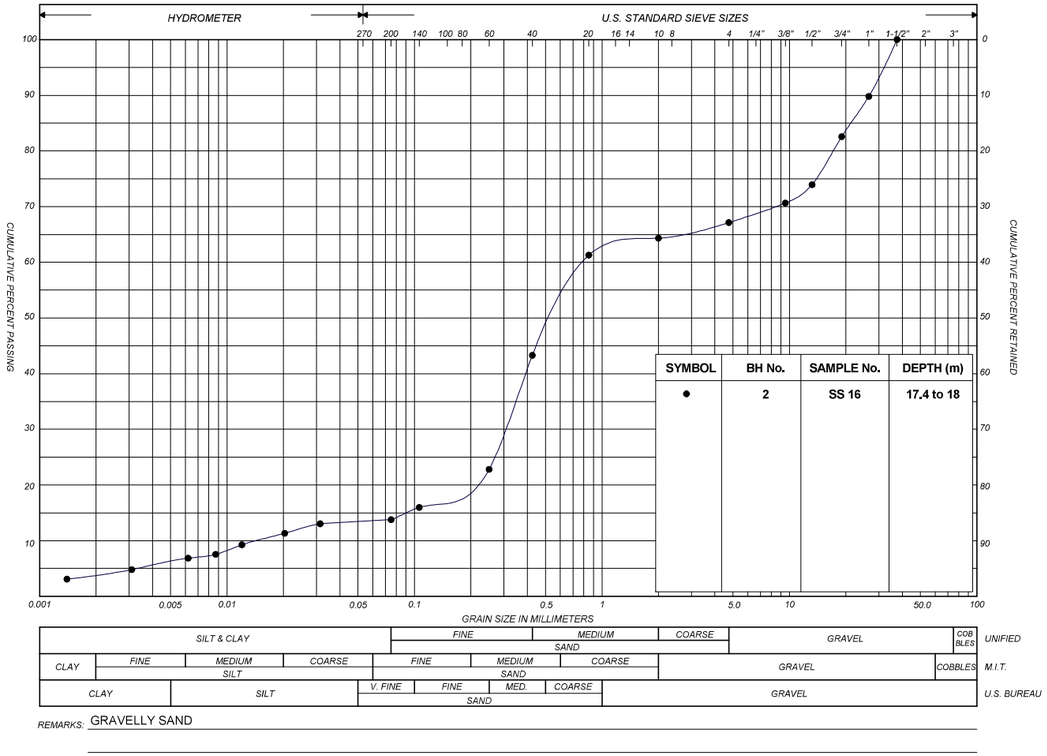
REMARKS: SILT TILL

PML GRAINSIZE (9 PLOTS) 23KF020 - BH LOGS.GPJ PETOMAC.GDT 2023-09-13 4:29:50 PM

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PARTICLE SIZE DISTRIBUTION CHART

PROJECT NO. 23KF020
FIGURE NO. 4



SYMBOL	BH No.	SAMPLE No.	DEPTH (m)
●	2	SS 16	17.4 to 18

SILT & CLAY			FINE		MEDIUM		COARSE	GRAVEL		COB BLES	UNIFIED
			SAND								
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL			COBBLES	M.I.T.
	SILT			SAND							
CLAY	SILT			V. FINE	FINE	MED.	COARSE	GRAVEL			U.S. BUREAU
				SAND							

REMARKS: GRAVELLY SAND

PML GRAINSIZE (9 PLOTS) 23KF020 - BH LOGS.GPJ PETOMAC.GDT 2023-09-21 11:01:37 AM



Photograph 1: Borehole 1, Rock Core Depth from 19.7 m to 25.3 m



Photograph 2: Borehole 2, Rock Core Depth from 19.8 m to 25.1 m

UP – 001 1/96

NOTES

1. The need to underpin existing footings/utilities is dependent upon soil type, proximity of the existing facility to the face of the excavation, loads imposed on the foundation and permissible movements.

   ZONE A:
   Foundations of relatively heavy and/or settlement sensitive structures/ utilities located in Zone A generally require underpinning.

   ZONE B:
   Foundations of structures located within Zone B generally do not require underpinning. Consideration should be given to underpinning of settlement sensitive utilities or heavy foundation units located in this zone.

   ZONE C:

   Utilities and foundations located within Zone C do not normally require underpinning.

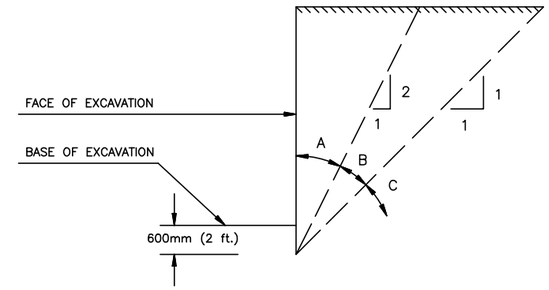
   Underpinning of foundations located in Zones A and B should extend at least into Zone C.

2. As an alternative to underpinning, it may be possible to control movement of existing utilities and foundations by supporting the face of the excavation with bracing/tiebacks or a rigid (caisson) wall. Horizontal and vertical earth pressures imposed on the excavation wall by non–underpinned foundations must be considered in the design of the support system.

3. A condition survey should be conducted prior to construction and appropriate monitoring (surface and insitu) carried out during construction to monitor any movement which may occur.

4. All work should be carried out in accordance with the Occupational Health and Safety Act and local regulations. Good quality workmanship and construction practices are to be employed.

5. This sheet is to be read in conjunction with text of report for this project. Additional comments and recommendations concerning these general guidelines will be provided if required.



Peto MacCallum Ltd. CONSULTING ENGINEERS	STANDARD DRAWING GENERAL RECOMMENDATIONS REGARDING UNDERPINNING OF FOUNDATIONS/UTILITIES LOCATED CLOSE TO EXCAVATION	DATE	JOB NUMBER	FIGURE NO.
		SEPT 2023	23KF020	6

LIST OF ABBREVIATIONS

PENETRATION RESISTANCE

Standard Penetration Resistance N: - The number of blows required to advance a standard split spoon sampler 0.3 m into the subsoil. - Driven by means of a 63.5 kg hammer falling freely a distance of 0.76 m.

Dynamic Penetration Resistance: The number of blows required to advance a 51 mm, 60 degree cone, fitted to the end of drill rods, 0.3 m into the subsoil. The driving energy being 475 J per blow.

DESCRIPTION OF SOIL

The consistency of cohesive soils and the relative density or denseness of cohesionless soils are described in the following terms:

CONSISTENCY	N (blows/0,3 m)	c (kPa)	DENSENESS	N (blows/0,3 m)
Very Soft	0 - 2	0 - 12	Very Loose	0 - 4
Soft	2 - 4	12 - 25	Loose	4 - 10
Firm	4 - 8	25 - 50	Compact	10 - 30
Stiff	8 - 15	50 - 100	Dense	30 - 50
Very Stiff	15 - 30	100 - 200	Very Dense	> 50
Hard	> 30	> 200		

WTPL	Wetter Than Plastic Limit
APL	About Plastic Limit
DTPL	Drier Than Plastic Limit

TYPE OF SAMPLE

SS	Split Spoon	TW	Thinwall Open
WS	Washed Sample	TP	Thinwall Piston
SB	Scraper Bucket Sample	OS	Oesterberg Sample
AS	Auger Sample	FS	Foil Sample
CS	Chunk Sample	RC	Rock Core
ST	Slotted Tube Sample	USS	Undisturbed Shear Strength
PH	Sample Advanced Hydraulically	RSS	Remoulded Shear Strength
PM	Sample Advanced Manually		

SOIL TESTS

Qu	Unconfined Compression	LV	Laboratory Vane
Q	Undrained Triaxial	FV	Field Vane
Qcu	Consolidated Undrained Triaxial	C	Consolidation
Qd	Drained Triaxial		

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LOG OF BOREHOLE NO. 1

17T 541881E 4825947N

PROJECT West Montrose Covered Bridge — **PML REF.** 23KF020
LOCATION West Montrose Covered Bridge, West Montrose, Ontario — **BORING DATE** 2023-08-08 — **ENGINEER** W. Loghrin
BORING METHOD Continuous Flight Hollow Stem Augers with N Casing — **TECHNICIAN** M. Rapsey

DEPTH (metres)	ELEV	DESCRIPTION	NUMBER	TYPE	"N" VALUES
		SURFACE ELEVATION 323.8			
0.0	323.57	PAVEMENT STRUCTURE: 25 mm asphalt over granular base, some silt, damp			
		Fill: Brown sand and gravel, occasional cobbles, occasional boulders, moist	1	SS	9
2.0	321.7	becoming brown fine sandy silt fill, moist; inclusions of black silty organics and topsoil	2	SS	2
3.0	320.3		3	SS	4
4.0	319.5	SILT: Loose greyish brown silt, some fine sand, moist to wet, faintly stratified (possible fill)			
5.0		SAND AND GRAVEL: Very dense brown fine to coarse sand and angular gravel, some silt, occasional cobbles, wet	4	SS	52
6.0			5	SS	110
7.0					
8.0			6	SS	38
	315.1	SILT TILL: Very dense / hard grey clayey silt, trace to some sand, trace to some gravel, slightly plastic, DTPL	7	SS	44
9.0					
10.0			8	SS	43
11.0					
12.0			9	SS	54
13.0	310.7	becoming grey silt and fine sand, some gravel, moist			
14.0			10	SS	100
	309.2	becoming dense grey silt, trace of sand, CONTINUED			
15.0					

Switched to wash boring with N casing.

Approximately 11000 Litres of water used to advance casing and core.

NOTES
RQD (Rock Quality Designation) is the total length of those pieces of sound core which are 10 cm or greater in length in a core run expressed as a percentage of the total length of that core run. RQD is measured on minimum NQ size (nominal 50 mm diameter) cores. WWR (wash water return) is the observed fraction of drilling water which has returned to the surface during coring.

DRAFT

PML - BH/TP LOG GEO/ENV WITH MWS-R1 23KF020 - BH LOGS.GPJ ON_MOT.GDT 2023-09-22 3:14:37 PM

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CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 1

17T 541881E 4825947N

PROJECT West Montrose Covered Bridge — **PML REF.** 23KF020
LOCATION West Montrose Covered Bridge, West Montrose, Ontario — **BORING DATE** 2023-08-08 — **ENGINEER** W. Loghrin
BORING METHOD Continuous Flight Hollow Stem Augers with N Casing — **TECHNICIAN** M. Rapsey

DEPTH ELEV (metres)	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER OBSERVATIONS AND REMARKS / GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL
15.0	CONTINUED FROM PREVIOUS PAGE				
15.5 / 308.3	becoming very hard grey clayey silt, some sand, some gravel, occasional cobbles, occasonal boulders, DTPL	11	SS	113	
		12	SS	86/230 mm	
		13	SS	120	
19.7 / 304.1	BEDROCK: Dolostone, moderately to severely weathered light brown to grey, with interbeds of dark grey shale, sandstone and siltstone	14	SS	50/75 mm bouncing	
		15	RC		DEPTH (m) 19.9 — RUN (m) 0.84 — REC (%) 52 — RQD (%) 12 — WWR (%) 0
		16	RC		20.7 — 1.52 — 52 — 0 — 0
		17	RC		22.3 — 0.51 — 100 — 0 — 0
		18	RC		22.8 — 1.02 — 95 — 13 — 0 — Rock compressive strength at 22.8 m, 67.0 MPa
		19	RC		23.8 — 1.52 — 27 — 9 — 0 — Rock compressive strength at 24.5 m, 81.6 MPa
25.3 / 298.5	BOREHOLE TERMINATED AT 25.3 m				25.3 — Upon completion of drilling, artesian head of water was 2.0 m above the ground surface in cased borehole. Borehole below 19 m depth was sealed with portland cement and weighting compound.

SHEAR STRENGTH (kPa): +FIELD VANE △TORVANE ○ Qu ▲POCKET PENETROMETER ○ Q (50 100 150 200)
DYNAMIC CONE PENETRATION STANDARD PENETRATION TEST × ● (20 40 60 80)
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30 40)
UNIT WEIGHT kN/m³

NOTES
RQD (Rock Quality Designation) is the total length of those pieces of sound core which are 10 cm or greater in length in a core run expressed as a percentage of the total length of that core run. RQD is measured on minimum NQ size (nominal 50 mm diameter) cores. WWR (wash water return) is the observed fraction of drilling water which has returned to the surface during coring.

Peto MacCallum Ltd
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 2

17T 541863E 4825974N

PROJECT West Montrose Covered Bridge — **PML REF.** 23KF020
LOCATION West Montrose Covered Bridge, West Montrose, Ontario — **BORING DATE** 2023-08-08 — **ENGINEER** W. Loghrin
BORING METHOD Concrete Coring Equipment and N Casing — **TECHNICIAN** M. Rapsey

DEPTH ELEV (metres)	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER OBSERVATIONS AND REMARKS / GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL
	SURFACE ELEVATION 324.3				
0.37 / 323.89	BRIDGE DECK: 30 mm asphalt, 90 mm wood decking over 250 mm void (between joists)				
	BRIDGE PIER: 1.8 m of portland cement concrete	1	CS		
		2	CS		
		3	CS		
		4	CS		
		5	CS		
2.1 / 322.2	becoming dolostone boulders with portland cement mortar	6	CS		
		7	CS		
2.8 / 321.5	becoming concrete with cobbles/boulders	8	CS		
		9	CS		Construction coring terminated at 3.5 m due to refusal on boulder. Resumed drilling using wash boring with N casing.
3.5 / 320.8	becoming sandy gravelly cobbles and boulders, wet				El. 320.4
					Approximately 18000 Litres of water used to advance casing from 3.5 m to 6.7 m depths.
6.7 / 317.6	SAND AND GRAVEL: Very dense brownish grey fine to coarse sand and sub-rounded gravel, trace of silt, saturated	10	SS	99	45 44 9 1
8.8 / 315.5	SILT TILL: Hard brownish grey clayey silt, some fine sand, slightly to low plastic, DTPL	11	SS	100/250 mm	Approximately 11000 Litres of water used to advance casing and core remainder of the borehole.
		12	SS	39	15 7 46 32
12.2 / 312.1	layer of hard greyish brown silty clay, trace of sand, low to medium plastic, APL	13	SS	43	
	CONTINUED	14	SS	98	

SHEAR STRENGTH (kPa): +FIELD VANE △TORVANE ○ Qu ▲POCKET PENETROMETER ○ Q (50 100 150 200)
DYNAMIC CONE PENETRATION STANDARD PENETRATION TEST × ● (20 40 60 80)
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30 40)
UNIT WEIGHT kN/m³

NOTES
RQD (Rock Quality Designation) is the total length of those pieces of sound core which are 10 cm or greater in length in a core run expressed as a percentage of the total length of that core run. RQD is measured on minimum NQ size (nominal 50 mm diameter) cores. WWR (wash water return) is the observed fraction of drilling water which has returned to the surface during coring.

▼ GROUND WATER STRIKE

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LOG OF BOREHOLE NO. 2

17T 541863E 4825974N

PROJECT West Montrose Covered Bridge
PML REF. 23KF020
LOCATION West Montrose Covered Bridge, West Montrose, Ontario
BORING DATE 2023-08-08
ENGINEER W. Loghrin
BORING METHOD Concrete Coring Equipment and N Casing
TECHNICIAN M. Rapsey

DEPTH ELEV (metres)	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER OBSERVATIONS AND REMARKS
15.0	CONTINUED FROM PREVIOUS PAGE				
16.8		15	SS	87/200 mm	
307.5	GRAVELLY SAND: Very dense brown gravelly sand, some silt, saturated	16	SS	64	33 53 10 4
18.3					
306.0	COBBLES AND BOULDERS: Very dense sandy cobbles and boulders, saturated	17	RC		
19.8					
304.5	BEDROCK: Dolostone, moderately to severely weathered light brown to grey, with interbeds of dark grey shale, sandstone and siltstone	18	RC		
		19	RC		Rock compressive strength at 21.5 m, 100.9 MPa
		20	RC		Artesian pressure after RC 20
		21	RC		Rock compressive strength at 24.2 m, 69.7 MPa
25.1					
299.2	BOREHOLE TERMINATED AT 25.1 m				Upon completion of drilling and coring, borehole sealed below 6.0 m depth with bentonite, portland cement and weighting compound. From surface to 6.0 m depth, borehole sealed with grout and coarse aggregates. Approximate volume of the sealing materials used in the upper 6 m were 2 to 3 times the volume of the borehole.

SHEAR STRENGTH (kPa): +FIELD VANE △TORVANE ○ Qu ▲POCKET PENETROMETER ○ Q; 50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●; 20 40 60 80
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%); 10 20 30 40
UNIT WEIGHT kN/m³
GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL

DEPTH (m)	RUN (m)	REC (%)	RQD (%)	WWR (%)
18.9	0.28	0		0
19.2	1.52	0		0
20.7	1.60	70	8	0
22.3	1.24	25	0	0
23.6	1.52	100	12	0
25.1				

NOTES
RQD (Rock Quality Designation) is the total length of those pieces of sound core which are 10 cm or greater in length in a core run expressed as a percentage of the total length of that core run. RQD is measured on minimum NQ size (nominal 50 mm diameter) cores. WWR (wash water return) is the observed fraction of drilling water which has returned to the surface during coring.

▼ GROUND WATER STRIKE

PML - BH/TP LOG GEO/ENV WITH MWS-R1 23KF020 - BH LOGS.GPJ ON_MOT.GDT 2023-09-22 3:14:40 PM

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LOG OF BOREHOLE NO. 3

17T 541845E 4826003N

PROJECT West Montrose Covered Bridge
PML REF. 23KF020
LOCATION West Montrose Covered Bridge, West Montrose, Ontario
BORING DATE 2023-07-18
ENGINEER W. Loghrin
BORING METHOD Continuous Flight Hollow Stem Augers
TECHNICIAN D. Subburaj

DEPTH ELEV (metres)	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER OBSERVATIONS AND REMARKS
	SURFACE ELEVATION 324.2				
0.38	PAVEMENT STRUCTURE: 80 mm asphalt, 300 mm granular subbase, moist	1	SS	26	
323.78	FILL: Brown silty sand and gravel, moist	2	SS	11	
2.2		3	SS	12	
322.0	becoming brown silty sand, trace to some black coal pieces, trace organics, moist	4	SS	2	
		5	SS	5	
4.0		6	SS	6	
320.2	becoming black/grey, some organics, moist				
4.6		7	SS	23	
319.6	SAND: Compact fine to medium brown sand, trace silt, saturated				
5.1		8	SS	12	
319.1	SAND AND GRAVEL: Compact to dense grey sand and gravel, trace to some silt, saturated				
6.6		9	SS	34	
317.6	SANDY SILT: Dense grey sandy silt, trace clay, saturated	10	SS	32	
8.5					
315.7	SAND: Dense fine to medium brown sand, trace silt, saturated	11	SS	47	
9.4					
314.8	SILT TILL: Hard grey clayey silt, trace sand, DTPL	12	SS	66	
12.5		13	SS	100	
311.7	occasional silt layers, wet	14	SS	72	
	CONTINUED				

SHEAR STRENGTH (kPa): +FIELD VANE △TORVANE ○ Qu ▲POCKET PENETROMETER ○ Q; 50 100 150 200
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●; 20 40 60 80
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%); 10 20 30 40
UNIT WEIGHT kN/m³
GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL

62
El. 319.6
45 34 18 4

NOTES

▼ GROUND WATER STRIKE

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CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 3

17T 541845E 4826003N

PROJECT West Montrose Covered Bridge — **PML REF.** 23KF020

LOCATION West Montrose Covered Bridge, West Montrose, Ontario — **BORING DATE** 2023-07-18 — **ENGINEER** W. Loghrin

BORING METHOD Continuous Flight Hollow Stem Augers — **TECHNICIAN** D. Subburaj

DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH (kPa) +FIELD VANE △TORVANE ○Qu ▲POCKET PENETROMETER ●Q; DYNAMIC CONE PENETRATION × STANDARD PENETRATION TEST ●	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%)	UNIT WEIGHT kN/m³	GROUND WATER OBSERVATIONS AND REMARKS; GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL
15.0	CONTINUED FROM PREVIOUS PAGE						50 100 150 200; 20 40 60 80	10 20 30 40		
15.2										
309.0	occasional silt layers, moist		15	SS	48	309				
17.1										
307.1	GRAVELLY SAND: Very dense grey gravelly sand, some silt, wet to saturated		16	SS	71	307				
18.4										
305.8	BOREHOLE TERMINATED AT 18.4 m. No further progress due to hydraulic condition.		17	SS	55/75 mm	306				Borehole terminated due to sand heave inside casing after SS17. Upon completion of augering cave at 16.8 m and free water at 5.0 m

NOTES

▼ GROUND WATER STRIKE

PML - BH/TP LOG GEO/ENV WITH MWS-R1 23KF020 - BH LOGS.GPJ ON_MOT.GDT 2023-09-22 3:14:42 PM

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LOG OF BOREHOLE NO. 1A

17T 541880E 4825950N

PROJECT West Montrose Covered Bridge — **PML REF.** 23KF020

LOCATION West Montrose Covered Bridge, West Montrose, Ontario — **BORING DATE** 2023-08-08 — **ENGINEER** W. Loghrin

BORING METHOD Ramsounder — **TECHNICIAN** D. Subburaj

DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH (kPa) +FIELD VANE △TORVANE ○Qu ▲POCKET PENETROMETER ●Q; DYNAMIC CONE PENETRATION × STANDARD PENETRATION TEST ●	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%)	UNIT WEIGHT kN/m³	GROUND WATER OBSERVATIONS AND REMARKS; GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL
	SURFACE ELEVATION 324.0						50 100 150 200; 20 40 60 80	10 20 30 40		
0.25	PAVEMENT STRUCTURE: 70 mm asphalt, over granular base, moist		1	SS	20	323				
323.79	FILL: Compact brown sand and gravel, occasional cobbles and boulders, moist		2	SS	19					
1.5										
322.5	becoming loose to compact brown silty sand and gravel, moist		3	SS	6	322				
			4	SS	6					
			5	SS	23	321				
4.5			6	SS	8					
319.4	occasional pieces of wood					320				
	BOREHOLE TERMINATED AT 4.6 m. No further progress due to split spoon refusal on wood.									Upon completion of sampling open and dry.

NOTES

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LOG OF BOREHOLE NO. 1B

17T 541879E 4825950N

PROJECT West Montrose Covered Bridge — **PML REF.** 23KF020

LOCATION West Montrose Covered Bridge, West Montrose, Ontario — **BORING DATE** 2023-08-11 — **ENGINEER** W. Loghrin

BORING METHOD Concrete Coring Equipment — **TECHNICIAN** D. Subburaj

DEPTH (metres)	ELEV	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH (kPa) + FIELD VANE △ TORVANE ○ Qu ▲ POCKET PENETROMETER ○ Q; DYNAMIC CONE PENETRATION × STANDARD PENETRATION TEST ●	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%)	UNIT WEIGHT kN/m³	GROUND WATER OBSERVATIONS AND REMARKS; GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL
		SURFACE ELEVATION 324.1						50 100 150 200; 20 40 60 80	10 20 30 40		
0.0	324.04	PAVEMENT STRUCTURE: 50 mm asphalt					324				
		CONCRETE: Portland cement concrete (Abutment), numerous cobbles, occasional boulders		1	CS						At 0.6 m depth, concrete density 2,431 kg/m3 with compressive strength of 36.7 MPa.
				2	CS						
				3	CS		323				
				4	CS						
1.0	1.6			5	CS						
	322.5	BOREHOLE TERMINATED AT 1.6 m. No further progress due to core refusal on boulder.									Upon completion of coring open and no free water.
2.0											
3.0											
4.0											
5.0											
6.0											
7.0											
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											

NOTES

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LOG OF BOREHOLE NO. 3A

17T 541847E 4825999N

PROJECT West Montrose Covered Bridge — **PML REF.** 23KF020

LOCATION West Montrose Covered Bridge, West Montrose, Ontario — **BORING DATE** 2023-08-08 — **ENGINEER** W. Loghrin

BORING METHOD Ramsounder — **TECHNICIAN** D. Subburaj

DEPTH (metres)	ELEV	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	ELEVATION SCALE	SHEAR STRENGTH (kPa) + FIELD VANE △ TORVANE ○ Qu ▲ POCKET PENETROMETER ○ Q; DYNAMIC CONE PENETRATION × STANDARD PENETRATION TEST ●	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%)	UNIT WEIGHT kN/m³	GROUND WATER OBSERVATIONS AND REMARKS; GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL
		SURFACE ELEVATION 324.2						50 100 150 200; 20 40 60 80	10 20 30 40		
0.0	0.25	PAVEMENT STRUCTURE: 70 mm asphalt, over granular base									
	323.93	FILL: Brown sand and gravel, occasional cobbles and boulders, moist		1	SS	14	324				
				2	SS	6					
1.0	1.8										
	322.4	occasional layers of brown silty sand, moist		3	SS	2					
				4	SS	4	323				
2.0	3.1										
	321.1	occasional layers of dark reddish brown silty sand, moist		5	SS	2					
				6	SS	0					
3.0	4.5						322				
	319.6	occasional pieces of wood									
4.0		BOREHOLE TERMINATED AT 4.6 m. No further progress due to split spoon refusal on wood pieces.									Upon completion of sampling open and dry.
							321				
5.0											
6.0											
7.0							320				
8.0											
9.0											
10.0											
11.0											
12.0											
13.0											
14.0											
15.0											

NOTES

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CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 3B

17T 541847E 4825999N

PROJECT West Montrose Covered Bridge — **PML REF.** 23KF020

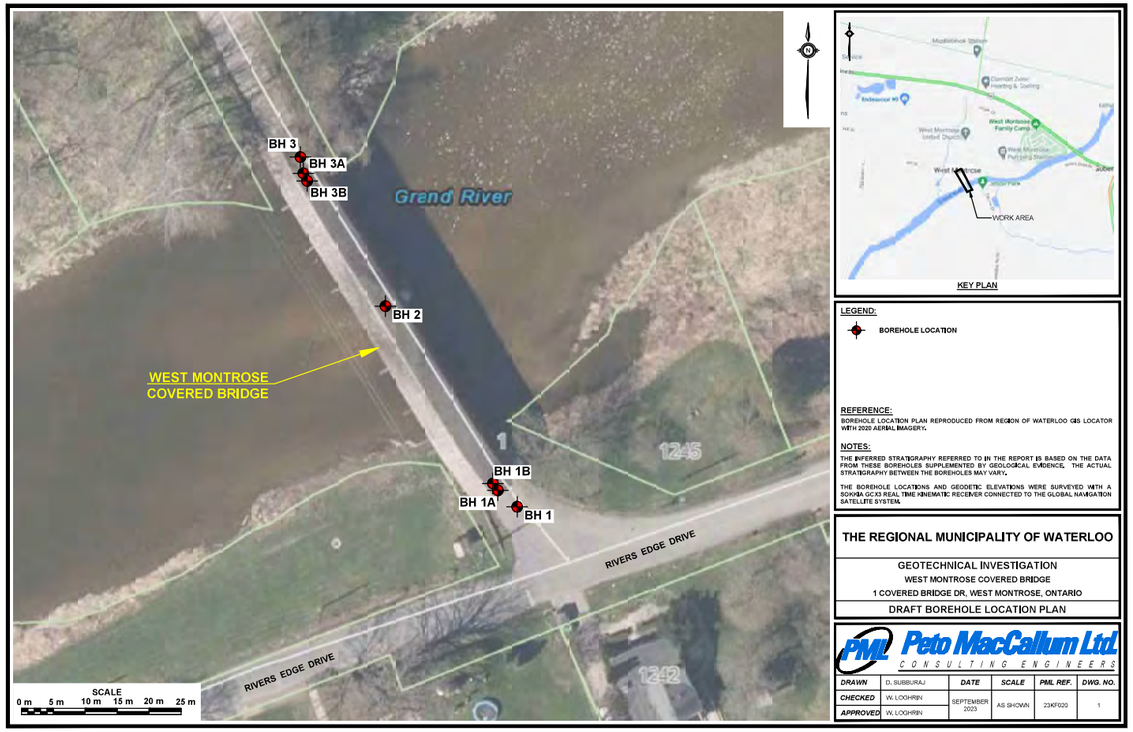
LOCATION West Montrose Covered Bridge, West Montrose, Ontario — **BORING DATE** 2023-08-09 — **ENGINEER** W. Loghrin

BORING METHOD Concrete Coring Equipment — **TECHNICIAN** D. Subburaj

DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	SHEAR STRENGTH (kPa) +FIELD VANE △TORVANE ○ Qu ▲POCKET PENETROMETER ○ Q; DYNAMIC CONE PENETRATION ×; STANDARD PENETRATION TEST ●	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%)	UNIT WEIGHT kN/m³	GROUND WATER OBSERVATIONS AND REMARKS; GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL
	SURFACE ELEVATION 324.2						50 100 150 200; 20 40 60 80	10 20 30 40		
0.20 / 324.01	CONCRETE: Portland cement concrete (Abutment), occasional cobble, occasional steel wire		1	CS		324				
	inclusion of steel wire		2	CS						
			3	CS						
			4	CS		323				
			5	CS						
			6	CS						
			7	CS		322				
			8	CS						
			9	CS						
			10	CS		321				
			11	CS						
4.4 / 319.8	occasional cobbles, occasional boulders		12	CS						At 4.1 m depth, concrete density 2,249 kg/m3 with compressive strength of 22.0 MPa.
			13	CS		320				
5.1 / 319.1	SAND AND GRAVEL: Very dense grey sand and gravel, occasional cobbles, occasional boulders, saturated		14	CS						
	BOREHOLE TERMINATED AT 5.1 m		15	SS	50 blows / 0 mm					Upon completion of coring open and free water at 5.0 m.

NOTES

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STATEMENT OF LIMITATIONS

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The report is based solely on the scope of services which are specifically referred to in this report. No physical or intrusive testing has been performed, except as specifically referenced in this report. This report is not a certification of compliance with past or present regulations, codes, guidelines and policies.

The scope of services carried out by PML is based on details of the proposed development and land use to address certain issues, purposes and objectives with respect to the specific site as identified by the client. Services not expressly set forth in writing are expressly excluded from the services provided by PML. In other words, PML has not performed any observations, investigations, study analysis, engineering evaluation or testing that is not specifically listed in the scope of services in this report. PML assumes no responsibility or duty to the client for any such services and shall not be liable for failing to discover any condition, whose discovery would require the performance of services not specifically referred to in this report.

The findings an comments made by PML in this report are based on the conditions observed at the time of PML's site reconnaissance. No assurances can be made and no assurances are given with respect to any potential changes in site conditions following the time of completion of PML's field work. Furthermore, regulations, codes and guidelines may change at any time subsequent to the date of this report and these changes may affect the validity of the findings and recommendations given in this report.

STATEMENT OF LIMITATIONS

The results and conclusions with respect to site conditions are therefore in no way intended to be taken as a guarantee or representation, expressed or implied, that the site is free from any contaminants from past or current land use activities or that the conditions in all areas of the site and beneath or within structures are the same as those areas specifically sampled.

Any investigation, examination, measurements or sampling explorations at a particular location may not be representative of conditions between sampled locations. Soil, ground water, surface water, or building material conditions between and beyond the sampled locations may differ from those encountered at the sampling locations and conditions may become apparent during construction which could not be detected or anticipated at the time of the intrusive sampling investigation.

Budget estimates contained in this report are to be viewed as an engineering estimate of probable costs and provided solely for the purposes of assisting the client in its budgeting process. It is understood and agreed that PML will not in any way be held liable as a result of any budget figures provided by it.

The Client expressly waives its right to withhold PML's fees, either in whole or in part, or to make any claim or commence any action or bring any other proceedings, whether in contract, tort, or otherwise against PML in anyway connected with advice or information given by PML relating to the cost estimate or Environmental Remediation/Cleanup and Restoration or Soil and Ground Water Management Plan Cost Estimate.

Appendix J

Bridge Hydraulic Report

The Regional Municipality of Waterloo

West Montrose Covered Bridge Rehabilitation

Bridge Hydraulic Engineering Report

December 2023



SANCHEZ ENGINEERING INC.

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1 Introduction

The Region of Waterloo retained the Entuitive/BTE Team to undertake the timber truss assessment and design of the required rehabilitation of the West Montrose Covered Bridge. The Project extends from Hill Street to River's Edge Drive in the Township of Woolwich. The Project Location is shown in Figure 1 – Location Plan.



Figure 1 - Location Plan

The purpose of this Report is to summarize the hydraulic considerations and calculations made in support of the assessment of the bridge rehabilitation alternatives and the detailed design of the recommended bridge rehabilitation measures.

1.1 Description of the Bridge

The West Montrose Covered Bridge is a two-span covered timber bridge constructed in 1881. Each of the two bridge spans is 30.02 m± (98.5 ft) long, for a total bridge length of 60.04 m± (197.0 ft). The bridge carries one lane of traffic with a 3-tonne posted load limit. From 1950 to 1965, major rehabilitation works were undertaken by the Ministry of Transportation Ontario (MTO) to strengthen the structure. This included the addition of steel Bailey trusses placed within the timber trusses and reconstruction of the bridge deck and the substructure.

The Region of Waterloo took ownership of the bridge in 1998 and undertook a major rehabilitation of the bridge in 1999. Portions of the steel Bailey trusses were upgraded. Various wooden components were also replaced. Rehabilitation works continued to be undertaken on the bridge from 1999 onwards. The northwest bearing seat of the timber truss was reconstructed in 2011. A cracked timber floor beam was discovered in 2012 and another two cracked floor beams were discovered in September 2019 and replaced. On both occasions, it is believed that the passage of

an overweight vehicle caused damage to the floor beams.

The bridge is one of the last remaining covered bridges in Ontario and forms an integral part of the Cultural Heritage landscape in West Montrose. The Region of Waterloo recognizes the bridge as a Regionally Significant Cultural Heritage Resource (RSCHR). The Township of Woolwich enacted Designation By-Law No. 60-2007, to designate the West Montrose Covered Bridge under Section 27, Part IV of the Ontario Heritage Act on August 14, 2007.

2 Existing Conditions

2.1 Bridge Hydraulic Characteristics

The Grand River Conservation Authority (GRCA) provided the HEC-RAS model of the Grand River between the Elora Gorge (upstream limit) to below Sawmill Road at the downstream end. The results of the model were set as the existing conditions.

The existing waterway consists of two 30.02 m± long spans. The abutments have a vertical face from the riverbed to the bearing level and have wingwalls on all bridge quadrants. The stone-faced pier is 1.32 m± wide at the bearing level and 2.2 m± wide at its base.

The GRCA HEC-RAS model provides the peak flow data for the reach of the Grand River that includes the bridge, summarized in Table 1.

Table 1 - GRCA Flow Data

Flood Event	Description	Total Discharge (m^3/s)
2-yr	2-year flood	331.0
5-yr	5-year flood	464.0
10-yr	10-year flood	603.0
25-yr	25-year flood	718.6
50-yr	50-year flood	827.0
100-yr	100-year flood	910.0
Nat Reg	Regional Storm flood with no regulation	1540.0
Reg Reg	Regional Storm flood with flow regulation	1356.0

The GRCA HEC-RAS model provides the following hydraulic data at the bridge, summarized in Table 2. The HEC-RAS datum is the CGVD28 datum. Thus, the water surface elevations have been adjusted to the project datum by subtracting 0.42 m to convert them to CGVD2013 datum, which is the survey datum used for this project.

From Table 2 it can be observed that the bridge can convey the 50-year flood with no vertical clearance to the underside of the floor/needle beams on the upstream side of the bridge. From the section shown in Figure 2 it can be observed that the 2-year flood will overtop River's Edge Drive and floodwaters will flow around the south bridge approach.

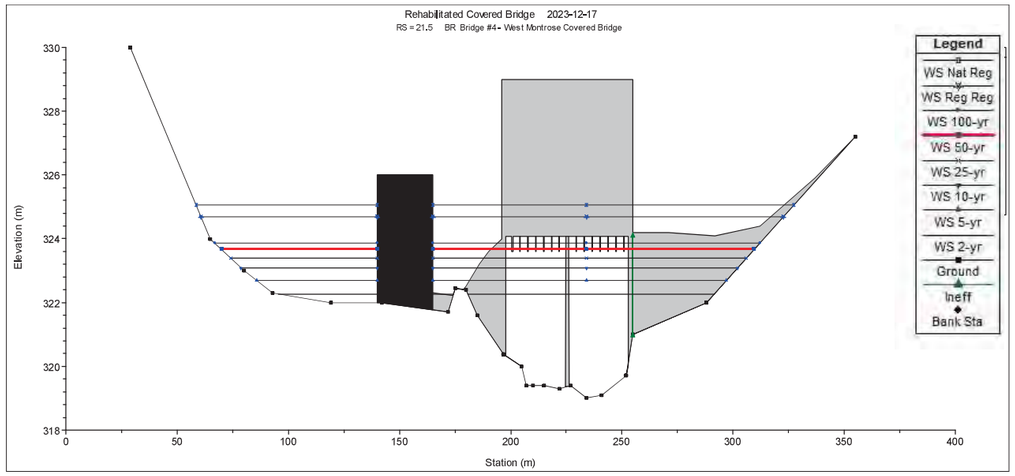


Figure 2 - Water surface elevation at upstream section of rehabilitated bridge

In Figure 2, the black area represents the house directly across the bridge (1242 Rivers Edge Drive) on the south approach, and the grey area represents the road embankment, the pier, the bridge deck, and the bridge superstructure.

The configuration of the south approach and the river overbanks upstream and downstream of the bridge results in the south approach being overtopped by the 2-year and larger floods, which provides relief flow to the bridge's waterway opening for all floods. During the 2-year flood, the south approach and the lands beyond it will be flooded by approximately 0.2 m of water.

Table 2 – Flow conditions at bridge after rehabilitation					
River Station See Figure 3 for locations	**Flood Event**	**Water Surface Elevation (m)**	**Lowest Soffit Elevation at bottom of floor beams (m)**	**Vertical Clearance to Lowest Soffit Elevation (m)**	**Flow Velocity in Channel (m/s)**
23	2-yr	321.94	323.187	1.25	1.97
23	5-yr	322.41	323.187	0.78	2.27
23	10-yr	322.84	323.187	0.35	2.46
23	25-yr	323.16	323.187	0.03	2.61
23	50-yr	323.42	323.187	-0.23	2.74
23	100-yr	323.72	323.187	-0.53	2.48
23	Nat Reg	324.80	323.187	-1.61	3.03
23	Reg Reg	324.46	323.187	-1.27	2.93
21.5 BRIDGE Upstream	2-yr	321.85	323.187	1.34	2.20
21.5 BRIDGE Upstream	5-yr	322.27	323.187	0.92	2.58
21.5 BRIDGE Upstream	10-yr	322.67	323.187	0.52	2.85
21.5 BRIDGE Upstream	25-yr	322.97	323.187	0.22	3.03
21.5 BRIDGE Upstream	50-yr	323.25	323.187	-0.06	3.08
21.5 BRIDGE Upstream	100-yr	323.45	323.187	-0.26	3.13
21.5 BRIDGE Upstream	Nat Reg	324.64	323.187	-1.45	3.20
21.5 BRIDGE Upstream	Reg Reg	324.26	323.187	-1.07	3.25
21.5 BRIDGE Downstream	2-yr	321.83	323.187	1.36	2.23
21.5 BRIDGE Downstream	5-yr	322.22	323.187	0.97	2.67
21.5 BRIDGE Downstream	10-yr	322.57	323.187	0.62	3.04
21.5 BRIDGE Downstream	25-yr	322.82	323.187	0.37	3.31
21.5 BRIDGE Downstream	50-yr	323.02	323.187	0.17	3.55
21.5 BRIDGE Downstream	100-yr	323.15	323.187	0.04	3.73
21.5 BRIDGE Downstream	Nat Reg	324.20	323.187	-1.01	4.30
21.5 BRIDGE Downstream	Reg Reg	323.87	323.187	-0.68	4.15



Figure 3 – Location of HEC-RAS cross-sections at bridge

In Table 2 the lowest (minimum) soffit elevation is the bottom of the floor and needle beams. The minimum bottom chord elevation is 0.406 m higher (323.662 m).

The minimum soffit elevation determines the elevation at which ice and debris could impact the bridge. The minimum bottom chord elevation is relevant for the calculation of the hydrostatic and hydrodynamic loads on the superstructure, as discussed in Section 5.

3 Hydraulic Design Criteria

The work is being carried out based on the following Ministry of Transportation documents:

- MTO Drainage Management Manual, 1997
- MTO Highway Drainage Design Standards, 2008
- All other applicable reports, manuals, directives, Provincial engineering memos, guidelines, standards, and relevant publications.

However, the design of the Covered Bridge rehabilitation requires adaptation of the requirements noted, due to the site and structure constraints, as discussed below.

3.1 Bridge Hydraulic Design Criteria

3.1.1 Desirable Bridge Hydraulic Design Criteria

The desirable bridge design criteria are determined by *Standard WC-1* in the Highway Drainage Design Standards, 2008. Based on this standard, with the road designed as a collector road, the required design flow return period for the project is 50 years for structures with total span longer than 6.0 m.

Standard WC-2 – Freeboard and Clearance at Bridge Crossings requires a minimum freeboard, measured from the energy grade elevation to the edge of the travel lane, of 1.0 m on freeways, arterials, and collectors.

The Desirable Bridge Hydraulic Design Criteria are summarized in Table 3.

Table 3 – Desirable Bridge Hydraulic Design Criteria	
Design Flood (span greater than 6.0 m)	50-year flood
Check Flood for scour	115% of 100-year flood
Vertical clearance	≥1.0 m
Freeboard	≥1.0 m
Check Flood Headwater Level	Below edge of travel lane

3.1.2 Actual Hydraulic Design Criteria

The Value Engineering component of the project investigated alternative modifications, including raising the bridge to provide additional vertical clearance, adding spans to reduce the headwater levels, and others. However, they were found unfeasible or to have significant negative effects. Consequently, the bridge will be rehabilitated while maintaining its existing approaches and structure elevations.

For Low Volume roads, with AADT < 400, the Standard allows for less stringent requirements. Since the road is a low volume collector road, Standards WC-1 and WC-2 allow the minimum hydraulic design criteria listed in Table 4.

Table 4 – Minimum Bridge Hydraulic Design Criteria	
Design Flood (span greater than 6.0 m)	50-year flood
Check Flood for scour	50-year flood
Vertical Clearance	≥0.3 m
Freeboard	Edge of travel lane
Check Flood Headwater Level	Below edge of travel lane

However, the existing configuration of the road and the bridge does not allow the project to meet all the criteria listed in Table 4. At this site, the south approach (Rivers Edge Drive) will be flooded by floods with return periods less than 2-years (it is flooded by about 0.2 m during the 2-year flood, as noted in the discussion regarding Figure 2). The freeboard is sub-standard: The south approach is very low and the road starts flooding during the 2-year flood (strictly, during floods smaller than the 2-year flood). Thus, the freeboard requirement cannot be met. The bridge span and its soffit are fixed, for practical purposes, so the vertical clearance requirement cannot be met.

Given the overall site and bridge configuration and the resulting limitations, it was agreed that the design will be based on the following criteria:

a. The bridge rehabilitation must result in no increase in water levels upstream of the crossing.
b. The bridge waterway dimensions must not be reduced (clear spans, soffit elevations).
c. Any proposed scour protection added to the bridge must not significantly reduce the available waterway opening area.
d. The bridge rehabilitation will be designed for the hydrostatic and hydrodynamic loads imposed by the Regional Storm.
e. The assessment of the potential vulnerability of the bridge to scour and any scour mitigation measures will be based on the Design Flood (50-year flood).

4 Proposed Improvements to Bridge

The technically preferred rehabilitation alternative was selected at the meeting of September 14, 2023, using the Multi-Attribute Trade-off System (MATS) methodology. The proposed improvements to the bridge will slightly raise the bridge soffit minimum elevations. The waterway dimensions will remain essentially unchanged. As a result, it can be affirmed that there will be no effects on the various flood water levels at and upstream of the bridge.

As part of the analysis, HEC-RAS models of the existing and proposed bridge configurations were prepared based on the latest drawings of the bridge. Water surface calculations based on the revised HEC-RAS models confirm that the proposed bridge rehabilitation will cause no changes to the water levels at or upstream of the bridge.

4.1 Soffit Elevation

At this site, flooding will commence at flows that are more frequent than the 2-year flood event. As noted in Figure 2, there is a significant discharge in the south overbank of the river. For the design flood (50-year flood), the water level will be 6 cm± above the elevation of the floor beams but below

the elevation of the truss low chord. The 25-year flood headwater level will be 22 cm± lower than the bottom of the floor beams.

Raising the structure to provide the required vertical clearance to the soffit elevation was considered during the study process, but it was concluded that the potential effects of raising the bridge on the approaches are severe, such as impact on properties near the approaches and the risk to the structure when raising it.

As a result, it was recommended that the soffit elevation be maintained at its existing elevation; or raised nominally to eliminate the existing sagging of the bridge lower chord. The final minimum soffit elevation (measured at the bottom of the floor beams) is 323.187 m, which is 2 cm± higher than the existing soffit elevation (323.165 m). Removal of the steel hardware and cables will reduce the possibility of debris or ice floes snagging the underside of the bridge.

As noted after Figure 2, the bottom chord lowest elevation will be 323.662 m, which is higher than the 50-year flood headwater level. The vertical clearance during the design flood, measured to the minimum low chord elevation, will be 0.24 m.

5 Hydraulic Forces on the Bridge

5.1 Bridge Superstructure

The expected hydraulic forces on the bridge superstructure comprise the following:

a. The unbalanced lateral hydrostatic pressure resulting from the difference in water levels at the upstream and downstream faces of the bridge.
b. Hydrostatic lift (buoyancy) caused by the uplift pressure on the bottom of the superstructure.
c. Hydrodynamic drag forces created by the flow velocities through the waterway opening.
d. Hydrodynamic uplift forces and torsional moment resulting from the submergence of the superstructure during flood events where the flood levels are above the bridge soffit.

The hydrostatic lateral forces, hydrodynamic drag forces, uplift forces, and moment about the centre of gravity of the deck were estimated using the methodology presented in *Hydrodynamic Forces on Inundated Bridge Decks, FHWA Publication FHWA-HRT-09-028, May 2009* (FHWA 2009 Report).

The FHWA 2009 Report methodology is based on Computational Fluid Dynamics (CFD) and physical models based on dimensional analysis of three bridge type configurations, namely a 6-girder bridge, a 3-girder bridge, and a streamlined bridge.

The FHWA 2009 Report takes into account the waterway height (height of the soffit above the bottom of the stream), total depth of flow, depth of the superstructure, width of the bridge, and the flow velocity. Figure 4, showing Figure 1 of the FHWA 2009 Report, illustrates these parameters.

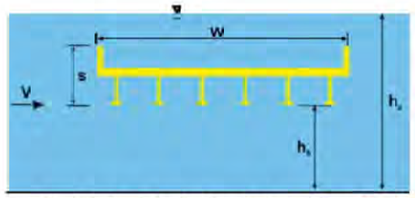


Figure 1. Diagram. Scaled six-girder bridge deck model used in assessments of drag and lift forces and the nomenclature for bridge deck and flume dimensions.

Figure 4 – Definition of variables used in the hydraulic model for determination of forces on bridge (Figure 1 of the FHWA 2009 Report)

Based on the calculated inundation ratio (a ratio of the total depth of flow, the waterway height, and the structure depth), the methodology provides equations for the hydrodynamic drag, lift, and moment based on the corresponding coefficients. Values of the maximum and minimum values of the coefficients can be computed based on regression equations presented in the FHWA 2009 Report.

Figure 5, showing Figure 4 of the FHWA 2009 Report, illustrates the definition of the forces and moment.

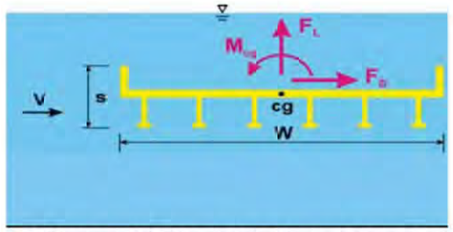


Figure 4. Diagram. Definition sketch of forces acting on bridge deck.

Figure 5 – Definition sketch of forces acting on bridge deck (Figure 4 of FHWA 2009 Report)

Lateral Hydrostatic Forces

Lateral hydrostatic pressures on the bridge will be caused by the water depth above the soffit of the bridge. Due to the difference between the upstream and downstream water levels, there will be a net force pushing the bridge downstream. This effect is in addition to the hydrodynamic forces discussed below.

Hydrostatic Lift Forces (Buoyancy)

Generally, a hydrostatic upward pressure from the flood will be applied in addition to the hydrodynamic forces. Given the differential water level across the bridge superstructure, the uplift pressure will be highest at the upstream face and will diminish across the deck.

As the flood rises above the road, it will inundate the bridge deck approximately to the level of the tailwater level, producing a counterweight to the buoyance forces and reducing but not completely counteracting the buoyance pressures. The flood will exert a net upward hydrostatic force that will

tend to lift the bridge.

Hydrodynamic Drag Forces

The drag force per linear metre of span was determined using the 6-girder model evaluated in the FHWA 2009 report. For the calculation of the hydrodynamic drag forces on the superstructure, the relevant elevation is the bottom of the low chord. The floor beams and the needle beams will not exert a significant resistance to flow and the difference in depth can be ignored. The sign convention defines positive drag forces acting in the direction of flow.

Hydrodynamic Lift

The lift force per linear metre of span was determined using the 6-girder model evaluated in the FHWA 2009 report. The sign convention defines positive lift acting vertically up. Thus, a negative value signifies that the flow pulls down on the bridge. The physical explanation is akin to the pressures on a hydrofoil.

Hydrodynamic Moment

The hydrodynamic moment per linear metre of span was determined using the 6-girder model evaluated in the FHWA 2009 report. The sign convention defines a positive value as a moment that acts counterclockwise when looking at a section of the bridge.

Summary of Hydraulic Actions

The ranges of hydrostatic and hydrodynamic forces per metre of bridge span were calculated based on the maximum and minimum values for the various coefficients, based on the calculated water levels and flow velocities for the Regional Storm without regulation (Nat Reg).

The estimated range of forces and moments is provided in Table 5. The calculations are included in Appendix A.

Table 5 – Hydraulic Forces on Superstructure per m of span

Force	Unit	Direction	Maximum Value	Minimum Value
Hydrostatic Force	kN	Horizontal	6.4	-
Hydrostatic Uplift (Buoyancy)	kN	Vertical	22.5	-
Hydrodynamic Drag	kN	Horizontal	11.4	9.1
Hydrodynamic Lift	kN	Vertical	-0.14	-0.21
Hydrodynamic Moment	kN-m	Torsion	0.15	-0.06

The values in Table 5 must be multiplied by the span length to obtain the total forces on the bridge.

5.2 Bridge Substructure

The forces in Table 5 will apply to the substructure as the forces are transmitted to it by the supports. In addition to these forces, the flood will impose forces directly on the pier, namely flow drag force and ice loads. The calculation of these forces is included in Appendix B.

Hydrodynamic Drag Force on Pier

The methodology for calculation of the hydrodynamic drag force on the pier is covered in the

Canadian Highway Bridge Design Code. For the semicircular nose pier, the estimated force P is 23.6 kN, based on a drag coefficient of 0.7 (Table 3.11 of the Code), flow velocity of 3.1 m/s, and pier projected area of 7.0 m^2. The flow velocity is calculated at the cross-section immediately upstream of the bridge.

Ice Load

The ice load was estimated based on Section 3.12.2 of the CHBDC. The estimated load on the pier from ice floe impact is 445 kN based on ice thickness of 300 mm and effective ice strength of 700 kPa. The design cases are governed by CHBDC Clause 3.12.2.3.

5.3 Ice Jams

Although ice jams have occurred in this reach of the Grand River, they commonly are initiated downstream of the bridge. There have been ice jams near the bridge, and the ice has risen near the soffit of the bridge. The most recent event occurred on February 5, 2019, which appears to have been a significant ice jam, based on comments by local residents (per news accounts). Photos of the aftermath of the ice jam are presented below.



Note the ice floes on the road.

(Woolwich Observer, February 7, 2019)

	Note the ice floes on the road, and the ice edge which appears to be a high water mark. (Woolwich Observer, February 7, 2019)
	Ice floes on the banks and the road (From X @MarkLPare)
	The ice levels reached about half-way from normal water level to the underside of the bridge. From X @MarkLPare

	The ice floes left on the far bank indicate a high water level about the 0.6 m below the porch of the house. From LiDAR data, the elevation is 322.5. The 2-year flood water level is 322.4 m±. From X @MarkLPare

Based on the location of the grounded ice floes, it appears that the maximum water level during the ice jam was approximately equal to the 2-year flood water level.

Because ice jams occur downstream of the bridge, the effect on the bridge is a high water level event, but the loads on the bridge are not expected to be abnormal. The provisions made in Section 5.1 and 5.2 cover the expected range of hydraulic loads on the bridge.

Regardless, CHBDC Clause 3.12.4 specifies that for clear openings of less than 30 m between the shoreline and the pier (the case for this bridge), a pressure of 10 kPa shall be considered to act against the pier. The force shall be applied above the level of still water for the expected thickness of the ice jam, both laterally and in the direction of the flow. Based on the previous discussion, we recommend that the still water level be set equal to the 2-year flood level (322.4 m±).

6 Scour Potential

6.1 Flow Velocities through Bridge Waterway

Table 6 summarizes the calculated portion of the flood that will flow through the bridge waterway opening. The remainder of the flood will flow over the approaches. The bridge waterway opening area is 245.4 m^2±.

Table 6 –Average Flow Velocities through Bridge Waterway

Flood Event	Flowrate through Opening (m^3/s)	Average Flow Velocity (m/s)
2-year flood	327	2.2
5-year flood	442	2.6
10-year flood	547	2.9
25-year flood	628	3.0
50-year flood	686	3.1
100-year flood	727	3.1
Regional Storm flood with no regulation	774	3.2
Regional Storm flood with flow regulation	789	3.3

The scour protection will be designed based on the 50-year flood.

6.2 Calculated Scour Depths

The scour depth calculation was based on the findings of the geotechnical investigation completed by Peto MacCallum Limited (PML) in the summer of 2023, presented in their draft report dated September 22, 2023 (PML Draft Report).

From the reported borehole logs and the gradation curves for the soil samples tested by PML, it was concluded that the soils encountered within the top 10 m below the existing streambed (approximate average elevation 318.5 m) consist of sand and gravel, sandy gravelly cobbles and boulders at the pier, and sand, overlaying a silt till at elevation 315.1 to 314.8 m, overtop of gravelly sand at elevation 307.1 m to 307.5 m.

The soils above elevation 307.1 have D_{50} diameters ranging from 0.005 mm (silt till) to 4 mm (sand and gravel). The maximum permissible velocities for these soils range from 0.5 m/s to 0.6 m/s. Since the average flow velocities through the bridge opening range from 2.2 m/s for the 2-year flood (Flow through opening = 327 m^3/s) to 3.7 m/s for the Regional Storm flood (Flow through opening = 789 m^3/s), it can be expected that the streambed will erode to provide a flow area 3.3 to 5.5 times greater than the existing waterway area.

Calculations of the potential unrestricted scour using the HEC-RAS Hydraulic Design Function indicate the scour could reach depths greater than 10 m at the pier and the abutments.

However, the calculated scour depth does not reflect the behaviour of the streambed during large floods, as discussed in the next section.

6.3 Scour Estimates Based on Observed Scour

6.3.1 Observed Scour

The Water Survey of Canada has a streamflow gauging station at the bridge (Station 02GA034 – Grand River at West Montrose. The station is a recording station, in operation since 1968. Streamflow has been recorded continuously since 1968. Based on the records, annual maximum peak discharge values are available for all years except for 1980, 1999, 2000, and 2001. A total of 50 records are available for analysis.

The largest flood recorded at the site took place on May 17, 1974, with a peak discharge of 674 m^3/s. The second largest event was in April 1972 with a peak discharge of 634 m^3/s. These discharges correspond to return periods of approximately 17 years and 14 years, respectively, based on the flood frequency data provided by the GRCA (See Table 1).

Flood frequency analysis of the annual maxima recorded at the gauge would indicate that the May 1974 flood had a return period of 100 years. However, the flowrates recorded at the gauge are affected by the regulation afforded by the Shand Dam. The results of the flood frequency analysis are included in Appendix C.

As noted in the PML Draft Report, some scour has affected the stonework on the upstream side of the pier, causing the stone to settle. The PML Draft Report recommends scour protection.

Based on the soil sizes found in the soil grain size distribution, the streambed should start to move at a flow velocity of about 1.0 m/s. It does not, which indicates that there is an armouring layer on

the streambed that is preventing significant scour at flows as high as the May 1974 flood. In general terms, it appears that the observed scour relative to the peak flowrates measured in the past 55 years has been substantially lower than predicted by the scour calculations discussed in Section 6.2.

The calculated average flow velocity through the bridge opening for the May 1974 flood is 3.1 m/s. If it is accepted that the streambed can resist at least that flow velocity without large local scour, the flow velocity for the May 1974 flood can be defined as the competent velocity for the streambed. This velocity will be labelled $V_{05\text{-}74}$. Floods that produce higher flow velocities inside the bridge will cause general scour until the flow velocity is equivalent to $V_{05\text{-}74}$, and smaller floods will pass through the bridge without scouring the streambed. This is exactly what has been observed.

6.3.2 Contraction Scour

Using $V_{05\text{-}74}$ as a basis, the depth of contraction scour for the 50-year flood (686 m^3/s through the bridge) is 0.2 m below the existing streambed elevation. Calculation of the contraction scour based on the methods in FHWA HEC-18 – Evaluating Scour at Bridges, 5th Edition, provides an estimated contraction scour through the bridge of 0.9 m. Methods proposed in the National Engineering Handbook, Technical Supplement 14B, result in estimates between 0.3 m and 0.6 m. Given the wide variation, it is proposed to use a value of 0.3 m, which reflects the experience at the crossing.

6.3.3 Pier Scour

Pier scour was calculated using the methodology provided in HEC-18 and the Florida Department of Transportation (Florida DOT) Bridge Scour Manual. The estimated pier scour depth is 2.5 m, which means the total scour at the pier will be 2.8 m. Therefore, protection measures are warranted to prevent damage to the bridge.

6.3.4 Abutment Scour

Abutment scour was estimated using the methodology provided in HEC-18. The estimated abutment scour depth is 1.5 m. below the elevation of the existing ground. Although the south abutment is set back from the streambank, it is proposed to apply the same depth of scour to both abutments.

7 Scour Protection

As discussed in Section 6, there is potential for scour of the streambed at the bridge abutments and the pier. It is necessary to provide scour protection to the abutments and the pier. The recommended scour protection is presented Figure 6.

7.1 Abutments

A layer of rock protection at the abutment should be provided extending 3.5 m into the watercourse, to act as a launching apron. The design flow velocity through the opening is 3.1 m/s, which requires stone with D_{50} diameter of 300 mm, placed in a layer 600 mm thick. The rock protection should be placed on Type 2 non-woven geotextile.

To avoid a change in upstream water levels by reducing the available waterway opening, the rock protection should be placed below the existing streambed. The recommended arrangement is shown in Figure 6.

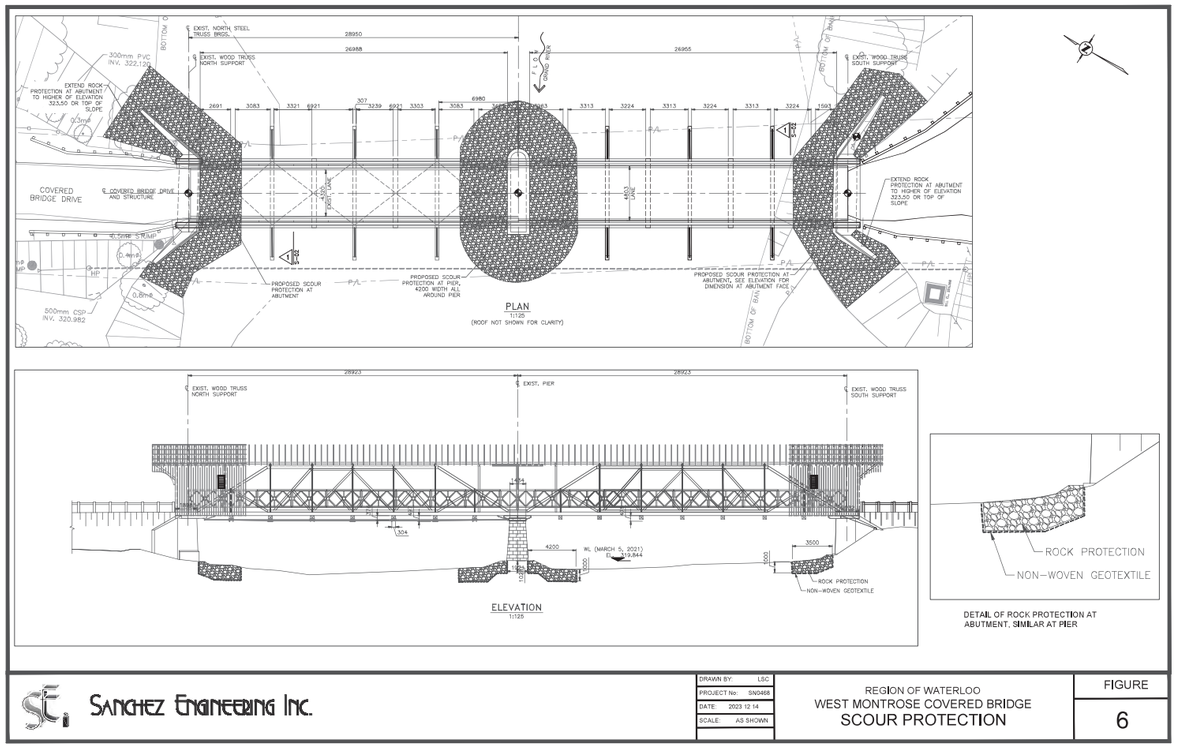
7.2 Pier

A layer of rock protection at the pier should be provided extending 4.2 m into the watercourse from the edges of the pier. The design flow velocity through the opening is 3.1 m/s, which requires stone with D_{50} diameter of 450 mm, placed in a layer 1000 mm thick. The rock protection should be placed on Type 2 non-woven geotextile, extending to the top of the rock.

To avoid a change in upstream water levels by reducing the available waterway opening, the rock protection should be placed below the existing streambed, as shown on Figure 6.

7.3 Effects on Upstream Water Levels

Assuming that the recommended rock protection is installed at the pier and the abutments to 600 mm thickness as illustrated in Figure 6, the scour protection will not cause any changes to the flood water levels upstream of the bridge due to constriction of the flow.

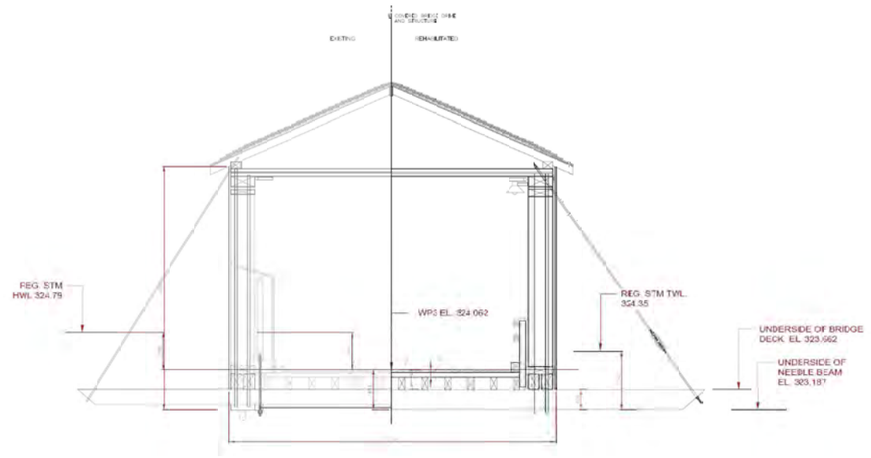


APPENDIX A

Calculation of Forces on Bridge Deck

Region of Waterloo
West Montrose Covered Bridge Rehabilitation

Hydrostatic and Hydrodynamic Forces on Bridge Deck



Regional Storm HWL	324.79 m		
Regional Storm TWL	324.35 m		
Top of deck	324.06 m		
Bottom of deck	323.19 m		
Total depth above bottom chord			
Upstream	1.603 m	ρ	1000 kg/m3
Downstream	1.163 m	Yw	9.81 kN/m3
Lateral Forces			
Upstream	12.6 kN/m		
Downstream	6.6 kN/m		
Net force on deck (U/S to D/S)	6.0 kN/m	Hydrostatic load	

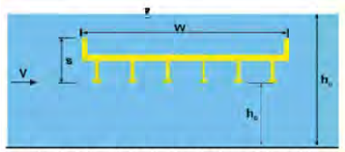


Figure 1. Diagram. Scaled six-girder bridge deck model used in assessments of drag and lift forces and the nomenclature for bridge deck and flume dimensions.

$$h^* = \frac{h_u - h_b}{s}$$

Figure 2. Equation. Inundation ratio.

$$Fr = \frac{v}{\sqrt{gh_u}}$$

Figure 3. Equation. Froude number.

Water level elevation	324.79	m
Top of Deck elevation	324.06	
Deck soffit elevation	323.66	m
Streambed elevation	318.8	m
Bridge width, W	6.134	m
Flow velocity, V	3.19	m/s
Inundation ratio		
hu	6.0	m
hs	4.9	m
s	5.0	m
h*	0.23	

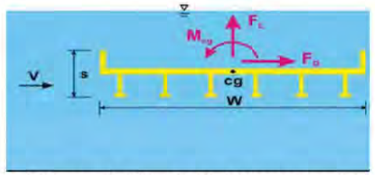


Figure 4. Diagram. Definition sketch of forces acting on bridge deck.

Assuming

$$C_D = \frac{F_D}{\frac{1}{2}\rho v^2 (Ls)}, \text{ if } h^* \geq 1; \text{ and } \quad C_D = \frac{F_D}{\frac{1}{2}\rho v^2 [L(h_u - h_b)]}, \text{ if } h^* < 1$$

Figure 5. Equation. Drag coefficient.

$$C_L = \frac{F_L}{\frac{1}{2}\rho v^2 (LW)}$$

Figure 6. Equation. Lift coefficient.

$$C_M = \frac{M_{cg}}{\frac{1}{2}\rho v^2 (LW^2)}$$

Figure 7. Equation. Moment coefficient.

$$C_D = A \cdot e^{-2\cdot(h^*)^2} - B \cdot e^{-0.75\cdot(h^*)^2} + a$$

Figure 37. Equation. Drag coefficient fitting equation for three- and six-girder bridges.

$$C_L = b \cdot \left(e^{-3.5\cdot(h^*)^2} - e^{-c\cdot(h^*)^{1.7}} \right)$$

Figure 38. Equation. Lift coefficient fitting equation for three- and six-girder bridges.

$$C_M = d \cdot (h^*)^{\alpha} \cdot e^{-f\cdot(h^*)^2} + g$$

Figure 39. Equation. Moment coefficient fitting equation for all bridge types.

$$C_D = 0.8 \cdot e^{-m\cdot(h^*)^3} + 0.33 \cdot (h^*)^{0.6} \cdot \left(1 - e^{-0.04\cdot(h^*)^{5.55}}\right) + n$$

Figure 40. Equation. Drag coefficient fitting equation for the streamlined bridge.

$$C_L = 1.5 \cdot e^{-1.6\cdot(h^*)^2} + 0.4213 \cdot (h^*)^{0.4} \left(1 - e^{-0.0626\cdot(h^*)^{4.4147}}\right) - j$$

Figure 41. Equation. Lift coefficient fitting equation for the streamlined bridge.

Table 1. Fitting equation coefficient values for six-girder (6-g) and three-girder (3-g) bridges.

Equation	A	B	a	b	c	d	f	g	α
6-g upper	2.7	2.7	2.15	2	0.65	1	1.4	0.03	2
6-g lower	2.7	2.7	1.75	3	0.62	0.8	1.6	-0.07	2
3-g upper	1.8	2	1.95	2	0.6	1	1.5	0	2
3-g lower	1.8	2	1.62	3	0.5	0.8	1.5	-0.11	2

Table 2. Fitting equation coefficient values for the streamlined bridge.

Equation	m	n	j	d	f	g	α
Streamlined upper	1.2	0.25	1.4	0.25	0.8	0.05	3
Streamlined lower	1.7	0.11	1.0	0.25	0.8	0	3

Table 3. Critical coefficient values by bridge type.

Bridge type	C_D	h^*_{crit}	C_L	h^*_{crit}	C_M	h^*_{crit}
6-g	2.15	0, > 3	-1.644	0.8025	0.2927 hi -0.07 lc	0.8452 0, > 2.5
3-g	1.95	0, > 3	-1.815	0.8312	0.2453 hi -0.11 lc	0.8165 0, > 2.5
Streamlined	~ 1.1	~ 4	-1.219	1.367	0.1932	1.369

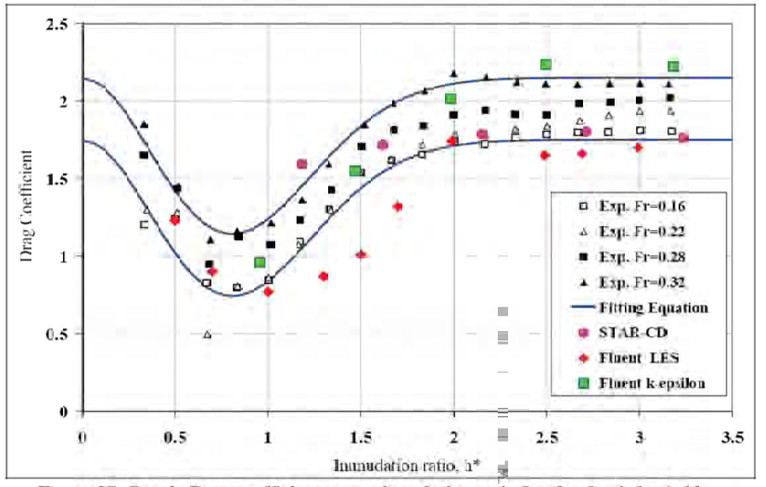


Figure 28. Graph. Drag coefficient versus inundation ratio for the six-girder bridge.

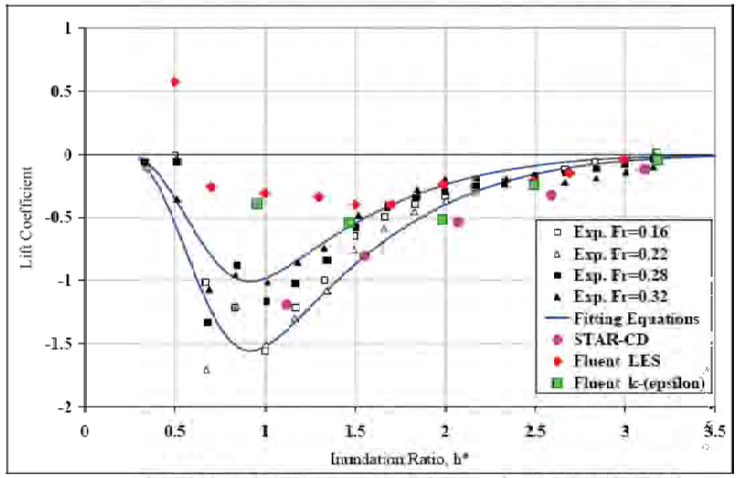


Figure 29. Graph. Lift coefficient versus inundation ratio for the six-girder bridge.

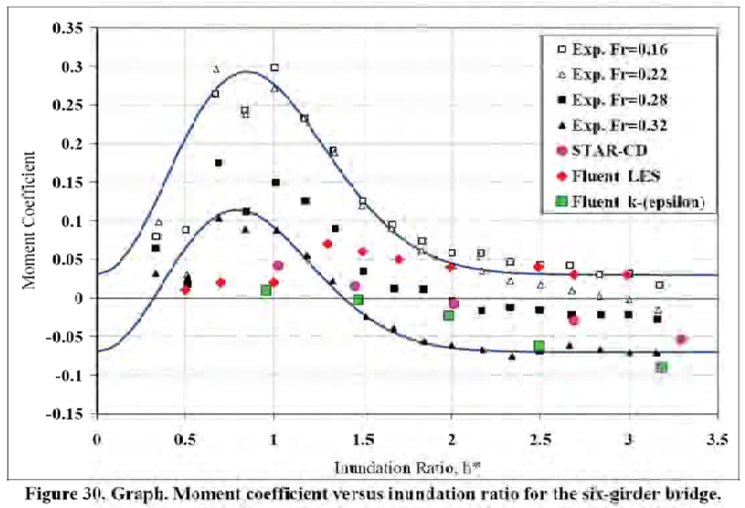


Figure 30. Graph. Moment coefficient versus inundation ratio for the six-girder bridge.

	Equations					From graph	
	h*	0.2				h*	0.3
		6-girder	3-girder	Streamlined		6-girder	
Upper	C_D	1.99	1.65	1.04		Cd max	1.75
Lower		1.59	1.32	0.89		Cd min	1.4
Upper	C_L	-0.23	-0.23	-0.02		CL max	-0.1
Lower		-0.35	-0.37	0.38		CL min	-0.15
Upper	C_M	0.08	0.05	0.05		CM	0.11
Lower		-0.03	-0.07	0.00			-0.01

6-girder bridge					
Max coefficients			Forces/Moments		
Drag Coefficient C_D	1.99		F_D	11420	N/Lm
Lift Coefficient C_L	-0.23		F_L	-138	N/Lm
Moment Coefficient C_M	0.08		M_{cg}	145	N-m/Lm

Min coefficients			Forces/Moments		
Drag Coefficient C_D	1.59		F_D	9124	N/Lm
Lift Coefficient C_L	-0.35		F_L	-211	N/Lm
Moment Coefficient C_M	-0.03		M_{cg}	-61	N-m/Lm

Buoyancy
Hydrostatic Upllift

	Measured above the bottom of the deck, at the top of the joists		
Elevation of deck underside	323.908	m	
Upstream water depth	0.88	m	Headwater minus deck underside
Downstream water depth	0.44	m	Tailwater minums deck underside
Average depth	0.66	m	
Average Uplift Pressure P	6.5	kN/m2	
Uplift Force, PxW	39.8	kN	per m of span
Depth of water on deck	0.29	m	Tailwater level minus top of deck (WP 3)
Weight of water	17.3	kN	per m of span
Net vertical uplift	22.5	kN	per m of span

APPENDIX B

Calculation of Forces on Pier

Region of Waterloo
West Montrose Covered Bridge Rehabilitation

Flow Forces on Pier

Table 3.11
Longitudinal drag coefficient, C_D
(See Clauses 3.3.2 and 3.11.4.1.)

Upstream shape of pier	Longitudinal drag coefficient, C_D
Semi-circular nosed	0.7
Square ended	1.4
Wedge nosed at ≤ 90°	0.8
Pier with debris lodged	1.4

Longitudinal Load P $P = C_D \rho A v^2 / 2$

Upstream shape of pier	Semicircular nose		
Drag Coefficient	0.7		
ρ	1000	kg/m3	
Projected Area A	7.0	m2	Measured from drawing
Flow velocity, v	3.1	m/s	Approach flow velocity. The flow velocity through the bridge is higher.

P = 23637 N $N = \frac{ML}{t^2} = \frac{M}{L^3} L^2 \frac{L^2}{t^2}$

Ice Force on Pier

p	700	kPa	kN/m2
t, ice thickness	0.3	m	
w, width of pier	1.5	m	
w/t	5		

Ice failure forces shall be determined as follows:

(a) Bending force, F_b:

$F_b = C_n p t^2$

where

$C_n = 0.5 \tan(\alpha + 15°)$, with α as shown in Figure 3.7

(b) Crushing force, F_c:

$F_c = C_a p t w$

where

$C_a = \sqrt{5\frac{t}{w} + 1}$

(c) Bending/crushing transition force F_{bc}:

$F_{bc} = \left[\left(C_n + \sqrt{66}\right)/72\right] p w^2$

3.12.2.2.3 Horizontal dynamic ice, force, *F*

The horizontal force, *F*, due to the pressure of moving ice shall be taken as follows:
when $F_c \le F_b$:
$F = F_c$

when $F_c > F_b$:
$F = F_c$ if $F_{bc} \ge F_c$
$F = F_b$ if $F_{bc} \le F_b$
$F = F_{bc}$ if $F_c > F_{bc} > F_b$

In small streams where it is unlikely that large-size ice floes will form, the force, *F*, may be reduced by up to 50% of the value in accordance with this Clause.

Bending force

α	84.24	degrees	
α + 15 (not to exceed 90)	90	degrees =	1.570796 rad
Cn	8.16E+15		
Fb	5.142E+17	kN	

Crushing force

Ca	1.4	
Fc	445.5	kN

Bending/crushing transition force (Fbc)

Fbc	5.14223E+17	kN

Fc < Fb **Use Fc** **445.5 kN**

	Fc	Fbc	Fb
Fc>Fb	445.5		5.14E+17
Fc>Fbc>Fb	445.5	5.14E+17	5.14E+17

Forces based on Momentum
Assume Ice floe dimensions

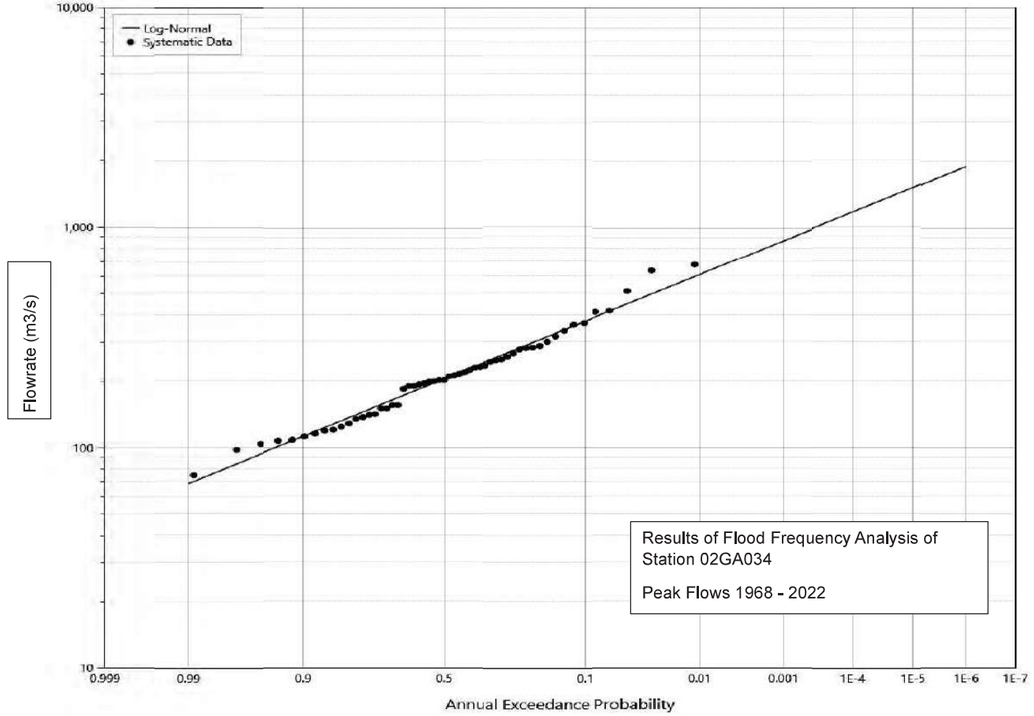
Thickness	0.3	m	
Width	5	m	
Length	10	m	
Volume	15	m3	
ρ_{ice}	900	kg/m3	
Mass	13500	kg/m3	
Velocity	3.1	m/s	
Momentum	41850	kg-m/s	
Assume ice floe impacts pier and is stopped by pier			
t	0.1	s	
Force due to Momentum cha	**418500**	**kg-m/s2**	**418.5 kN**

APPENDIX C

Flood Frequency Analysis of Annual Maximum Instantaneous Discharges at Water Survey of Canada Station 02GA034 – Grand River at West Montrose

Flood Frequency Analysis Results
Station 02GA034 - Grand River at West Montrose

	Measure	Log-Normal	Log-Pearson Type III	GRCA
	Location	2.3105	2.3105	
	Scale	0.2034	0.2039	
	Shape	N/A	0.4134	
	Minimum	0	21	
	Maximum	∞	∞	
	Mean	214	230	
	Std Dev	68	129	
	Skewness	0.9799	2.7899	
	Kurtosis	4.7545	22.0386	
Tr (years)	Annual Probability	Flow Estimate (m3/s)		
1000000	1.00E-06	1,893	3,962	
100000	1.00E-05	1,506	2,699	1,540
10000	0.0001	1,166	1,795	
5000	0.0002	1,073	1,578	1540
2000	0.0005	954	1,324	
1000	0.001	869	1,154	
500	0.002	787	1,000	
200	0.005	683	821	
100	0.01	608	701	910
50	0.02	535	593	827
25	0.04	464	495	719
20	0.05	442	466	
10	0.1	373	380	603
5	0.2	303	300	464
3	0.3	261	255	
2	0.5	204	198	331
1.43	0.7	160	156	
1.25	0.8	138	137	
1.11	0.9	112	115	
1.05	0.95	95	100	
1.02	0.98	78	87	
1.01	0.99	69	79	



APPENDIX D

Scour Calculations and Rock Protection Sizing

Region of Waterloo
West Montrose Covered Bridge

Calculation of Potential Scour through the bridge opening.

Contraction Scour

$$V_c = K_u\, y^{1/6}\, D^{1/3} \qquad (6.1)$$

where:

- V_c = Critical velocity above which bed material of size D and smaller will be transported, ft/s (m/s)
- y = Average depth of flow upstream of the bridge, ft (m)
- D = Particle size for V_c, ft (m)
- D_{50} = Particle size in a mixture of which 50 percent are smaller, ft (m)
- K_u = 6.19 SI units
- K_u = 11.17 English units

$$D = \left[\frac{Vc}{K_u y^{1/6}}\right]^3$$

	Velocity V_{05-74}	Calculated D_{50} (m)	
	m/s	m	
	2.96	0.060	Based on V_{05-74}
Design Velocity	3.10		

$$\frac{y_2}{y_1} = \left(\frac{Q_2}{Q_1}\right)^{6/7} \left(\frac{W_1}{W_2}\right)^{k_1} \qquad (6.2)$$

$$y_s = y_2 - y_o = \text{(average contraction scour depth)} \qquad (6.3)$$

where:

- y_1 = Average depth in the upstream main channel, ft (m)
- y_2 = Average depth in the contracted section, ft (m)
- y_o = Existing depth in the contracted section before scour, ft (m) (see Note 7)
- Q_1 = Flow in the upstream channel transporting sediment, ft^3/s (m^3/s)
- Q_2 = Flow in the contracted channel, ft^3/s (m^3/s)
- W_1 = Bottom width of the upstream main channel that is transporting bed material, ft (m)
- W_2 = Bottom width of main channel in contracted section less pier width(s), ft (m)
- k_1 = Exponent determined below

V_*/T	k_1	Mode of Bed Material Transport
<0.50	0.59	Mostly contact bed material discharge
0.50 to 2.0	0.64	Some suspended bed material discharge
>2.0	0.69	Mostly suspended bed material discharge

- V_* = $(\vartheta_o/\Delta)^{1/2} = (gy_1 S_1)^{1/2}$, shear velocity in the upstream section, ft/s (m/s)
- T = Fall velocity of bed material based on the D_{50}, m/s (Figure 6.8)
  For fall velocity in English units (ft/s) multiply T in m/s by 3.28
- g = Acceleration of gravity (32.2 ft/s^2) (9.81 m/s^2)
- S_1 = Slope of energy grade line of main channel, ft/ft (m/m)
- ϑ_o = Shear stress on the bed, (lb/ft^2) (Pa (N/m^2))
- Δ = Density of water (1.94 $slugs/ft^3$) (1000 kg/m^3)

Using HEC - 18 methods

$$\frac{y_s}{a} = 2.0\, K_1\, K_2\, K_3 \left(\frac{y_1}{a}\right)^{0.35} Fr_1^{0.43} \qquad (7.3)$$

where:

- y_s = Scour depth, ft (m)
- y_1 = Flow depth directly upstream of the pier, ft (m)
- K_1 = Correction factor for pier nose shape from Figure 7.3 and Table 7.1
- K_2 = Correction factor for angle of attack of flow from Table 7.2 or Equation 7.4
- K_3 = Correction factor for bed condition from Table 7.3
- a = Pier width, ft (m)
- L = Length of pier, ft (m)
- Fr_1 = Froude Number directly upstream of the pier = $V_1/(gy_1)^{1/2}$
- V_1 = Mean velocity of flow directly upstream of the pier, ft/s (m/s)
- g = Acceleration of gravity (32.2 ft/s^2) (9.81 m/s^2)

For 50-year flood

y1	4.84	m
y0	4.67	m
Q1	610	m3/s
Q2	686	m3/s
W1	58	m
W2	54	m
k1	0.59	
y2	5.6	m
ys = y2-y0	0.91	m

This estimate does not take into account the stream material sizes.

NEH Technical Bulletin 14B
Contraction Scour

These regime relationships may be expressed as:

$$z_t = KQ_d^a W_f^b D_{50}^c \qquad \text{(eq. TS14B–23)}$$

where:

z_t = maximum scour depth at the cross section or reach in question, ft (m)
K = coefficient (table TS14B–8)
Q_d = design discharge, ft^3/s (m^3/s)
W_f = flow width at design discharge, ft (m)
D_{50} = median size of bed material (mm)
a, b, c = exponents (table TS14B–8)

Table TS14B–8 Constants for Lacey and Blench relations, U.S. units (D_{50} in mm)

Condition	Lacey				Blench			
	K	a	b	c	K	a	b	c
Straight reach	0.097	1/3	0	–1/6	0.530	2/3	–2/3	–0.1092
Moderate bend	0.195	1/3	0	–1/6	0.530	2/3	–2/3	–0.1092
Severe bend	0.292	1/3	0	–1/6	0.530	2/3	–2/3	–0.1092
Right angle bend	0.389	1/3	0	–1/6	1.105	2/3	–2/3	–0.1092
Vertical rock wall	0.487	1/3	0	–1/6				

Table TS14B–9 Constant K for Lacey and Blench relations, SI units (D_{50} in mm)

	Lacey	Blench
K	0.06	0.16
Q, m3/s	686	686
Wf, m	58.00	58.00
D50, mm	60.00	60.00
a	0.33	0.67
b	0.00	-0.67
c	-0.17	-0.11
Zt	0.26	0.54

Local Scour

Pier

a	1.5 m
K1, square nose	1.10
K2, angle of attack = 0	1.00
K3, clear-water scour	1.10
y1 50-year flood	4.84 m
Fr	0.41
ys	2.49 m

maximum scour depth pe 2.4 * a for Fr <0.8
3.6 m
So calculation is in range.

However, this does not take into account the size of the streambed material.

FDOT Scour calculator 2.93 m

$$y_c = y_1\left(\frac{q_{2c}}{q_1}\right)^{6/7} \qquad (8.5)$$

where:

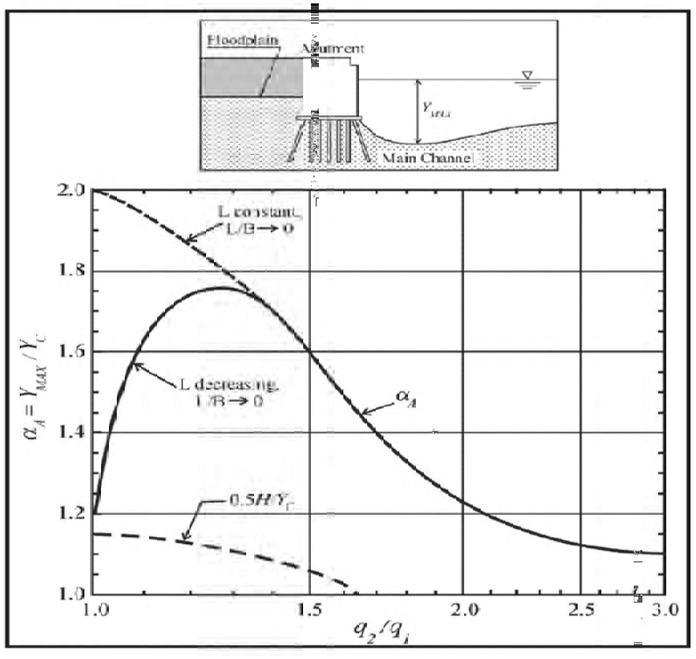
y_c = Flow depth including live-bed contraction scour, ft (m)
y_1 = Upstream flow depth, ft (m)
q_1 = Upstream unit discharge, ft^2/s (m^2/s)
q_{2c} = Unit discharge in the constricted opening accounting for non-uniform flow distribution, ft^2/s (m^2/s)

The value of q_{2c} can be estimated as the total discharge in the bridge opening divided by the width of the bridge opening. The value of y_c is then used in Equation 8.3 to compute the total flow depth at the abutment. The value of α_A is selected from Figure 8.9 for spill through abutments and Figure 8.10 for wingwall abutments. The solid curves should be used for design. The dashed curves represent theoretical conditions that have yet to be proven experimentally. For low values of q_2/q_1, contraction scour is small, but the amplification factor is large because flow separation and turbulence dominate the abutment scour process. For large values of q_2/q_1, contraction scour dominates the abutment scour process and the amplification factor is small.

Abutments

Width of flow upstream	95	m
Width of opening	58	m
Total flow upstream	694	m3/s
total flow in opening	716	m3/s
y1	4.84	m
q1	7.30	m3/s/m
q2	12.35	m3/s/m
q2/q1	1.69	
yc	7.59	m
α_A	1.50	
Abutment scour	6.55	m

Alternatively, with the contraction scour ,
The total abutment scour is
1.37 m
If we use the 1.0 m previously discussed, then
the total abutment scour is
1.49 m



$$y_c = \left(\frac{q_{2f}}{K_u D_{50}^{1/3}} \right)^{6/7} \qquad (8.6)$$

where:

y_c	=	Flow depth including clear-water contraction scour, ft (m)
q_{2f}	=	Unit discharge in the constricted opening accounting for non-uniform flow distribution, ft^2/s (m^2/s)
K_u	=	11.17 English units
K_u	=	6.19 SI
D_{50}	=	Particle size with 50 percent finer, ft (m)

q2f	11.4	m3/s	
Ku	6.19		
D_{50}	0.060	m	Based on V_{05-74}
yc	5.3	m	

CHBDC Commentary Provisions

dt not defined

Local Scour at Pier

dsp	$C_L C_s W_p$	4 m
	C_L	2
	C_s	1
	W_p	2 m
	L	6.2 m
	L/W	3.1
Average contraction scour		0.9 m
	Total scour	4.9 m

This estimate does not account for the material size.

Abutment as a straight wall (HEC-23)

$$\frac{y_s}{y_1} = 0.73 + 0.14\pi F_r^2 \qquad (4.3)$$

where:

y_s = Equilibrium depth of scour (measured from the mean bed level to the bottom of the scour hole), ft (m)
y_1 = Average upstream flow depth in the main channel, ft (m)
F_r = Upstream Froude Number

ys 3.9 m

Rock Protection Size required

$$d_{50} = \frac{0.692(V_{ces})^2}{(S_g - 1)2g} \qquad (11.1)$$

where: d_{50} = Particle size for which 50% is finer by weight, ft (m)
V_{des} = Design velocity for local conditions at the pier, ft/s (m/s)
S_g = Specific gravity of riprap (usually taken as 2.65)
g = Acceleration due to gravity, 32.2 ft/s^2 (9.81 m/s^2)

V_{des} (design velocity)	$K_1K_2V_{avg}$	4.65	m/s
K_1	1.5		round nose
K_2	1		straight channel
Sg	2.65		
d_{50}	0.46 m	463	mm

Gradation	Diameter	Min. (mm)	Max (mm)
	d_{15}	280	400
	d_{50}	430	520
	d_{85}	600	700
	d_{100}		900

Appendix K

Value Engineering Workshop Report

Region of Waterloo

Value Engineering Report

Region of Waterloo
West Montrose Covered Bridge

May 15, 2023

Submitted by:
Entuitive/BT Engineering Inc. Joint Venture
200 University Avenue, 7th Floor
Toronto, ON M5H 3C6

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The Region of Waterloo is conducting a Value Engineering (VE) Study to review the results of recent inspections of the timber elements and previous rehabilitation recommendations as part of the initial phase of the detail design to focus on value and affordability challenges of the project. This review is to allow the owners, designers, stakeholders and independent specialists an opportunity to examine the preliminary design alternatives with the objective of providing the required performance standards for this site-specific project, delivering a quality, context sensitive and cost-effective project to the Region.

EXECUTIVE SUMMARY

This report summarizes the results of the Value Engineering (VE) Study carried out by Entuitive/BT Engineering Inc. (BTE), Region, Township and stakeholders for the West Montrose Covered Bridge project. The VE Study has been completed during the initial review of preliminary design alternatives in the detail design stage of the project, which is being carried out by the Entuitive/BTE design team. Its focus is to review the previous recommendations of the Schedule A+ Municipal Class Environmental Assessment (EA), and the initial project review by the detail design team (2023).

A Schedule A+ EA Study was completed for the project, and two Public Information Centres (PICs) were held. The preferred design presented at the second public event was to strengthen the timber truss and remove the interior cladding material. Between 2012 and 2018, the Region undertook a series of studies and analyses to examine the existing condition of the bridge and develop a Preservation Plan (2014).

The key study issues include:

- The dead load and live loads are being carried by both the original wooden truss and the steel Bailey trusses;
- The Bailey trusses do not have sufficient capacity to carry the entire load of the bridge;
- The Bailey trusses cannot be readily retrofitted to achieve a strength sufficient to carry the entire load of the bridge;
- Pedestrian-only restrictions cannot be a standalone solution; and
- This is a designated heritage structure requiring preservation of all aspects of the bridge.

The Value Engineering team was comprised of participants from the Region of Waterloo, Township of Woolwich, BTE, Entuitive, Wendy Shearer Landscape Architect, Sanchez Engineering Inc, Bridge Keepers, Doug Dixon & Associates (DDA), IBI Group, Unterman McPhail Associates, CISL, and Moses Structural Engineers (MSE).

The purpose of the workshop was to develop the design criteria and a list of value proposals to be considered in the design development, and assist in selecting rehabilitation improvements to the bridge and moving the project design

This VE Review represents the consensus of the VE review, based on the results of the Workshop session. This report is intended to focus the Design Team on select elements of the project which appear to offer the best opportunity to improve value and to ensure constructability of the project.

forward. Its other purpose, at the start of the design phase, was to scope out alternatives to be carried forward for further review.

The study utilized the initial phases of the 6-phase job plan of SAVE International to define the necessary project requirements and prioritize elements. This was achieved through the three VE primary stages: pre-workshop, workshop, and post-workshop activities. The workshop focus was on the function analysis and creativity phases.

The pre-workshop activities included data collection and analyzing and reviewing study materials supplied by the Region and Design Team.

A 1-day workshop was held on March 21, 2023 to analyze functional requirements of the project, as well as generate, evaluate and develop ideas for alternative value enhancements to move forward with this project. The exercise was for the VE workshop to review the project definition and to then question all previous decisions before carrying forward a short list of preliminary design approaches to consider in greater detail i.e., value proposals (either related to cost or performance) to improve the project within affordability constraints.

The Value Engineering methodology is an interactive team approach that focuses on the functions that the project must deliver in order to achieve the needed balance between competing objectives and perspectives. For this project, the Workshop participants developed a common understanding of the problem, priorities of the community and defined their expectations. With this knowledge, they were able to identify feasible ideas for consideration by the owner and design team. This report documents the process and the ideas.

Study Results

A VE Workshop is a time management exercise. The study generated a long list of value proposals (82 ideas) that had the opportunity to improve value (i.e., improve performance, constructability or reduce life cycle costs) while meeting the required performance. Through an evaluation exercise, this long list was then short-listed to 55 ideas, shown in **Table E1**.

The complete listing of the 82 ideas is in **Appendix B**.

The workshop team built consensus for the following conclusions and recommendations. The design team will consider the

previously presented Alternative A and B (**Figure E1)**, as well as an internal suspension cable system (**Figure E2**), as well as various value proposals aimed at improving the structure and surrounding landscape. See The key recommendations for each alternative bridge type include:

- Set the posted load limit of the bridge to 3 tonnes (to maintain service to existing traffic and not attract larger vehicles to the bridge) and a design for a live load of 5 tonnes;
- Improve signage to restrict vehicles that are not permitted (weight and height);
- Improvements to hydraulic capacity and or designing for hydraulic loading caused by large storm events (preservation of the heritage asset from severe weather events which are increasing in frequency and intensity because of global warming); and
- The exterior cladding will be removed if a substantial amount of deterioration has occurred (the exterior cladding is the protective component to preserve the heritage wooden structure).

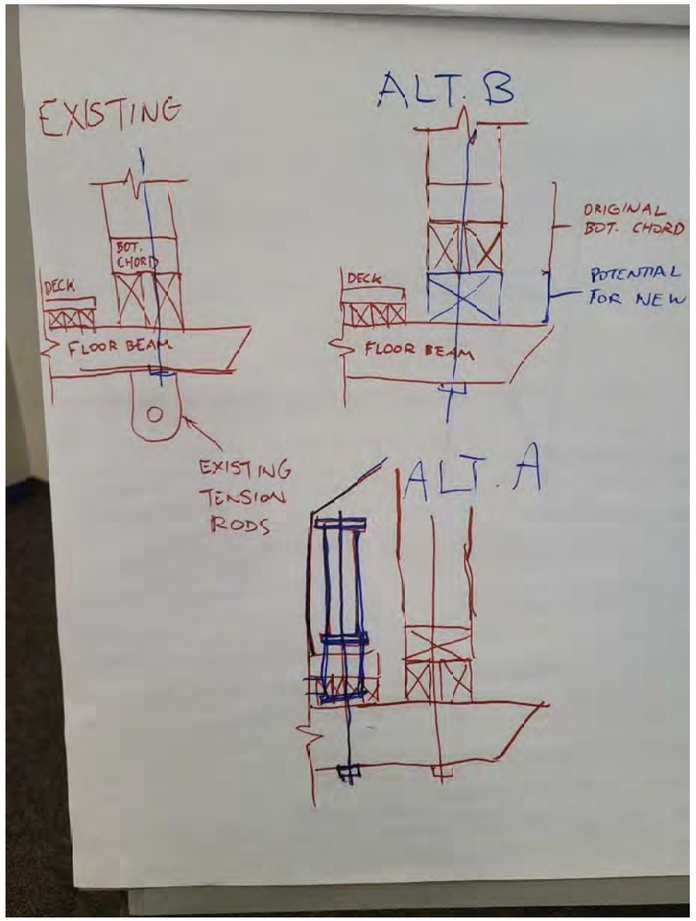


Figure E1: Sketches of the Existing Truss Cross Section and Alternative A and B Design

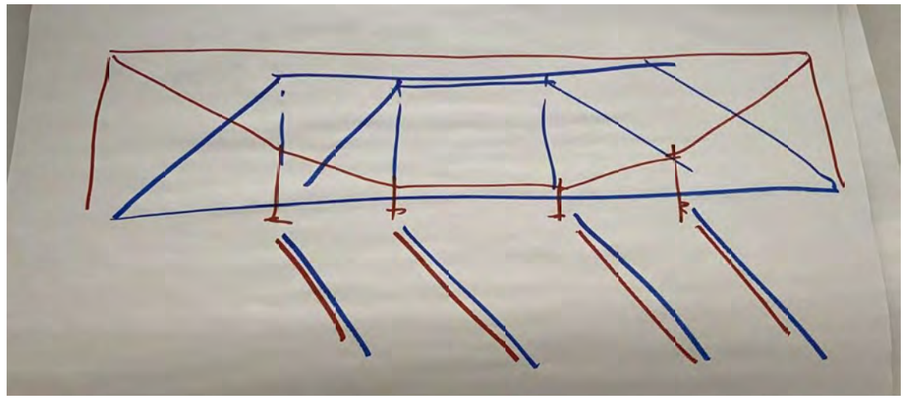


Figure E2:Internal Suspension Cable Sketch

Table E1: Short-Listed Creative Ideas	
Idea ID No.	**Idea Description**
1	Set load limit at 3 tonnes (posted) and design to a minimum of 5 tonnes
2	Review signage for load limits at the Regional Road
4	Improve signage with a picture sign of vehicle types not permitted
5	Provide a 3.3 m vertical clearance limit at the bridge
7	Vehicle weight sensors in the road (install weight scale)
10	Install interior barrier for protection of the truss
11	Alternative B (including raising soffit 150+/- mm)
12	Alternative A (including raising soffit 150+/- mm)
13	Reduce sag on bridge to increase clearance
14	Raise the bridge at the south abutment to match the height at the centre pier
15	Replace exterior cladding as needed (i.e. not entire replacement)
16	Replace all exterior cladding (similar, if feasible, to 1880s design) to reduce future maintenance requirements
17	Detailed survey of cladding to determine condition of each board. Create a design criterion for the board replacement
19	Salvage some existing bridge components that require replacement for on-site display
20	Maintain current gross external dimensions on the bridge to the greatest extent possible
21	Strengthen bridge but maintain original dimensions of the bridge
22	Remove Bailey truss and affix timber reinforcement on the sides of the bottom chord (modified Alternative B)
24	Reduce the height of the new FRP (or alternate material) to be reduced to the minimum amount possible to achieve 5 tonne load capacity (design)
25	Sandwich connection with steel plate between boards (instead of FRP)
31	Pedestrian walkway on the outside of the bridge across the needle beams (during construction)
32	Internal suspension cable system (inverted bowstring)
34	Dry system for fire suppression
35	Treat timbers with fire retardants
36	Cistern/reservoir at the park upstream from the bridge
37	Blackfriar bridge height restriction
38	Community input contest on the design for the height restrictor
43	Steepen driveway to 8% and find the dimension it allows to raise the bridge
46	Two-way stop at the south end and a stop sign at the north end
48	Tree clearing to improve visibility
51	Educational storyboard on the evolution of bridge technology employed on this bridge
52	Salvage materials of the bridge for an interactive storyboard
54	During construction, provide a dedicated lane on Line 86 for horse and buggies (remove a lane for vehicular traffic)
55	Reduce speed on Line 86 during construction for use as a detour
56	Maintain the exterior red colour
58	Maintain a wooden curb for splash guard
59	Move louvers back to the original height to allow more daylight

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Table E1: Short-Listed Creative Ideas	
Idea ID No.	**Idea Description**
62	Install safety rail to protect truss from errant vehicles travelling through the bridge
63	Interior railing/curb to be low height to see truss from the car
64	Prequalification of bidders
66	New cedar shingle roof
67	Hydraulic forecasting to consider climate change
68	Keep existing approach grades
69	Strengthen piers/abutments for increased hydraulic pressure
70	Design floor structure for hydraulic pressure
71	Tie-down superstructure
72	Install tie anchors on the exterior for future maintenance access
73	Accept existing profile through the truss
74	Create a working group at GRCA to review policies and downstream jamming mitigation
76	Increase exposure of the truss from the inside of the bridge
77	Restore window vents to original size
78	New work should be distinguishable from, compatible with and subordinate to the heritage structure, and reversible where possible
79	Selectively replace severely damaged chords of the truss
80	Video surveillance to deter vandalism
81	Maintain floor beam unique appearance under the bridge to the extent possible because this is unique to this truss design
82	Accept removal of the Bailey Bridge and adding lower splash guard

Context of the VE Review

It must be recognized that the proposals and recommendations from the VE workshop represent the consensus of the participants following the workshop review. However, these recommendations will be the subject of more detailed review, debate, and analysis. This was a scoping and brainstorming exercise utilizing industry expertise for project understanding as one of the phases of the project, and these short-listed ideas are expected to be used for building confidence in the project scope and establishing a budget.

1.0 INTRODUCTION

A Schedule A+ Municipal Class Environmental Assessment (EA) has been completed for the project. Two previous Public Information Centres (PICs) were held. The preferred design presented at the second public event was to strengthen the timber truss and remove the interior cladding material. Between 2012 and 2018, the Region undertook a series of studies and analyses to examine the existing condition of the bridge and create a Preservation Plan (2014).

1.1 Background

The key project issues include:

- The dead load and live loads are being carried by both the original wooden truss and the steel Bailey trusses;
- The Bailey trusses do not have sufficient capacity to carry the entire load of the bridge;
- The Bailey trusses cannot be readily retrofitted to achieve a strength sufficient to carry the entire load of the bridge;
- Pedestrian-only restrictions cannot be a standalone solution; and
- This is a designated heritage structure requiring preservation of all aspects of the bridge.

1.2 Purpose of the VE Workshop

The purpose of the workshop was to develop a list of value proposals to assist in selecting improvements to be made to the pedestrian bridge. The mandate was also to review the performance standards of the project and identify project risks that could be mitigated through the design development phase. Its other purpose, at the start of the design phase, was to scope out the alternatives to be carried forward for further review.

2.0 VALUE ENGINEERING PROCESS

The Value Engineering approach is a powerful decision-making process, which differs from the conventional scientific process by focusing on the project needs as expressed by functions to allow both convergent and divergent thinking. Alternatives are then generated to deliver the functions required for the success of the project. How well an alternative performs is balanced as a trade-off with the resources that are required to implement the alternative.

The Value Study involved a pre-workshop stage (where a basic understanding of the project issues, needs, and previous studies was gained), the Value Workshop, and post-workshop activities.

2.1 Governing Principles

Based on the discussions prior to, during, and following the Workshop, Entuitive/BTE helped to define the principles that were important, and that would contribute to the success of the Value Engineering review. The governing principles of the Study were defined to be:

- The Team will remain focused on necessary elements defined in the study scope, but will document generated ideas, outside the scope, that may be of benefit to others;
- All suggestions will be accepted by the Team and evaluated later for application and development;
- The Team will focus on the value of components to ensure that the most appropriate and cost-effective solutions are selected; and
- The Owner (Region of Waterloo) will continue to have the authority and responsibility to accept, modify, or reject any/all recommendations and estimate corrections made by the VE Team.

2.2 Study Agenda

The VE Study included a 1-day workshop in March 2023 to analyze functional requirements and generate, evaluate and develop ideas for alternative value enhancements as well as to validate the current design. The workshop was held in-person on March 21, 2023.

The Agenda for the Workshop is presented in **Appendix A**. The Agenda is summarized in **Table 1**. Further details of the approach are discussed in **Section 2.4.**

Table 1: Workshop Agenda

Activities
Pre-workshop • Review of background information • Draft Quality Model **Information Phase** • Value Management overview • Project overview presentations • Define opportunities/ commitments/ constraints **Function Analysis** • Identify project functions • Quality Modelling • Preparation of FAST diagram **Creativity** - Define targets • Creative brainstorming **Evaluation -** Initial screening of ideas to be further developed **Post-Workshop** • Presentation of ideas and concepts • Draft and final Value Engineering Report • Technical studies and liaison with approval agencies

2.3 VE Team

The Value Engineering team was comprised of participants from the Region of Waterloo, Township of Woolwich, BTE, Entuitive, Wendy Shearer Landscape Architect, Sanchez Engineering Inc, Bridge Keepers, Doug Dixon & Associates (DDA), Unterman McPhail Associates, IBI Group, CISL, and Moses Structural Engineers (MSE). During the workshop, the members who made up the VE Team were asked to set aside the perspectives of their individual organizations and act solely as knowledgeable experts in their fields of planning, design and operations. The VE Team recommendations/ ideas do not reflect the approval of any agency.

The VE Study Team members and their affiliation, expertise, and attendance are listed in **Table 2**. A photo of the group is in **Photo 1**.

Steve Taylor, the VE Team Leader, presented background information to inform the VE team members and workshop participants of the Value Management Approach.

Steve Taylor, P.Eng., M.Eng., CVS-Life, BT Engineering (BTE), served as the VE Team Leader (VETL) for the Workshop session and oversaw the preparation of the VE report.

Darcie Dillon, P.Eng., was the Assistant VE Team Leader, led the discussion of the Quality Model and prepared the VE report.

Independent Specialist team members included:

- Unterman McPhail Associates;
- National Society for the Preservation of Covered Bridges (post workshop input);
- IBI Group.

Table 2: VE Team

Name	Specialty	Representing
Michelle Pinto	Project Manager	Region of Waterloo (Region)
Skylar Van Kruistum	Head of Design and Construction	Region
Darryl Schwartzentruber	Bridges Project Manager	Township of Woolwich (Township)
Wendy Shearer	Heritage	Wendy Shearer Cultural Heritage Specialist
Leo Sanchez	Hydraulics	Sanchez Engineering Inc.
Sandy Shantz	Mayor	Township
Bonne Bryant	Councillor	Township
Tony Dowling	Bridge Keeping	Bridge Keepers
Kitson Morden	Bridge Keeping	Bridge Keepers
Shawn Buckley	Assistant Manager	Region
Richard Unterman	Heritage	Unterman McPhail Associates
Kevin Li	Bridge Engineering	DDA
Doug Dixon	Bridge Engineering	DDA
Ted Brumfitt	Bridge Engineering	IBI Group
John Stephenson	Bridge Engineering	CISL
David Moses	Bridge Engineering	Moses Structural Engineers
Maria Vogiatzis	Water Resources Engineering	GRCA
Karen Cummings	Heritage	Bridge Keepers
Stephen Brown	Bridge Engineering Lead	Entuitive
Andrew Lehan	Senior Bridge Engineer	Entuitive

Table 2: VE Team

Name	Specialty	Representing
Steve Taylor	VE Team Lead	BT Engineering Inc. (BTE)
Darcie Dillon	Assistant VE Team Lead	BTE
Stephen Brook	Senior Traffic Engineer	BTE
Wasim Aldabbagh	Transportation EIT	BTE



Photo 1: West Montrose Covered Bridge VE Workshop Attendees

2.4 Job Plan

The Job Plan prepared for the VE Study follows the standard VM methodology (October 1998) of SAVE International (authority to accredit Value Management). The VE Job Plan (refer to **Figure 1**) is conducted in three stages – Pre-Workshop, Workshop, and Post-Workshop.

2.4.1 Pre-Workshop Activities

The pre-workshop activities included data collection, analyzing and reviewing study materials supplied by the Design Team, and model development, which established the primary elements of the project baseline design. The workshop identified functional requirements and generated alternative solutions to meet these needs. The ideas generated were screened to identify ideas for further analysis.

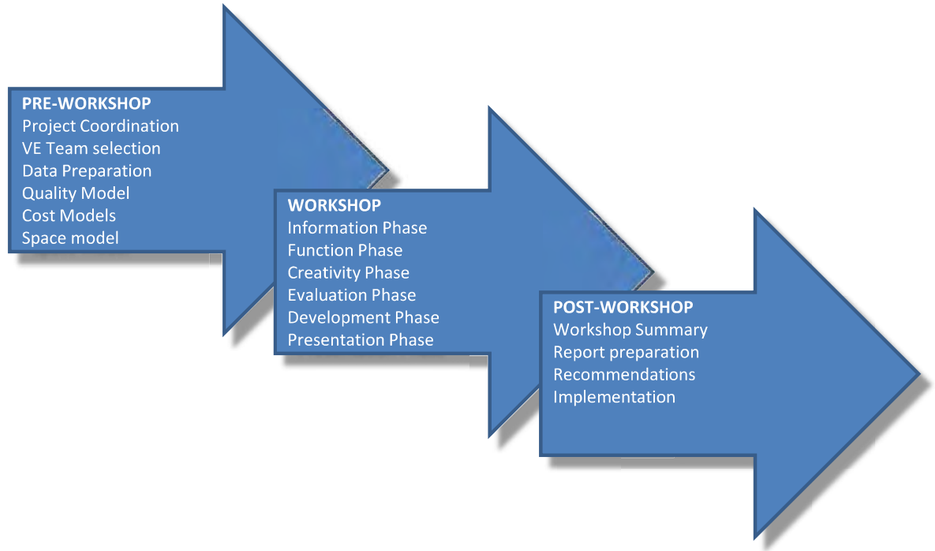


Figure 1: Value Engineering Job Plan

2.4.2 Workshop Activities

The study utilized the initial phases of the 6-phase job plan of SAVE International to define the necessary project requirements and prioritize elements.

The information phase session included the study team and community members. Participants were briefed through a series of presentations outlined in **Section 3.0**, reviewed and updated the Quality Model, and identified issues.

The workshop involved function analysis, the creative phase (brainstorming alternative ideas to achieve key functions), and a selection of ideas for further development.

The FAST (Function Analysis System Technique) diagram was finalized based on the draft FAST diagram developed at the in-person workshop and the functions identified during the Workshop.

A list of creative ideas was created by the VE team and shortlisted to develop and evaluate ideas to be carried forward for the design team to review and potentially implement.

2.4.3 Post-Workshop Activities

Post-workshop activities include a draft and final report (this report) to summarize the workshop and screening by the owner and design team on which standalone ideas or scenarios to implement.

3.0 WORKSHOP PRESENTATIONS

Introductory presentations were made to the workshop attendees by the Facilitation Leader and various attendees from the Region and design team. These presentations (included in **Appendix C**) provided a common understanding of background on the project. The following briefly summarizes the key presentation points.

Sandy Shantz, Region of Waterloo, gave opening remarks. The Region is looking for stakeholder collaboration and good value for the project.

Steve Taylor, P.Eng., M.Eng., CVS-Life, BT Engineering (BTE), served as the VE Team Leader (VETL) for the Workshop session. He provided an introduction to Value Engineering.

Michelle Pinto (Region of Waterloo Project Manager) and **Kevin Li** (Doug Dixon & Associates) presented the project background, including:

- The bridge was originally constructed in 1881;
- Numerous rehabilitations have been done since 1904;
- The bridge ownership has been transferred multiple times and it is now owned by the Region;
- A timeline is shown in **Figure 2**;

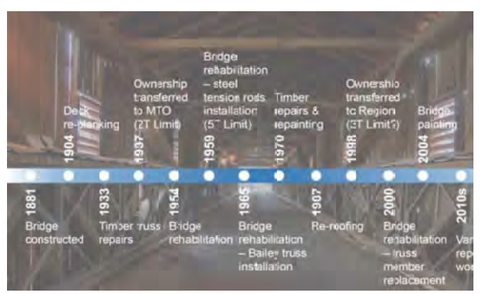


Figure 2: Structural History of the Bridge

- IBI Group, Struct-Sure and Moses Structural Engineers have all undertaken investigations to determine the rehabilitation needs for the bridge;
- The Mennonite community uses the bridge and there are long detours if the bridge is closed;
- Project budget of $5.6 million includes engineering fees, reporting, and investigations. ICIP funding is approximately 33%, provincial funding is 40% and the Region pays the rest (27%);
- ICIP funding requires construction by the end of 2026 and the Region is aiming for construction in 2024;
- The pedestrian load is high and can reach the 3-tonne limit, so the bridge must be strengthened regardless of whether vehicular traffic is permitted;
- Two alternatives were presented to the public and Alternative B is the most recent recommended alternative;
- GRCA, MECP, DFO, and Indigenous Peoples have been consulted; and
- Following the detailed timber assessment, the Region/Project Team will finalize the preferred alternative, present to Regional Council and proceed to detailed design and tender/construction.

Richard Unterman (Unterman McPhail Associates) summarized the heritage components of the project, including:

- A Heritage Impact Assessment (HIA) has been completed to summarize the impacts of the bridge alternatives;

- The bridge was designated by the Township of Woolwich in 2007 as a Part IV designated structure;
- The Grand River, which the bridge crosses, and its major tributaries were designated as Canadian Heritage Rivers in 1994;
- The designation of the bridge includes elements that have been added since 1881. Removing these elements may modify the heritage designation;
- The West Montrose Covered Bridge is the eighth oldest covered bridge in Canada;
- The HIA was compiled using the Provincial toolkit, Standards and Guidelines, historical documents, articles and reflecting the Township of Woolwich HIA Guidelines; and
- Additional changes can be made as long as they are documented/recorded.

Andrew Lehan (Entuitive) and **David Moses** (Moses Structural Engineers) summarized the Site Assessment completed to date:

- Entuitive and Moses Structural Engineers have completed a detailed site assessment of the above-deck timber elements that are accessible;
- Observations included:
  - Signs of undocumented repairs
  - Geometric variation (e.g. uneven width along member)
  - Observations of misalignment
  - Member deflection / tilt / distortion
  - Wood Observations: staining, decay, weathering, checks, splits, and crushing
  - Steel Observations: corrosion
  - Moisture content in wood members at select points
  - Resistograph readings were taken to locate signs of decay or unsound wood within members
- The cladding may be protecting the members from splashing water.

Wendy Shearer (Wendy Shearer Cultural Landscape) provided an additional heritage review of the bridge, including:

- The original intent of the exterior cladding was likely to protect the overall structure;
- The heritage designation of the bridge is for an evolved structure that shows changes made over time. Heritage attributes include the layers that have changed and been added to the form;
- Modifications may add to the form and integrity of the bridge and may complement the timber form. Reversibility is not the only consideration to be made with respect to the heritage attributes;
- The experience of the bridge to locals and visitors should be considered;
- Visibility is poor for pedestrians in the bridge and cars entering the bridge;
- The viewing opportunities from a cultural heritage landscape perspective are limited;

- Not all cladding today is original; there is some evidence that there may be some original panels.

Leo Sanchez (Sanchez Engineering Inc.) described the bridge hydraulics and **Steve Taylor** (BTE) described the effects of climate change, including:

- The risk of flooding for the bridge is at the 10-year storm and beyond;
- Ice jamming takes place close to the underside of the bridge;
- The underside of the bridge elevation is lower than the 10-year flood headwater level;
- For all floods higher than the 5-year flood (the largest flood that passes under the bridge soffit), there will be lateral pressure forces and drag forces on the bridge (to be determined);
- The bridge is rated “high vulnerability”, i.e. it can be washed away or significantly damaged during flooding;
- The consideration of climate change should be a forward-thinking assessment of impacts (recognizing historical data is not indicative of the probability of future events), rather than a backward assessment of historical data/ storm events.

4.0 WORKSHOP RESULTS

4.1 Quality Modelling

The project analysis included a quality modelling exercise. This exercise highlighted the areas of greatest concern and high priority for this project, as shown in **Figure 5**.

Quality Modelling is a consensus building technique designed to identify the more sensitive aspects of the study. The VE Team developed unique definitions of predefined quality design standards or criteria and ranked them in a relative manner.

The value of the Quality Modelling session is not the end-product graphic but rather the discussion preceding the development of the model, during which definitions are agreed to and consensus is reached on the relative importance of the quality indicators.

The Quality Modelling exercise was focused on gaining consensus of the VE Team members when considering **18** quality indicators.

These indicators were:

- Costs
- Project Schedule
- Durability
- Ease of Operation and Maintenance
- Hydraulics
- Climate Change
- Cycling, Pedestrians, and Horse and Buggies
- Design Vehicle/Load Limit
- Vertical and Horizontal Truss Alignment
- Heritage
- Heritage Bailey Bridge
- Archaeological
- Approvals
- Natural Environment
- Fire Suppression
- Social Environment
- Safety and Personal Security
- Aesthetics/Prominence of Project/ Tourism

Of the **18** criteria considered, there were **8** quality/ performance factors that the VE Team collectively considered as the most important when considering their individual priorities and perspectives. These are along the outside edge of the circle on the Quality Model in **Figure 5**.

- Cost
- Project Schedule
- Durability
- Cycling, Pedestrians, and Horse and Buggies
- Design Vehicle/Load Limit
- Heritage
- Fire Suppression
- Aesthetics/Prominence of Project/ Tourism

The remaining factors were considered to be of relatively lower importance to the VE Study Team.

4.2 Function Analysis

4.2.1 Project Understanding

As an initial exercise, the concept of functions was explained. The analogy was used of a pencil as a "project" illustrating the components of the pencil and that the basic function had to satisfy the user requirement. In the example of the pencil the basic function is "Make Mark" i.e. the reason a user buys the pencil. In the Value Methodology this reflects a "work function" as the reason the customer buys the product. The value of the pencil is entirely determined by the work performed.

A second example presented the second type of basic function related not to the performance of work but rather related to "esteem function" of the customer. As illustrated in **Figure 3,** the Mont Blanc pen sells for a very high price not

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because it is an exceptional pen but rather based on marketing that it is a pen of high esteem. Most users carry it to show the white star in their breast pocket without actually using it as a pen.



Figure 3: Mont Blanc Pen

A third example for the workshop participants was to review an example of an asset that began as a "work function" (a portrait to record the image of a family member) that eventually became an international treasure because of the esteem value of the painter and the quality of his work. The painter was Leonardo da Vinci and the example was the Mona Lisa (see **Figure 4**).



Figure 4: Mona Lisa

For the consideration of the historic covered bridge, the team was asked to reflect on four covered bridges from New Brunswick in an exercise to understand which of the projects had a basic function related to "Performing Work" or related to "Providing Esteem". In this case the esteem value was to consider if the "worth" or "value" to society was related to the functions: "preserving history"; "historical preservation" of building practices, engineering and construction and materials from a previous era; and/or "creating a living record" for tourism and education. In short, the group was asked to look at examples and judge if they represented a "work function" primarily to move goods and people or an "esteem function" to preserve history (such as the international art treasure Mona Lisa).

In the four examples, included in **Appendix C,** there were distinguishable differences. In cases where the wooden trusses were asked to carry large vehicle weights and there was no alternative vehicular route for traffic to carry traffic over a watercourse, the primary purpose of the bridge was a work function – carry traffic.

In these cases no alternate route existed for traffic and the trusses were either modern or accepted large modern modifications to the wooden trusses to accomplish the movement of modern traffic and heavy loads of this traffic. In stark contrast were two examples - the Hartland Bridge and Florenceville-Bristol wooden truss bridges - which had new modern vehicular bridge constructed in close proximity. In these two examples, these functions of the bridges were for historical preservation, tourism, and education and not primarily to carry traffic.

Based on this exercise, the workshop participants were then asked to consider the West Montrose Covered Bridge. They were asked if this asset had the "primary purpose" to perform work (carry traffic) or rather to preserve history (esteem value such as the Mona Lisa). The group consensus was that the "basic function" of the project was not to complete the work function of carrying traffic but rather to achieve the esteem value of "preserving history" of the 1880 Howe truss design, building practices and materials. The consensus was that the investment was to prioritize preserving the asset without any or with minimal intrusion of the historic materials (with any intrusions to be reversible if required).

Based on this perspective of the project, it is not considered important to accommodate more or larger vehicles. It is more important to maintain the historic elements of the bridge by supporting the bridge (as was completed using the Bailey bridge rehabilitation) rather than modifying / altering and strengthening the historic truss bridge structural system which was designed for lower design loads in the era of horse and buggies (2 tonnes previously estimated).

4.2.2 Workshop Function Analysis

The success of any VE Study is predicated on the Team being focused on the right problem or opportunity.

Value Engineering is a team-oriented review process in a Workshop format, focused on the functions that the project, product or process must successfully deliver. During the Workshop, the VE Team identified the functions and prepared a Function Analysis System Technique (FAST) diagram.

The functions that must be performed were identified and categorized during the workshop. The full VE Team reviewed and augmented the FAST diagram during the workshop.

The VE Team identified and categorized the functions into Higher Order Goals, Basic (essential) and Supporting (desirable related to stakeholder requirements or assisting Basic) functions.

The Highest Order function was to **Protect People**.

The Basic Function was determined to be **Preserve Heritage**. (This is the base reason for the project). Functions that achieve this goal included:

- Accommodate Traffic
- Protect Structure
- Maintain Setting
- Conserve Materials
- Suppress Fire
- Reversible Rehab

Other necessary Supporting Functions (which may be necessary but are not essential for the project) include:

- Educate Visitors
- Improve Signage
- Improve Tourism
- Improve Safety

- Stage Construction
- Preserve Flow Gauge
- Protect Environment

The interdependency of the project functions is illustrated in the overall project FAST diagram, see **Figure 6**.

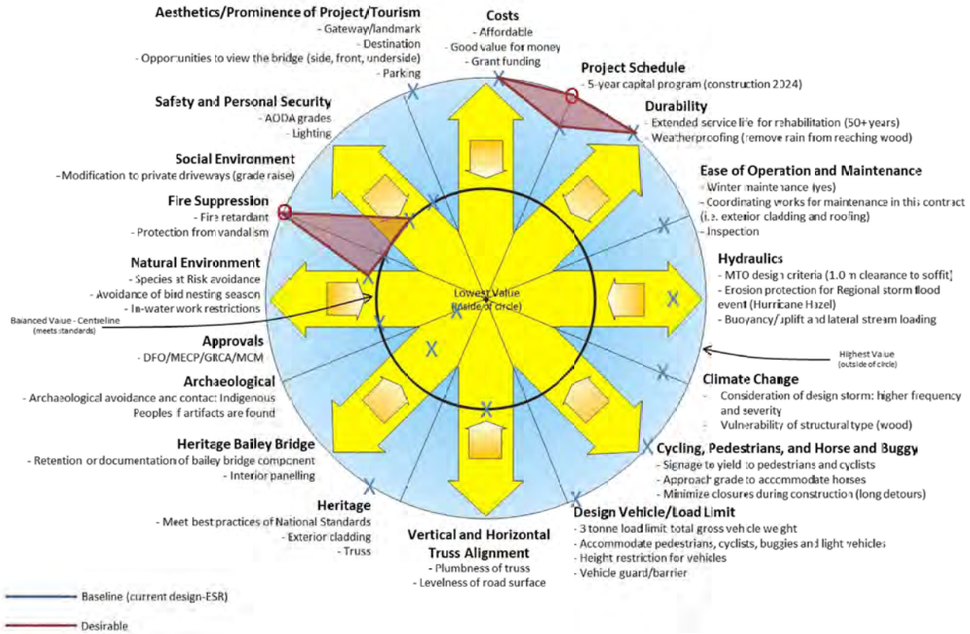


Figure 5: Quality Model

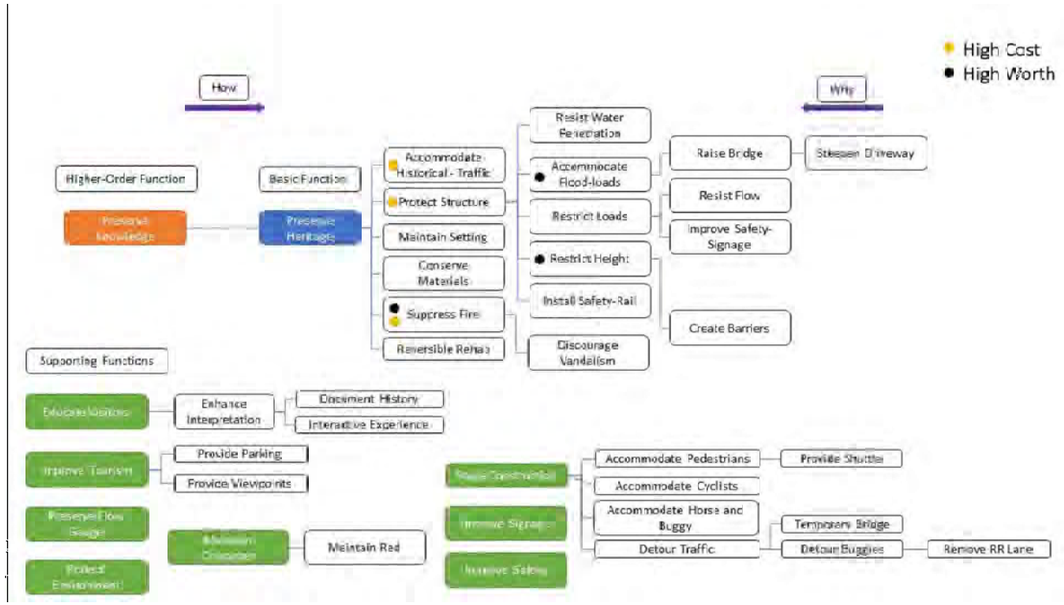


Figure 6: Overall FAST Diagram

Reading the FAST Diagram

The FAST Diagram is a model of the interdependencies of the project/process functions. While the graphical presentation of the functions is the end result, it is the discussion, teamwork, and consensus building that went into the development of the FAST diagram that truly benefits the VE Team. This is because a diverse group of participants have been able to reach agreement on what the Basic and Secondary functions of the project/process should be, described using a verb-noun pair for each function.

The FAST diagram is read from left to right asking the question for each function box: "**How** is <the function> performed…by doing <function to the right>. It can also be read from right to left: **Why** does it perform <the function>….to do the <function to the left>. Vertical function boxes when linked are read as <function 1 is done **when** doing function 2>.

The power of the function analysis as a tool is its ability to question project elements from first principles. For this study, the team was asked to understand the functional requirements for each element. For example, the more detailed analysis of the **Improve Tourism** supporting function identified several functions that can achieve this desirable outcome including **Provide Parking** and **Provide Viewpoints**.

Assessing the rationale for the project elements by function rather than the prescriptive solution led to greater abstraction by the team for methods to accomplish these objectives. This led to creative ideas that achieved the function but were not limited to the solution.

5.0 IDEA GENERATION AND EVALUATION

5.1 VE Study Targets

A VE Study is a time management exercise in that critical choices must be made to select the best proposals for development, given the limited time available.

The goal of the VE Study is to improve the value of the project. Value is best defined as the relationship of Function (quality or performance or benefits) versus Cost (monetary, time, environmental impact, etc.). The relationship between Value, Function, and Cost is expressed:

Value = Function/Cost

In most VE Workshops, Study Targets are generally selected based on the functions identified in the FAST diagram, the higher rated quality indicators from the Quality Modelling exercise. A total of 81 ideas were generated.

5.2 Idea Development and Tracking

The purpose of the VE exercise was to develop a list of ideas for submission to, and for consideration by the Region. During the VE session, the Team reviewed each of the ideas to screen out relatively weaker/ less-promising ideas.

One objective of the VE Study was to reduce the number of ideas to a manageable number that represent the best ideas, or those ideas that have the greatest opportunity for acceptance.

The short-listed ideas include a reference number used by the VE Team during the generation of alternatives, which relates to the function being studied. This list of ideas formed the basis for further development by the VE Team.

5.2.1 Evaluation

The coarse screening evaluation of the ideas focused on eliminating duplicate or very similar ideas or those with the least likelihood of being implemented when considering the quality model indicators. Combining dependent ideas was also considered.

The study generated **82** ideas that had the opportunity to improve value (i.e., improve performance or reduce cost while meeting the required performance). From this long list, the Constructability and VE team short-listed **55** ideas which were most likely to be implemented. **Table 3** presents the list of ideas from the creative phase of the workshop championed by one or more team member for further review. Because the workshop was constrained by time, the VE team was asked to prioritize ideas to carry forward. However, the entire list contains other ideas that can be reviewed by the design team. The complete list of the 82 ideas generated by the VE Team to improve the project is presented in **Appendix B**.

The VE Team developed **45** ideas for further review by the Project Team. The value proposal write-ups are included in **Appendix D**.

Table 3: Short-Listed Creative Ideas	
Idea ID No.	**Idea Description**
1	Set load limit at 3 tonnes (posted) and design to a minimum of 5 tonnes
2	Review signage for load limits at the Regional Road
4	Improve signage with a picture sign of vehicle types not permitted
5	Provide a 3.3 m vertical clearance limit at the bridge
7	Vehicle weight sensors in the road (install weight scale)
10	Install interior barrier for protection of the truss
11	Alternative B (including raising soffit 150+/- mm)
12	Alternative A (including raising soffit 150+/- mm)
13	Reduce sag on bridge to increase clearance
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15	Replace exterior cladding as needed (i.e. not entire replacement)
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17	Detailed survey of cladding to determine condition of each board. Create a design criterion for the board replacement
19	Salvage some existing bridge components that require replacement for on-site display
20	Maintain current gross external dimensions on the bridge to the greatest extent possible
21	Strengthen bridge but maintain original dimensions of the bridge
22	Remove bailey truss and affix timber reinforcement on the sides of the bottom chord (modified Alternative B)
24	Reduce the height of the new FRP (or alternate material) to be reduced to the minimum amount possible to achieve 5 tonne load capacity (design)
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67	Hydraulic forecasting to consider climate change
68	Keep existing approach grades
69	Strengthen piers/abutments for increased hydraulic pressure
70	Design floor structure for hydraulic pressure
71	Tie-down superstructure
72	Install tie anchors on the exterior for future maintenance access
73	Accept existing profile through the truss
74	Create a working group at GRCA to review policies and downstream jamming mitigation
76	Increase exposure of the truss from the inside of the bridge
77	Restore window vents to original size
78	New work should be distinguishable from, compatible with and subordinate to the heritage structure, and reversible where possible
79	Selectively replace severely damaged chords of the truss
80	Video surveillance to deter vandalism
81	Maintain floor beam unique appearance under the bridge to the extent possible because this is unique to this truss design
82	Accept removal of the Bailey Bridge and adding lower splash guard

6.0 STUDY RECOMMENDATIONS

The VE Team built consensus for the following key conclusions and recommendations. The design team will consider the previously presented Alternatives A and B (**Figure 7**), an internal suspension cable system (**Figure 8**), and various value proposals aimed at improving the structure and surrounding landscape. The key recommendations for each alternative bridge type will include:

- Set the load limit to 3 tonnes (posted) and design for a minimum live load of 5 tonnes;
- Improve signage for vehicles that are not permitted (weight and height);
- Design elements to resist hydraulic loading or increase hydraulic capacity, considering global climate change.

6.1 Context of Review

It must be recognized that the proposals and recommendations from the VE Workshop represent the consensus of the participants. However, these recommendations will be the subject of more detailed review, debate, and analysis. This was a scoping and brainstorming exercise utilizing industry expertise for project understanding as one of the phases of the study, and these short-listed ideas are expected to be used for building confidence in the project and establishing a reliable project budget.

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Region of Waterloo
West Montrose Covered Bridge
Value Engineering Report, May 15, 2023

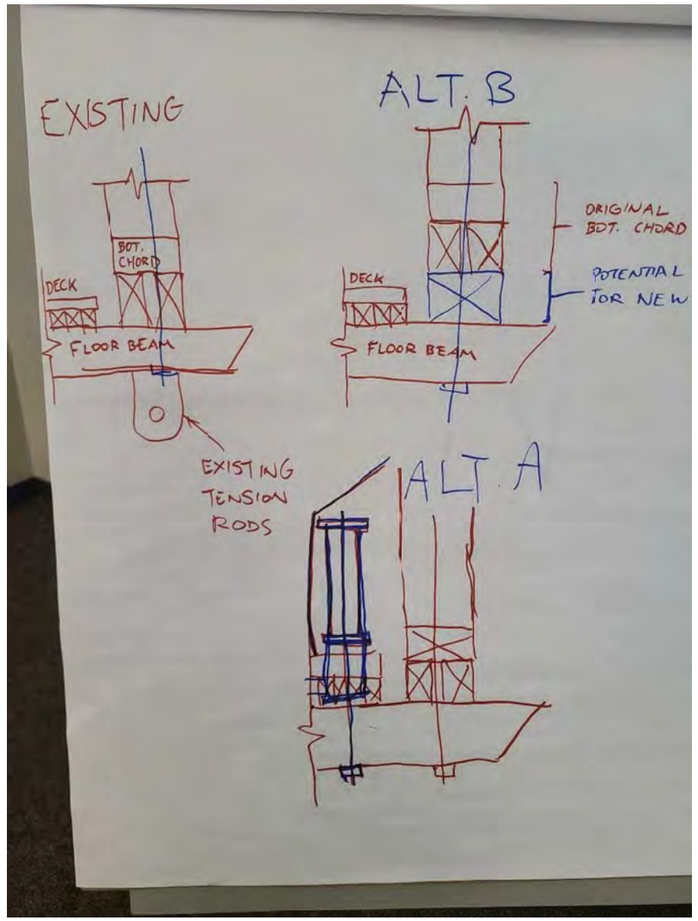


Figure 7: Sketches of the Existing Truss Cross Section and Alternative A and B Design

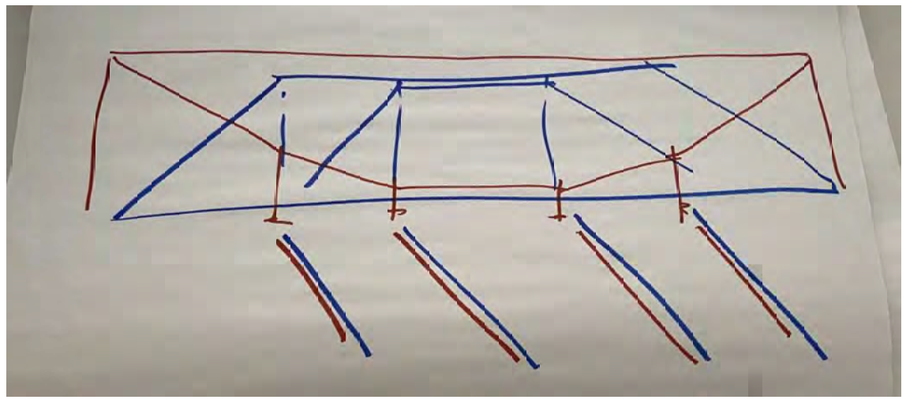


Figure 8: Internal Suspension Cable Sketch

Appendix A

VE Workshop Agenda and Team Memo

AGENDA

Project: West Montrose Covered Bridge Rehabilitation
Value Engineering Workshop

BTE Project No.: 22-058

Venue: Region of Waterloo Operations Centre, Big Classroom
100 Maple Grove Road
Cambridge, ON

Date: Tuesday, March 21, 2023

Time: 9:00 to 4:00 pm

Host Contact: Michelle Pinto
Project Manager, Region of Waterloo
Email: mipinto@regionofwaterloo.ca

Workshop Team Leader: Steve Taylor P.Eng., P.E., M.Eng., CVS-Life
President, BT Engineering Inc.
Email: stevenj.taylor@bteng.ca

Day/Time	Workshop Phase	Activity	Duration
9:00 am		**TEAM MEMBERS ARRIVE**	5 min
9:05 am	**Introduction**	**INTRODUCTION TO WORKSHOP/INFORMATION PHASE**	
		Welcome and Opening Remarks – Sandy Shantz, Mayor of the Township of Woolwich	5 min
		Team Member Introductions	10 min
		Objectives of the Workshop – Steve Taylor	5 min
		Introduction to Value Management Principles and Workshop Stages – Steve Taylor	15 min
9:40 am	**Information**	**Project Briefing - Design Team Technical Presentation**	50 min
		Presentations will be made to provide an overview of the background of the project and the expectations of the owners and stakeholders. *The following topics will be presented:* • *Project Introduction – Michelle Pinto* • *Owner expectations – Michelle Pinto* • *Vision/Budget/User Expectations – Michelle Pinto* • *Overview of Design Approach Moving Forward/Roles and Responsibilities – Michelle Pinto*	

Day/Time	Workshop Phase	Activity	Duration
		• *Design Team Project Briefing - description of overall project completed to date (Schedule A EA, stakeholder consultation, environmental and community issues, GRCA/DFO/Ministry of Citizenship and Multiculturalism (MCM) design permits/approvals, significant features in Study Area, designs and design criteria). Topics will include:* • *Schedule – Michelle Pinto* • *Project Overview and Background (Doug Dixon, Doug Dixon & Associates)* o *Structural alternatives developed and presented at previous PICs* o *Approvals* o *Road closure and staging* • *Discussion of public comments received to date – Michelle Pinto*	
10:30 am	**BREAK**		15 min
10:45 am	**Information**	**Project Briefing - Design Team Technical Presentation – Continued** • *Heritage requirements – coordination with Township and other parties (Richard Unterman)* • *Natural environment investigations/studies (Michelle Pinto)* • *Climate Change and Bridge Hydraulics (Leo Sanchez)* • *Structural investigations completed 2023 (David Moses, Andrew Lehan and Wendy Shearer)*	45 min
11:30 am	**Information**	**Constraints, Commitments and Opportunities** *The workshop will review the constraints, commitments and opportunities of the project and document them for future use in the study. The intent of this is to define the design goalposts for the Project Team.*	15 min
11:45 am	**Information**	**QUALITY MODEL** *Quality Modelling is an interactive consensus building technique, which is focused on defining project sensitivities and expectations for the Project.*	30 min
12:15 pm	**Lunch Break**	Lunch will be provided.	45 min

Day/Time	Workshop Phase	Activity	Duration
1:00 pm	**Function Analysis**	**FUNCTION ANALYSIS** *Value Management is a powerful decision-making technique that considers ways to improve the functions provided by the project. This difference – improving functions versus products – is critical to the outcome of the study.* *A FAST (Function Analysis System Technique) diagram documents the interrelationship between functions of the project and is used as a tool to identify "target functions" that will be focused on during the workshop. The FAST diagram will serve as a catalyst during the Creativity Session.*	1 h
2:00 pm	**Cost Analysis**	**TARGET COST/WORTH ANALYSIS** *A Target Costing exercise will be completed by the team associating each project component in the baseline cost estimate with a series of functions and a target cost.*	15 min
2:15 pm	**Creative Phase**	**CREATIVE PHASE** *The Team will be asked to identify the functions that they collectively feel should be targeted for improvement.* *The Team will also consider the various functions in terms of risk, constructability and opportunity to define target functions.* *Creative Brainstorming - The Team will then use brainstorming techniques utilizing the functions/FAST diagram as a guide to list ideas to improve the target functions identified earlier.* *Targets may include:* • *Bridge aesthetics/user experience* • *Bridge alignment(s)/personal safety and security* • *Bridge type(s)/substructure and utility protection* • *Environmental* • *Constructability*	1 h 15 min
3:30 pm	**Evaluation Phase**	**EVALUATION PHASE** *The team will use a two-stage process to screen and then evaluate the ideas. The first stage will utilize a first-preference approach to develop a shortlist of ideas.* *The second stage will focus on review and shortlisting of the alternative concepts to be carried forward for development.* *The team will create a long list of potential evaluation criteria for the subsequent Multi-Attribute Trade-off System (MATS) evaluation workshop.*	30 min

Day/Time	Workshop Phase	Activity	Duration
4:00 pm	**Adjourn**		

Distribution: All

509 Talbot Street
London, ON N6A 2S5
519-672-2222

MEMORANDUM

To:	Value Engineering Workshop Members
From:	Steve Taylor, CVS VE Team Leader
Date:	March 9, 2023
Project No:	22-058
Project:	West Montrose Covered Bridge Rehabilitation Value Engineering Workshop
Re:	Team Introduction Memo

Introduction

We are delighted that you are able to participate in the above noted Value Engineering workshop for the Region of Waterloo's West Montrose Covered Bridge rehabilitation project.

This workshop team consists of the design team and independent engineering specialists who will review the project before it proceeds further. We will follow the structured Value Engineering methodology to review the project from first principles to:

- Identify the problem and benchmark costing analysis;
- Ensure value for money for the Region;
- Identify any significant risks and mitigation or avoidance measures that should be included in the design of the project;
- Ensure constructability of the design; and
- Develop a list of value proposals for further consideration during detailed design.

Participants will be asked to review the project requirements including: the quality and scope of the project as currently defined, each component of the project against the available budget, and develop a list of recommended ideas that we, the workshop team, believe offer the best opportunities to improve the value of the project (i.e. make it work better and/or lower the cost of ownership considering life cycle costs), or reduce risks to the owner and project team. Collectively, our team will use its experience and knowledge to validate the design development to date, provide proposals on how to deliver the project on budget, and then develop these ideas for presentation to the key decision-makers. The design team, Region and Regional Council will be the final decision-makers on the proposals following the workshop.

An agenda, indicating the workshop location and start/finish times, is being distributed as an attachment.

Workshop Logistics

The workshop will be held at:

Region of Waterloo Operations Centre, Big Classroom
100 Maple Grove Road
Cambridge, ON
Date: Tuesday, March 21, 2023

Parking is available at the site.

Transportation

Team members will be responsible to make their own arrangements to attend the workshop. The workshop is most effective when attendees can be there for the entire day. Your attendance for the full day is encouraged and appreciated; however, we understand if you can only attend for part of the day.

Breaks and Lunch

Light refreshments and lunch will be provided at the workshop. Please advise ASAP of any dietary restrictions.

Background Information

External specialist team members are not expected to complete a detailed review but are to familiarize themselves with the project. The Design Team will brief participants at the workshop. An agenda is appended to this memorandum.

Closing

This will be an interesting and challenging project and I look forward to the results we will achieve. The purpose of the workshop is to formulate value proposals for consideration in the design, to develop the best value project for the owner and end users. Your role as a team member will be to contribute your knowledge and expertise to the team so that these recommendations can be identified and developed to the extent that time allows.

For one of the activities, I am asking you to **bring 4 loonies ($4.00)**. The reason why will be explained at the workshop.

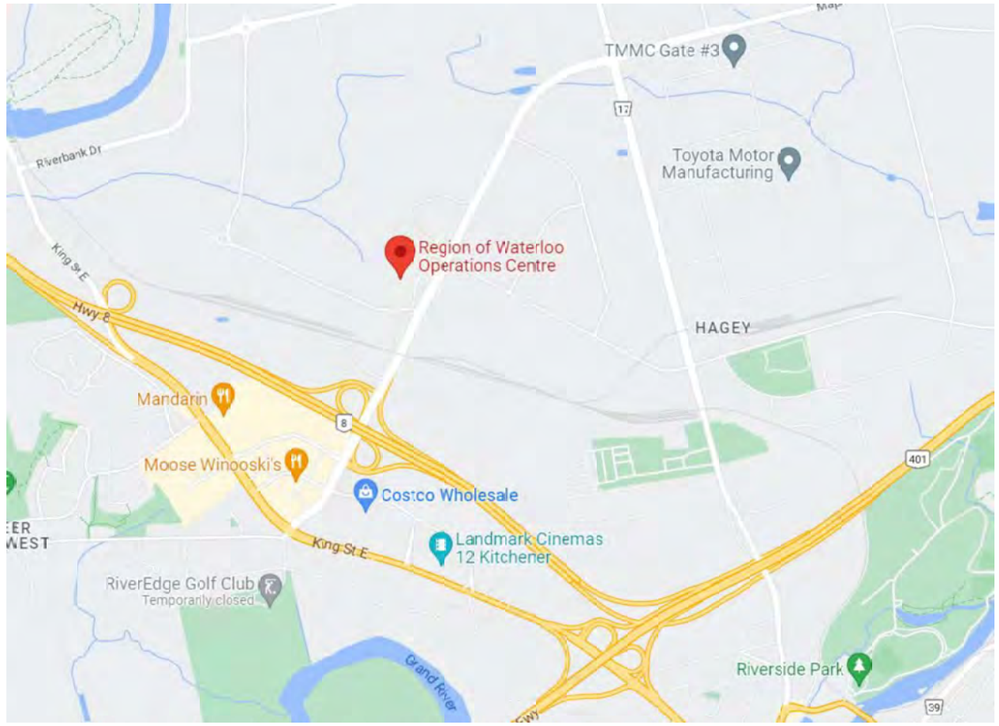
We appreciate the commitment you have made to participate in our workshop team. Please feel free to contact me at stevenj.taylor@bteng.ca or at (519) 672-2222 if any further information is required. We look forward to working with you, and remember, a positive attitude fosters great ideas.

Sincerely,

Steve Taylor, P.Eng., M.Eng. CVS-Life
Workshop Team Leader / Project Manager

Attachments: 1) Workshop Agenda
2) Workshop Location Map

Workshop Location Map





Appendix B

Creative Idea Listing

ID No.	Description	Carry Forward?
1	Set load limit at 3 tonnes (posted) and design to a minimum of 5 tonnes	Y
2	Review signage for load limits at the Regional Road	Y
3	Accommodate vehicle turnaround at the bridge	N
4	Improve signage with a picture sign of vehicle types not permitted	Y
5	Provide a 3.3 m vertical clearance limit at the bridge	Y
6	Set load limit at 5 tonnes (posted)	N
7	Vehicle weight sensors in the road (install weight scale)	Y
8	Signage for one vehicle crossing the bridge at a time	N
9	Signage for maximum occupancy (people in the bridge at a time)	N
10	Install interior barrier for protection of the truss	Y
11	Alternative B (including raising soffit 150+/- mm)	Y
12	Alternative A (including raising soffit 150+/- mm)	Y
13	Reduce sag on bridge to increase clearance	Y
14	Raise the bridge at the south abutment to match the height at the centre pier	Y
15	Replace exterior cladding as needed (i.e. not entire replacement)	Y
16	Replace all exterior cladding (similar, if feasible, to 1880s design) to reduce future maintenance requirements	Y
17	Detailed survey of cladding to determine condition of each board. Create a design criterion for the board replacement	Y
18	Interior moisture barrier lining behind the exterior cladding (cladding remains as is)	N
19	Salvage some existing bridge components that require replacement for on-site display	Y
20	Maintain current gross external dimensions on the bridge to the greatest extent possible	Y
21	Strengthen bridge but maintain original dimensions of the bridge	Y
22	Remove bailey truss and affix timber reinforcement on the sides of the bottom chord (modified Alternative B)	Y
23	Salvage boards with a finger joint	N
24	Reduce the height of the new FRP (or alternate material) to be reduced to the minimum amount possible to achieve 5 tonne load capacity (design)	Y
25	Sandwich connection with steel plate between boards (instead of FRP)	Y
26	New horizontal cladding at the rooftop with the original boards under to the soffit	N
27	Replace the existing bailey truss with a stronger bailey truss	N
28	Double the bailey truss (i.e. side by side)	N
29	Pedestrian signals on the two ends	N
30	Elevated pedestrian walkway inside the bridge	N
31	Pedestrian walkway on the outside of the bridge across the needle beams (during construction)	Y
32	Internal suspension cable system (inverted bow string)	Y
33	Glulam timber arch (Vermont example)	N

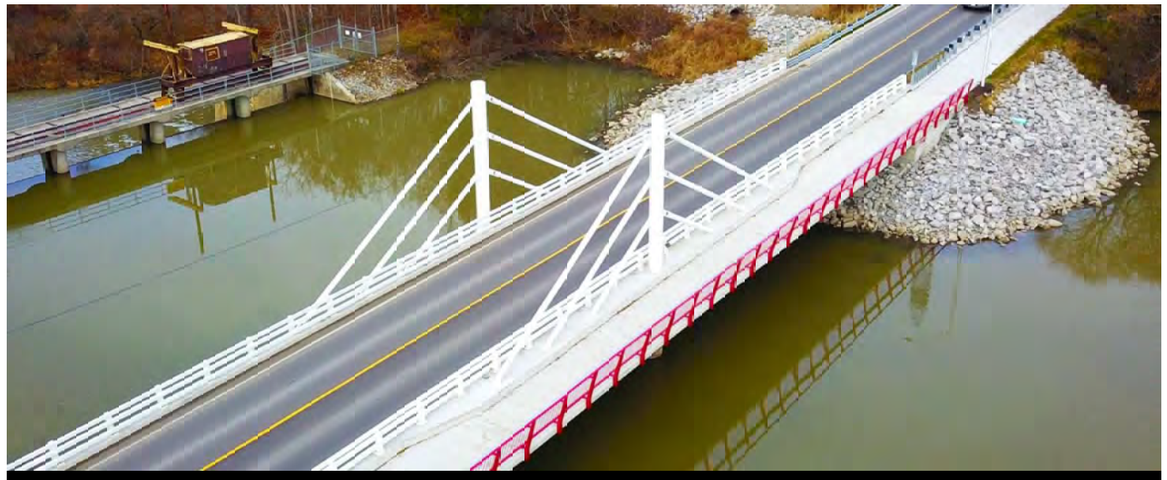
ID No.	Description	Carry Forward?
34	Dry system for fire suppression	Y
35	Treat timbers with fire retardants	Y
36	Cistern/reservoir at the park upstream from the bridge	Y
37	Blackfriars Bbridge height restriction	Y
38	Community input contest on the design for the height restrictor	Y
39	Electronic height restrictor (sensor)	N
40	Signage for spacing vehicles as one at a time	N
41	Signage to restrict vehicles on the bridge at the same time as a pedestrian	N
42	Signage to identify pedestrian occupancy load	N
43	Steepen driveway to 8% and determinefind the dimension this wouldit allow allows to raise the bridge to be raised	Y
44	Improve visibility (convex mirrors to see vehicles approaching the bridge)	N
45	Traffic signals at the bridge	N
46	Two-way stop at the south end and a stop sign at the north end	Y
47	Stop bar to be moved back to allow the horse and buggy to swing wide with the southbound left turn lane	N
48	Tree clearing to improve visibility	Y
49	Bridge approaches to be removable during large storms	N
50	Culvert under the bridge approaches to allow flood overflow	N
51	Educational storyboard on the evolution of bridge technology employed in this bridge	Y
52	Salvage materials of the bridge for an interactive storyboard	Y
53	Bridge on the north side under the approach to accommodate flood overflow	N
54	During construction, provide a dedicated lane on Line 86 for horse and buggy (remove a lane for vehicular traffic)	Y
55	Reduce speed on Line 86 during construction for use as a detour	Y
56	Maintain the exterior red colour	Y
57	Exterior lighting on the bridge	N
58	Maintain a wooden curb for splash guard	Y
59	Move louvers back to the original height to allow more daylight	Y
60	Transparent splash guards	N
61	Review Guelph bridge for vandalism issues	N
62	Install safety rail to protect truss from errant vehicles travelling through the bridge	Y
63	Interior railing/curb to be low height to see truss from the car	Y (see 58 and 62)
64	Prequalification of bidders	Y
65	Steel roof	N
66	New cedar shingle roof	Y
67	Hydraulic forecasting to consider climate change	For review
68	Keep existing approach grades	Y

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West Montrose Covered Bridge
Value Engineering Report – Creative Idea Listing

ID No.	Description	Carry Forward?
69	Strengthen piers/abutments to accommodatefor increased hydraulic pressure	Y
70	Design floor structure to accommodatefor hydraulic pressure	Y
71	Tie-down superstructure	Y
72	Install tie anchors on the exterior for future maintenance access	Y
73	Accept existing profile through the truss	(see 13)
74	Create a working group at GRCA to review policies and downstream jamming mitigation	Y
75	Improve downstream river hydraulics from the bridge	N
76	Increase exposure of the truss from the inside of the bridge	Y
77	Restore window vents to original size	(see 59)
78	New work should be distinguishable from, compatible with and subordinate to the heritage structure, and reversible where possible	Y
79	Selectively replace severely damaged chords of the truss	Y
80	Video surveillance to deter vandalism	For consideration by community association
81	Maintain floor beam appearance under the bridge to the extent possible because this is unique to this truss design	Y

Appendix C

Workshop Presentations





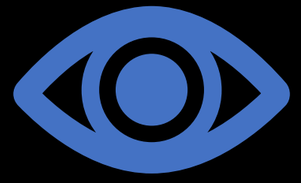
Background/Experience

- CVS-Life
- Transportation Background with approximately 1500 projects
- VE projects have included Transportation, Transit, Buildings, Water and Sewage Plants, Patent Applications, Planning for Business (Hockey Team) etc.



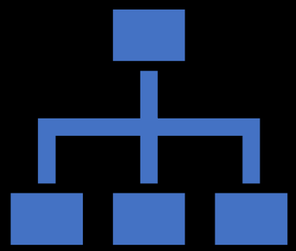
Workshop Objectives

- Team Building
- Clear Definition of Problem
- Question all Previous Decisions
- Generation of Quantity of Ideas
- Capture Group Experience
- Build Certainty for Budget
- Identify High Risk (Risk =Cost)



Keep your eyes open for:

- A mismatch in value
- Areas of high risk- accept but manage risk
- What has a low worth (not related to basic function)
- Separate the “I wants” from the “I needs”
- Consider all subsystems (Chain)



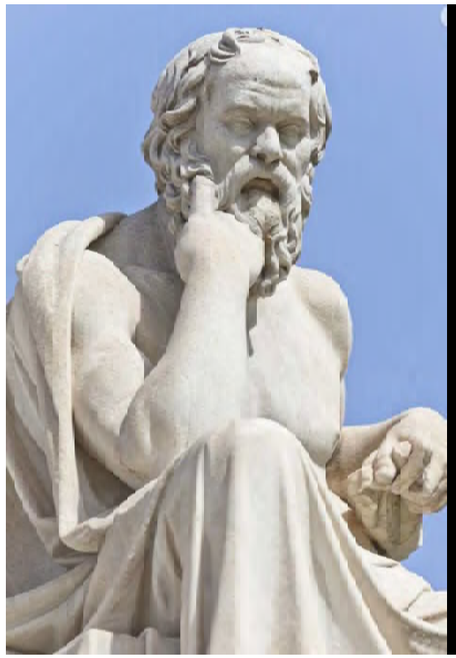
Workshop Organization

- Generally One person speaks at a time
- Casual and Informal Discussions
- Be Respectful of Others
- We will not all have common opinions
- Everyone will contribute
- VETL will control the clock
- Final presentation will reflect concensus of opinion of industry experts



Workshop Agenda

- Information Phase
  - Project Background
  - Constraints, Commitments and Opportunities
  - Quality Modelling
- Function Analysis Phase
- Creative Phase
- Development Phase-Task Assignments
- Presentation Phase

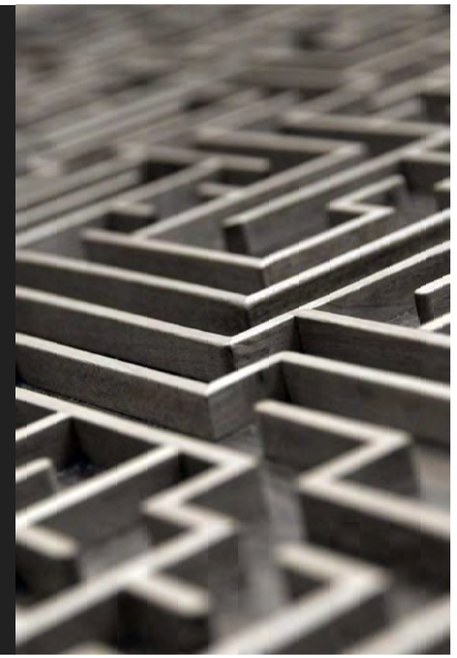


Basis of Value Engineering Ask Critical Questions

- Socrates known as the father of father of philosophy
- He fostered Critical Thinking by asking exploratory questions
- He taught by asking questions, a method known as the Socratic method, which aimed to expose contradictions and stimulate critical thinking
- Enquiring questions to reason - Value Engineering uses similar tools to lead to greater understanding

Change

- Fundamental changes have occurred in society – the basic ways we do things
- What would have been thought impossible became ordinary





Paradigms –New Ways of Seeing

What is a Paradigm?

- Accepted examples of actual scientific practice (research based on shared paradigms are committed to the same rules and standards for scientific practice)
- A set of shared assumptions (give us the advantage of being able to set a valid set of expectations)

Last Weeks Paradigm

- Roundabouts always have less conflicts than signals



Who are these paradigm shifters

1. Young person fresh out of training – Albert Einstein!
2. An older person changing fields – Dr. Alex Mueller, Nobel Prize winner: a physicist goes to superconducting

Unintentional blindness

- Researchers looking at data unintentional disregard data that does not fit the paradigm
- Focused groups do not see the edges



Value Methodology

VE Work Plan Phases

- Information
  - What is the purpose of the projects or project elements?
- Function Analysis
  - What must it do
  - What does it cost?
  - What is it worth?
- Creative
  - What else will do it?
- Judicial
  - How well does it do it?
- Development
  - What will it cost?
- Presentation

Value / Quality

- Quality
  - good performance
- Value
  - appropriate performance and cost

The Origins of VE?

- General Electric in the 1940's
- Developed by Lawrence Miles
- Purchasing Engineer
- Result of shortage of materials
- Created function based methodology
- Results reduced cost/improved value
- Formalized VE process

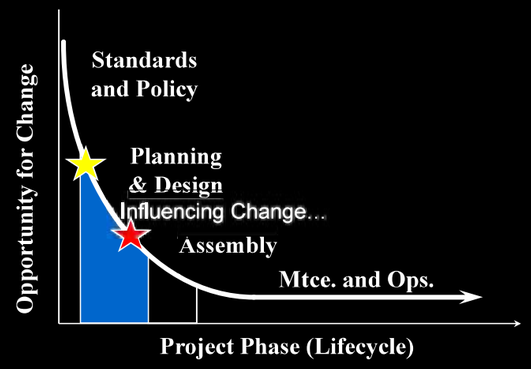
Value Engineering Overview

- VM Definition:
  - Value Management is a systematic, creative, function-oriented, team approach to optimize project performance/quality for the resources spent
- Another way of looking at it:

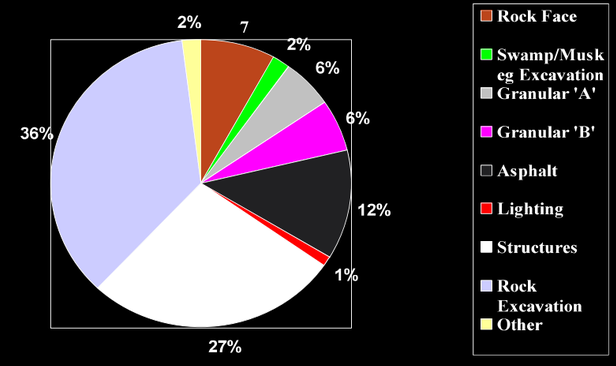
$$\text{Value} \sim \frac{\text{Function}}{\text{Cost*}}$$

* monetary, schedule, environmental or property impacts, space, etc.

Influencing Change…

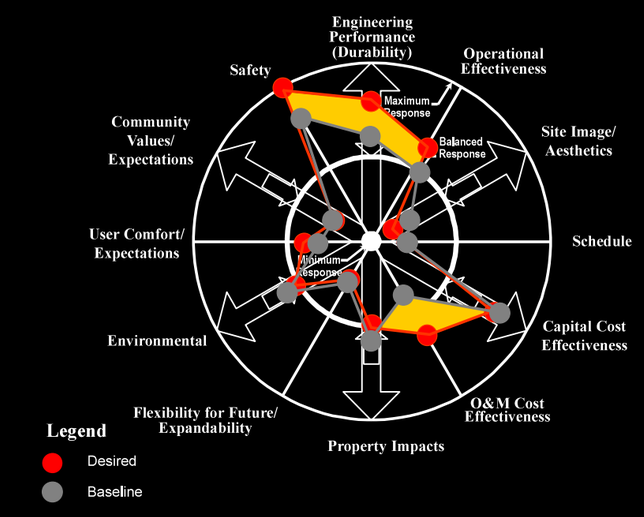


Sample Cost Model



Information Phase

Quality Model



Analysis Phase

Defining Functions

- The work performed by a project, product, process, or procedure.
- A concise statement of what is being accomplished without specifying the means.
- A two-word performance description using an active verb and a measurable noun.

Function Analysis

- Identifies:
  - what customers really want
  - how much they are willing to pay for
- The 6 “What Questions” we ask…
  - What is the purpose of the project or project element?
  - What does it do?
  - What does it cost?
  - What is it worth?
  - What alternative would do the same Job?
  - What would that alternative cost?

Defining Functions

Action Verb		Noun
Transports	→	Vehicles
Conveys	→	Weight
Transmits	→	Flow
Protects	→	Heat
Houses	→	People
Supports	→	Load

Functional Analysis

Convention Design Review

Project A → ■ → Project A'

Value Analysis

Project A → ■ → Project A' or B

Understanding the Basic Function



- Charles Bytheway - "The answer depends on who you ask":
  - Passenger
  - Employee
  - CEO
  - Shareholder

Eye Glasses Example

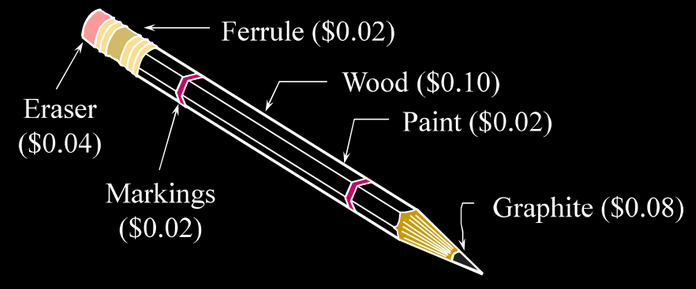


FAST

- Uses intuitive logic
- Allows people to communicate
- Common language
- Physicists/engineers/…agree on a common basis

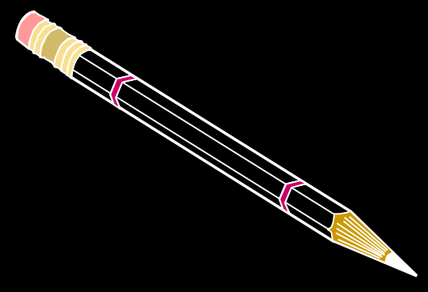
Pencil Example

- **What is the cost of the pencil?** $0.28



Pencil Example

- **What is the function of a pencil?**

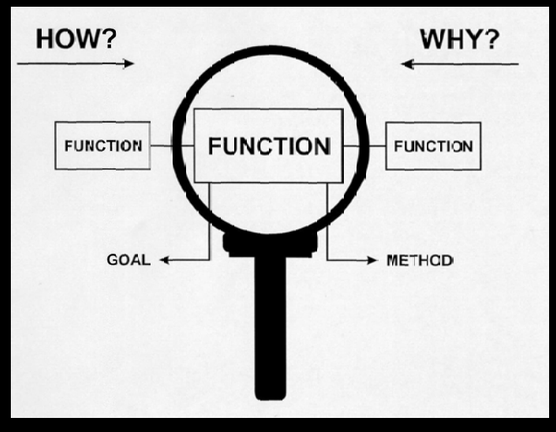


Pencil Example

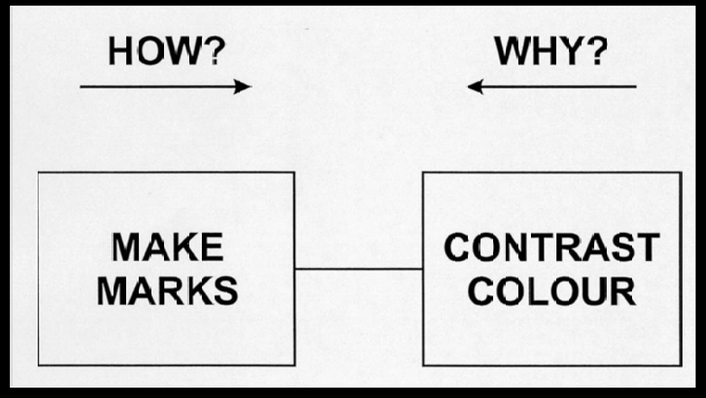
Pencil		make marks
eraser	S	remove marks
ferrule	S	hold eraser
wood	S	hold graphite
paint	S	protect wood/add beauty
markings	S	identify product
graphite	B	make marks

B – Basic Function
S – Secondary/Supporting Function

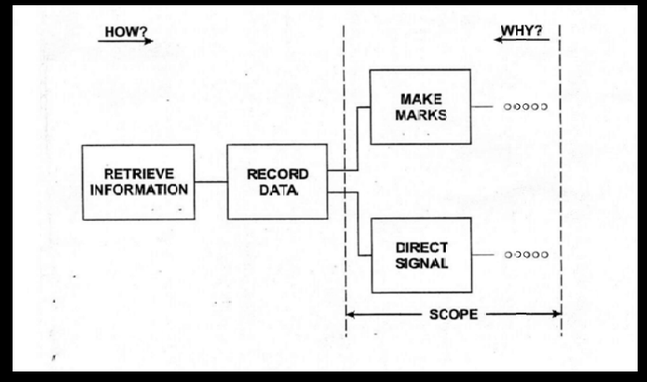
The Language of Functions



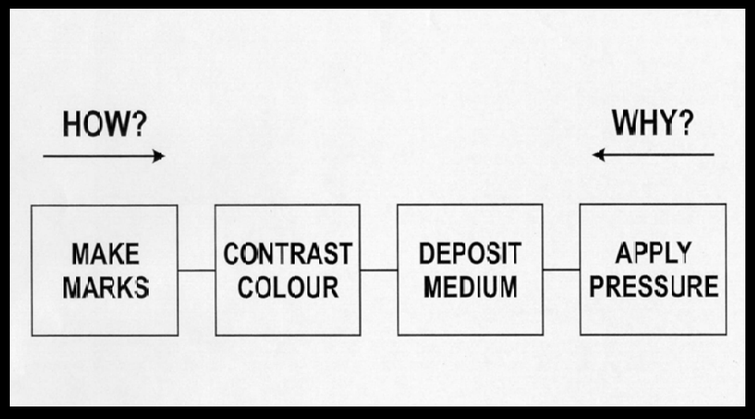
The Language of Functions



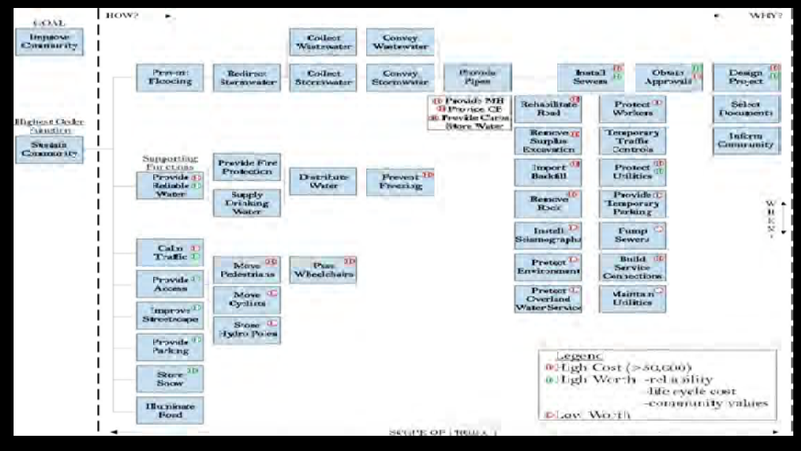
Documenting Function Relationships/Level of Abstraction



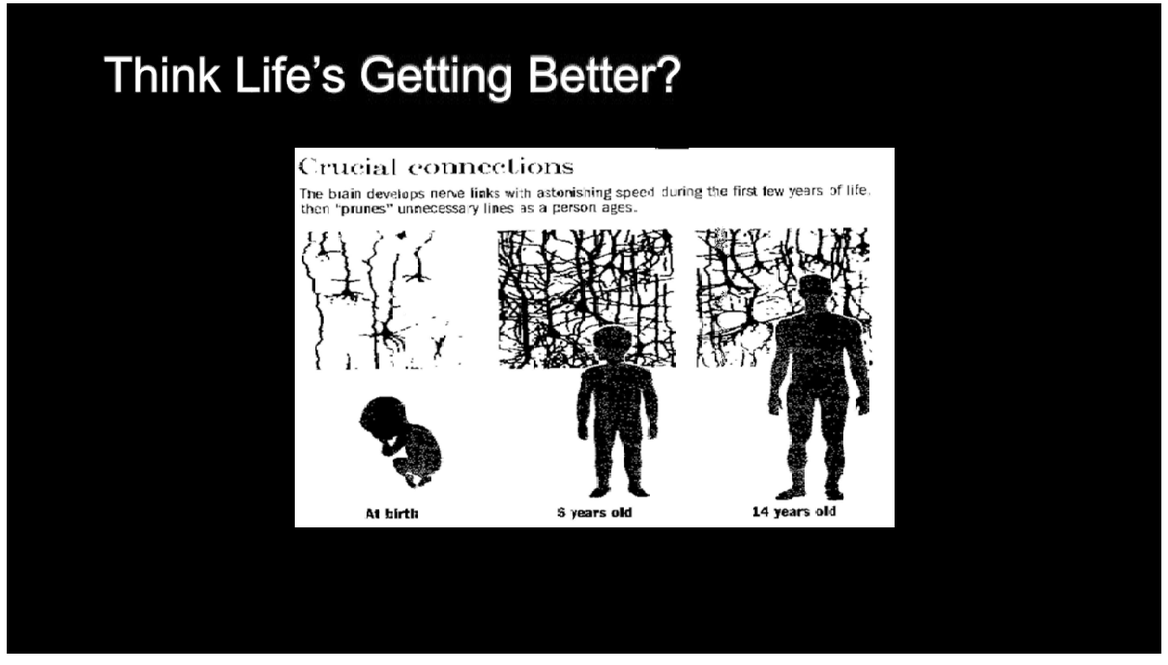
The Language of Functions

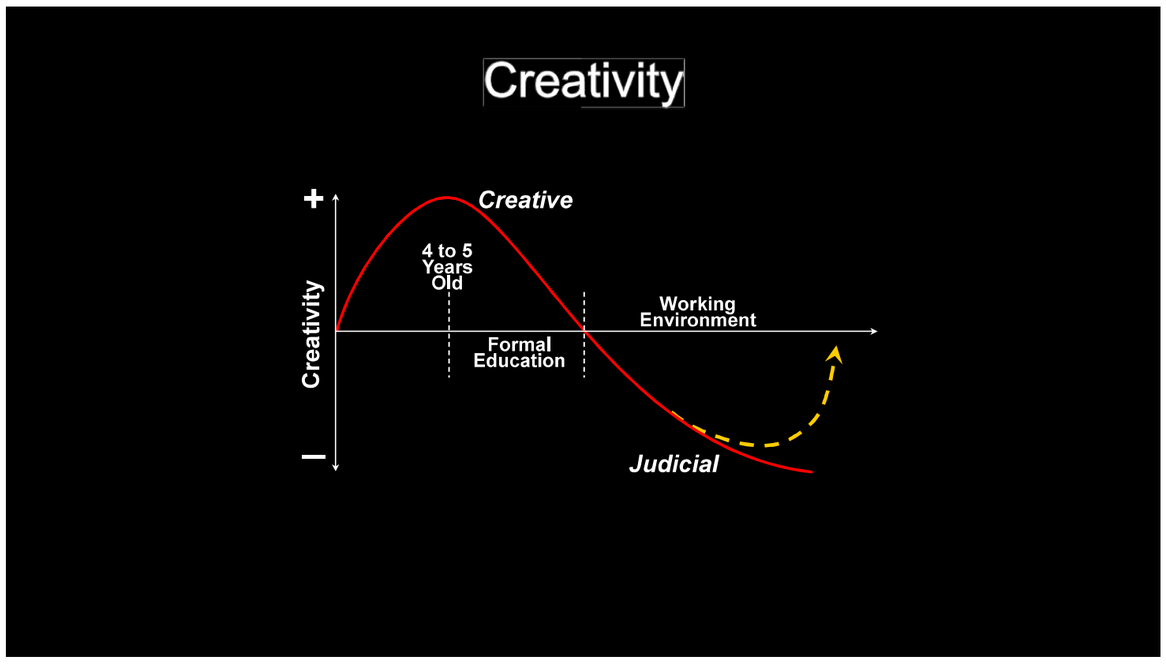


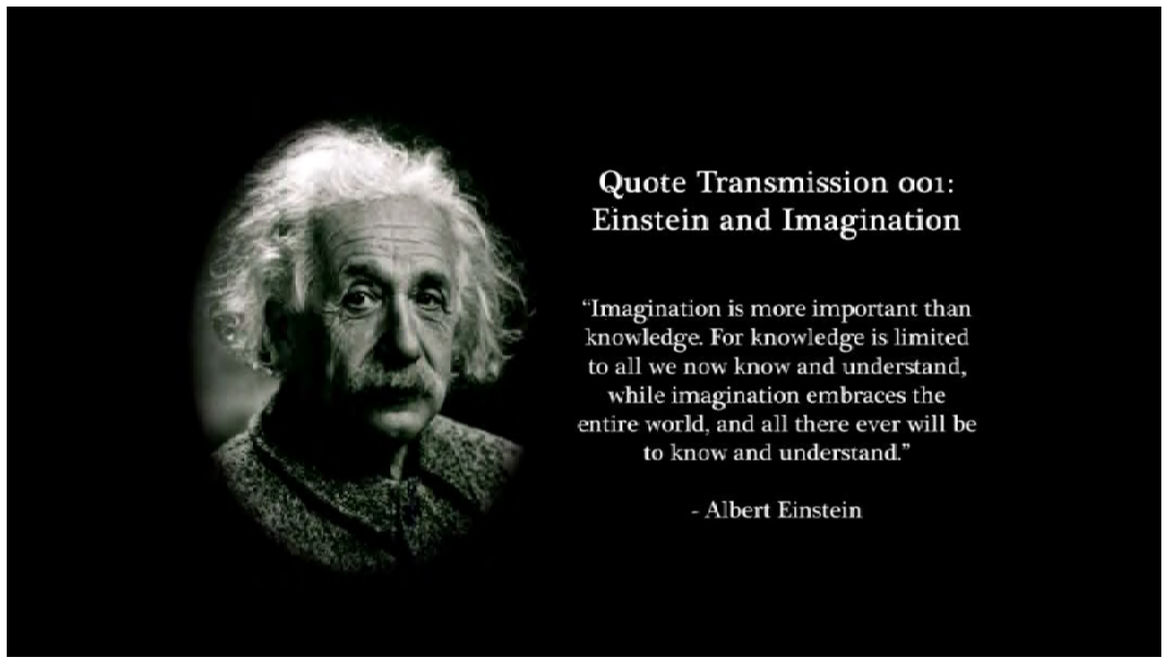
FAST Diagram



Creative/ Speculation Phase







Road Blocks

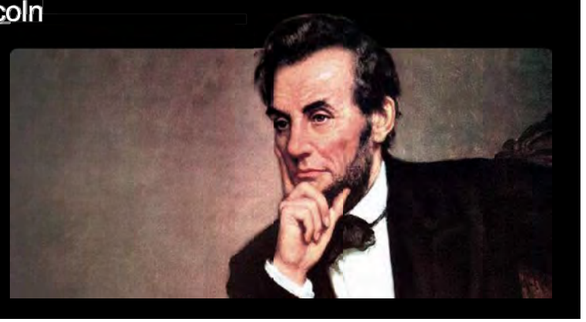
- We tried that before.
- It would cost too much.
- That's not my job.
- We don't have the time.

Example:
Algonquin College
Police/Justice Pedestrian Bridge

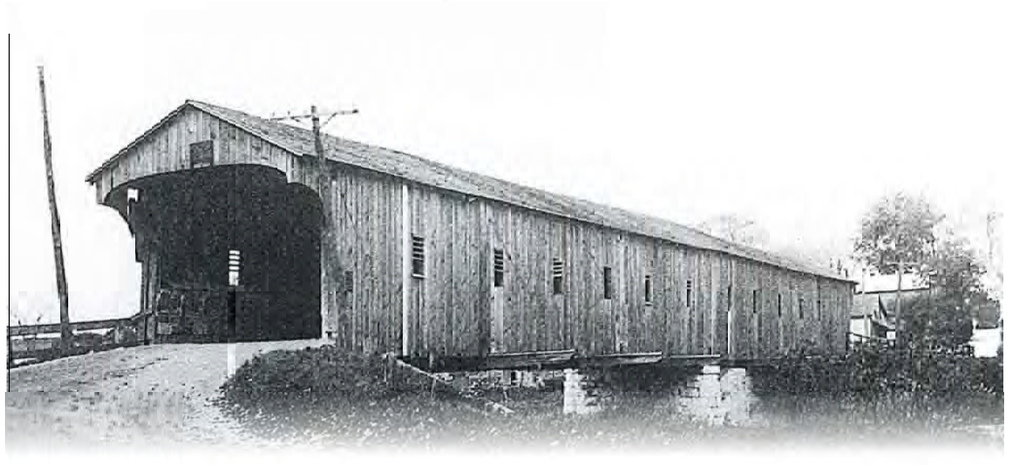


Closing Thoughts

- If I had an hour to cut a tree ……
- I'd spend the first 50 minutes sharpening my axe!
- ……Abraham Lincoln

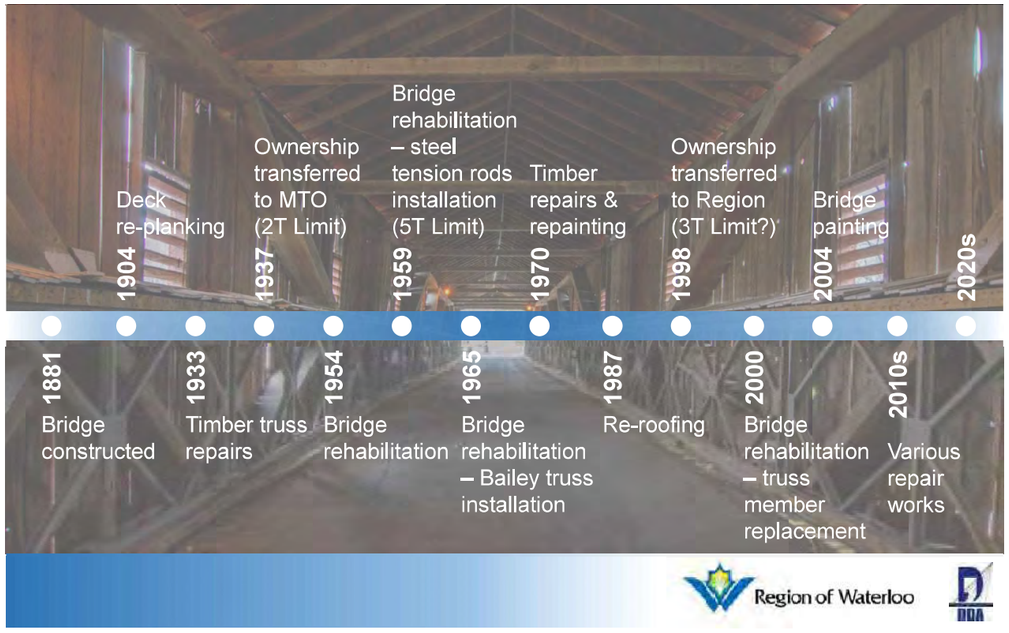


West Montrose Covered Bridge
Project Introduction and Background



Region of Waterloo

West Montrose Covered Bridge
Structural History of the Bridge



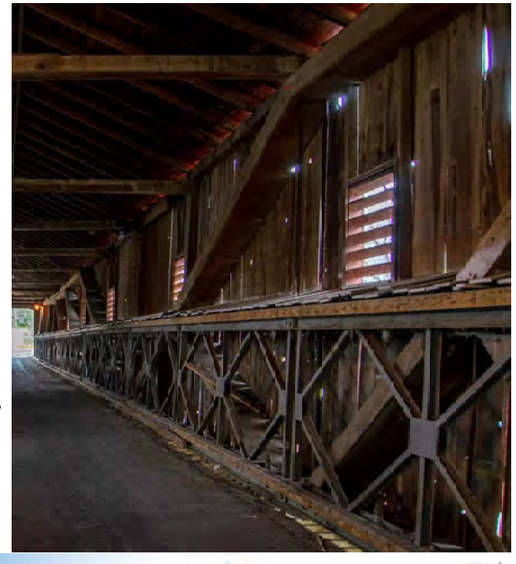
Region of Waterloo

West Montrose Covered Bridge
Background on the Rehabilitation Need

2014 Preservation Plan (IBI Group)
- Identified the need to strength the bridge

2017 Structural Monitoring (Struct-Sure)
- Bridge vehicle loading frequently exceeded the 3T posted limit
- Temperature effect creates 14x more stress in timber truss members than a 3T vehicle load
- The steel Bailey truss is estimated to carry 45% of the load during a dynamic event and 70% of load during a static event
- Unbalanced loading between west and east timber truss

2017 Timber Condition Assessment (Moses Structural)
- Moisture content in timber makes the timber susceptible to decay
- Multiple tested timber components requires replacement due to poor condition



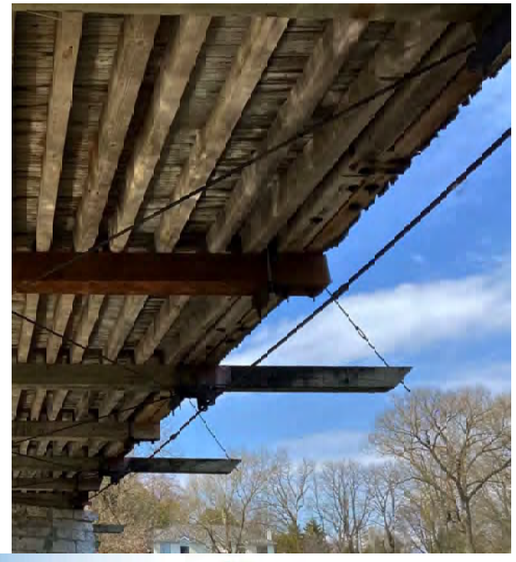
Region of Waterloo

West Montrose Covered Bridge
Background on the Rehabilitation Need

Steel Bailey Trusses
- Single plane truss is inherently unstable
- Panel pins will wear and affect the load-carrying capacity of the steel truss
- Will be over-stressed if the timber truss loses all load-carrying capacity

Timber Floor Beams
- The critical member in the current structural system (first to break during vehicular overloading)
- Expensive to replace, long lead time to procure

Timber Trusses / Façade
- Defects noted in several truss members
- Interior of steel hardware (i.e., splice bolts) may have corrosion and be compromised
- Vertical and lateral deflection noted
- Protection of timber is compromised due to poor roof and exterior cladding condition



Region of Waterloo

West Montrose Covered Bridge
Project Introduction

- Bridge requires a rehabilitation to ensure long-term safety and preservation of the structure
- Implement recommendations of the 2014 Preservation Strategy and subsequent studies
- Schedule A+ project under the Municipal Class Environmental Assessment
- Budget in the 2023 Transportation Capital Program is $5,600,000
- Two rounds of Public Consultation to date

West Montrose Covered Bridge
Study Team – Region and Township Staff

Region of Waterloo

Sandy Shantz
Township of Woolwich
Mayor and Regional Councillor

Michelle Pinto, P.Eng., MBA
Project Manager
Design & Construction

Shawn Buckley, P.Eng.
Supervisor
Transportation Infrastructure

Skylar van Kruistum, P.Eng.
Head
Design & Construction

WOOLWICH TOWNSHIP

Bonnie Bryant
Councillor
Ward 3

Kayla Grant
Councillor
Ward 3

Jared Puppe, C.E.T.
Director of Infrastructure Services

West Montrose Covered Bridge
Owner's Expectation and Vision

Structural Rehabilitation



Strengthen the overall structural system to ensure long-term safety and preservation of the structure

Heritage Conservation



Preserve the heritage designation of the bridge

Ongoing Maintenance



Minimize future maintenance requirements

West Montrose Covered Bridge
Consultant Team

Specialist Review

Region of Waterloo

Substructure Design

DDA

Doug Dixon, M.A.Sc., P.Eng.
Kevin Li, E.I.T

Timber/Superstructure Design

ENTUITIVE BTE

Steve Taylor, M.Eng., P.Eng.
Wasim Aldabbagh
Darcie Dillon, P.Eng.

Bridge Engineering

Stephen Brown, M.Eng., P.Eng., P.E. (EN-BTE)
Andrew Lehan, M.A.Sc., P.Eng. (EN-BTE)
David Moses, PhD, P.Eng., P.E., LEED®AP

ENTUITIVE

IBI

Ted Brumfitt, P.Eng.

cambrium INFRASTRUCTURE

John Stephenson, M.Eng., P.Eng., P.E.

ASI

Archeological

Natural Heritage

EcoTec

Heritage Impact Assessment

UNTERMAN McPHAIL ASSOCIATES
HERITAGE RESOURCE MANAGEMENT CONSULTANTS

Richard Unterman, M.A., CAHP

Engineering & Support Services

Architectural Design MontgomerySisam
Robert Davies, B.Arch., OAA
Shannon Wiley, M.Arch.

Cultural Heritage
Wendy Shearer, CAHP (EN-BTE)

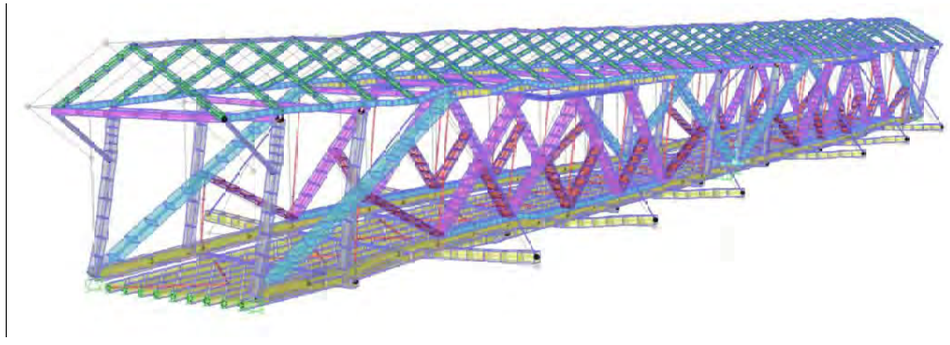
Drainage and Hydrology
Leo Sanchez, P.Eng. (Sanchez Engineering)

Environmental
Gordon Bell, B.E.S. (EN-BTE)
Zachary Wells, M.S. (EN-BTE)

Traffic
Stephen Brook, P.Eng. (EN-BTE)

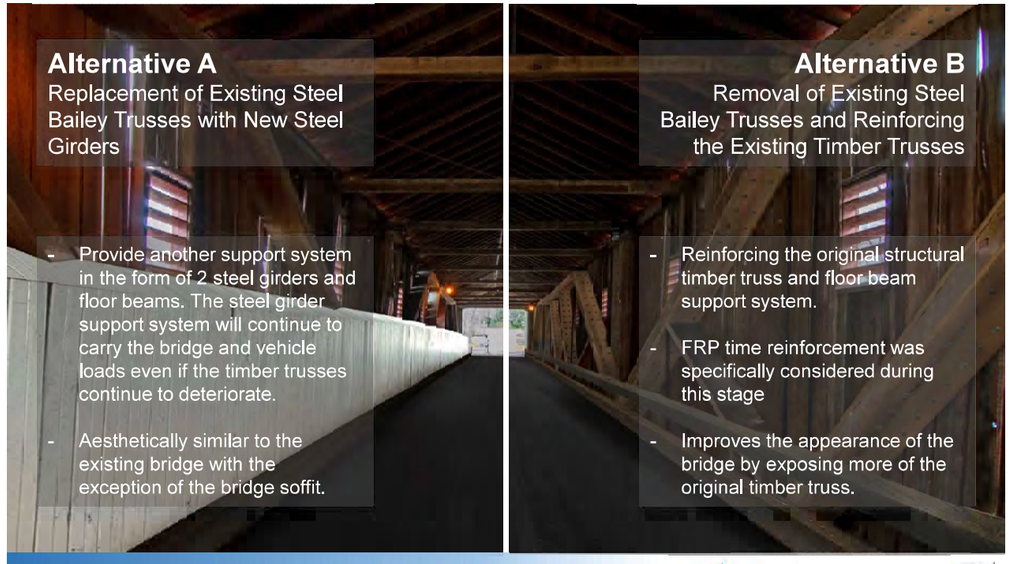
Constructability Reviews
Garry Carriveau (EN-BTE)

West Montrose Covered Bridge
Development of Rehabilitation Alternatives



Region of Waterloo

West Montrose Covered Bridge
Development of Rehabilitation Alternatives



Region of Waterloo

West Montrose Covered Bridge
Development of Rehabilitation Alternatives

Alternative	Description	Addresses Rehabilitation Needs	Heritage Preservation and Conservation	Minimize Ongoing Maintenance	Comment
Do Nothing	Leave the existing Bailey Truss in place. Continue to perform ongoing maintenance.	✗	✗	✗	Does not address the Project Objectives.
Restrict the Vehicular Traffic	Convert the bridge to pedestrian and cyclist use only.	✗	✗	✗	Does not address the Project Objectives. Bridge would still require rehabilitation.
Post-Tensioning the Timber Truss Bottom Chord	Install high-strength steel tensioning rods along the bottom chord of the timber truss.	✗	✓	✗	The existing system is temperature sensitive and appears to be in-effective. Impacts hydraulic opening of the bridge. Not carried forward.
Steel Girder Reinforcement	Remove the existing Bailey trusses and replace with new steel girders/floor beams. The new steel reinforcement would be generally hidden from view.	✓	✓	✓	Carried forward for further assessment as **Alternative A.**
Timber Truss Reinforcement	Remove the existing Bailey truss and strengthen the existing wooden truss with high strength fiber-reinforced polymer.	✓	✓	✓	Carried forward for further assessment as **Alternative B.**

Region of Waterloo

West Montrose Covered Bridge
Development of Rehabilitation Alternatives

CRITERIA	ALTERNATIVE A Replacement of Existing Steel Bailey Trusses with New Steel Girders	ALTERNATIVE B Removal of Existing Steel Bailey Trusses and Reinforcing the Existing Timber Trusses
Structural	●	◕
Constructability	◕	◕
Cultural Heritage	●	●
Aesthetics	◕	●
Sustainability	◕	●
Life-Cycle Cost	●	●
Recommended Alternative	**Not carried forward.** ✗	**Carried Forward as the Preferred Rehabilitation Alternative.** ✓

Region of Waterloo

West Montrose Covered Bridge
Development of Rehabilitation Alternatives



Region of Waterloo

West Montrose Covered Bridge
Stakeholder Engagement

Environmental

- Grand River Conservation Authority (GRCA)
  - No major concerns with the work
  - Permit to be obtained before construction

- Ministry of the Environment, Conservation and Parks (MECP) / Fisheries and Oceans Canada (DFO)
  - Provided a list of Species-at-Risk (SAR) in the area
  - Evidence of Threatened and Special Concern species were noted within project area (i.e., Bank Swallow, Rainbow Mussel, Wavy-rayed lampmussel, etc.)
  - Requested the relocation of aquatic SAR before in-water works
  - In-water works not permitted between March 15th and July 15th
  - Clearing and grubbing is not permitted between April 1st and August 30th without nest surveying

Region of Waterloo

West Montrose Covered Bridge
Stakeholder Engagement

Archaeological

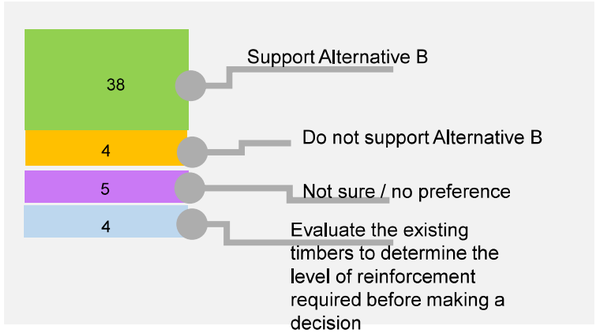
- Stage 1 Archaeological Assessment completed
- No previously registered archaeological sites are within the project area
- Reports shared to Haudenosaunee Confederacy Chiefs Council, Six Nations of the Grand River, and Mississauga of the Credit First Nation. No major comments received

Heritage

- Draft Heritage Impact Assessment (HIA) was completed during the development of Alternative A and B
- HIA will be updated upon finalizing the Preferred Alternative

Region of Waterloo

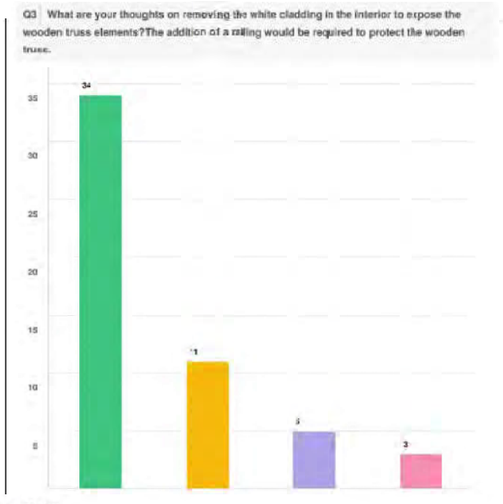
West Montrose Covered Bridge
Public Consultation Centre No. 2



Region of Waterloo

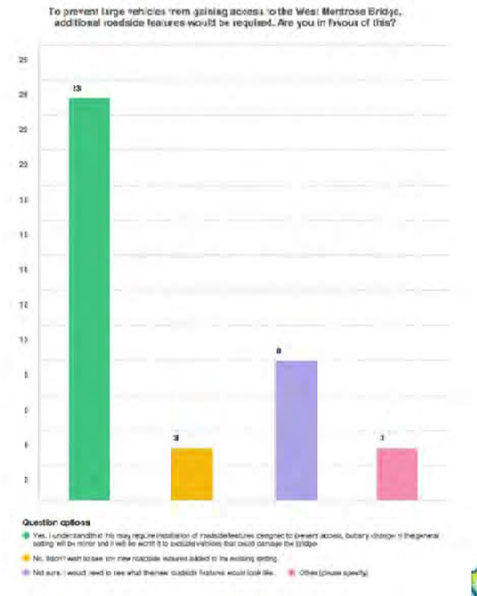
West Montrose Covered Bridge

Public Consultation Centre No. 2



West Montrose Covered Bridge

Public Consultation Centre No. 1 – Additional Roadside Features



West Montrose Covered Bridge

Public Consultation Centre No. 2 – Height Restriction Bar – Option 1



West Montrose Covered Bridge

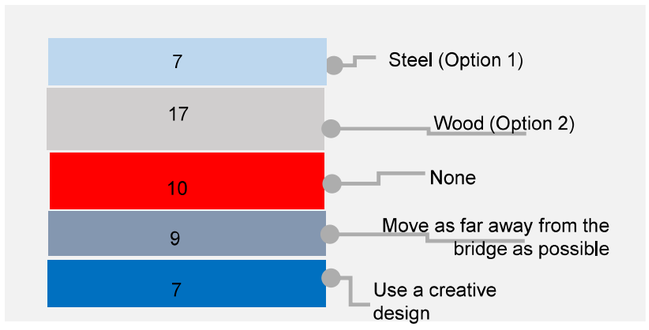
Public Consultation Centre No. 2 – Height Restriction Bar – Option 2



West Montrose Covered Bridge
Public Consultation Centre No. 2 – Height Restriction Bar – Proposed Location



West Montrose Covered Bridge
Public Consultation Centre No. 2



West Montrose Covered Bridge
Public Consultation Centre No. 2

Community Priorities

Heritage Preservation



Confirm time period that the bridge should be restored to, structurally and aesthetically

Minimize Truss Reinforcement



Dislikes extensive truss reinforcement and modifications to the geometry of the bridge (i.e., raising the height of the bridge)

Preservation of Existing Timber



Minimize the replacement of existing timber. Reuse existing timber where possible (i.e., roof, exterior cladding)

West Montrose Covered Bridge
Public Consultation Centre No. 2

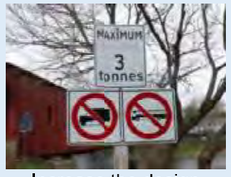
Community Priorities

Restore Bridge Deformation



Remove vertical sag

Additional Structural Capacity



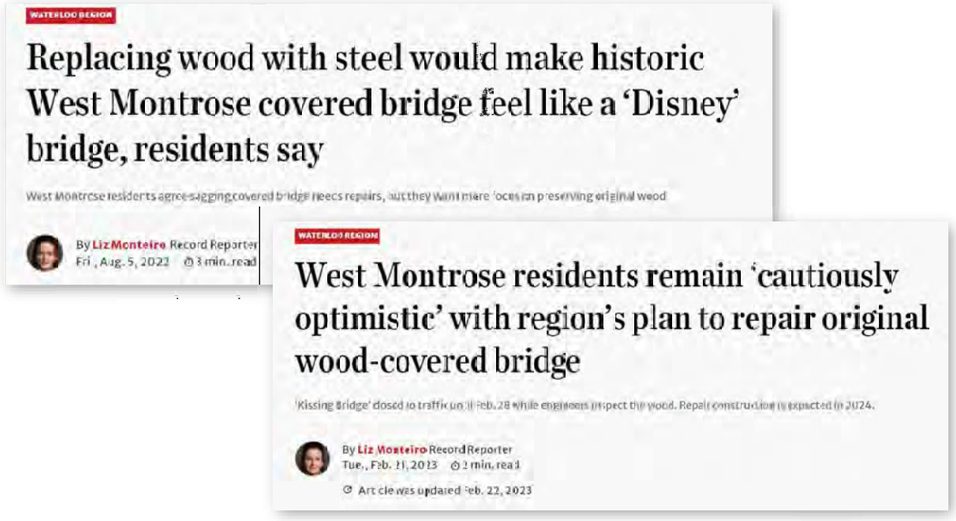
Increase the design capacity of the bridge

Evaluation of the Bridge by Timber Expert

BTE
moses structural
ENTUITIVE

Engage an expert in historic timber bridge restoration to evaluate the existing timber structure.

West Montrose Covered Bridge
Public Consultation Centre No. 2



West Montrose Covered Bridge
National Society for the Preservation of Covered Bridges

NSPCB Feedback

Heritage Assessment



Should the bridge be restored to the way it was when it was first constructed or how it appears now?

Live Load Capacity



Confirm live load capacity of bridge

Height Barrier

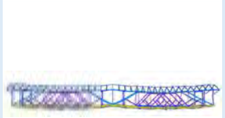


Supports the use of height barriers at each end of the bridge to prevent the entry of over-sized vehicles

West Montrose Covered Bridge
National Society for the Preservation of Covered Bridges

NSPCB Feedback

Restore Bridge Deformation



Remove vertical sag

Evaluation of the Bridge by Timber Expert

BTE moses structural ENTUITIVE

Engage an expert in historic timber bridge restoration to evaluate the existing timber structure.

Contractor Pre-Qualification

bids&tenders

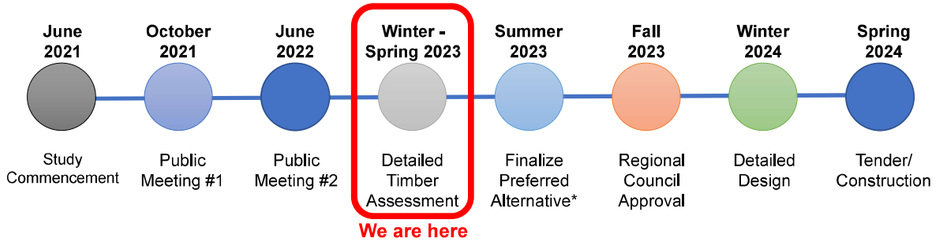
Utilize specialized timber restoration Contractor during construction

West Montrose Covered Bridge
Road Impacts during Construction

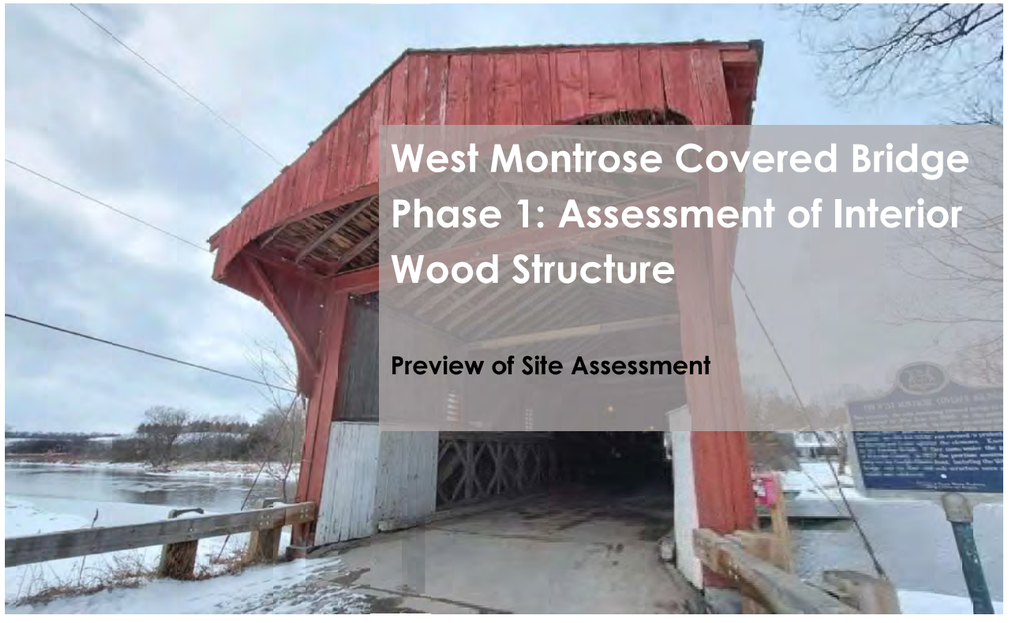
- Full closure of the bridge to all motorized vehicles and horse-and-buggy traffic for up to one full year will be required. Detour routes will be established.
- Bridge may be able to remain open to pedestrians and cyclists for some of the construction period; however, there will be critical phases where the bridge will be unavailable for a period of up to two weeks.
- Construction impact and staging method to be determined during detailed design

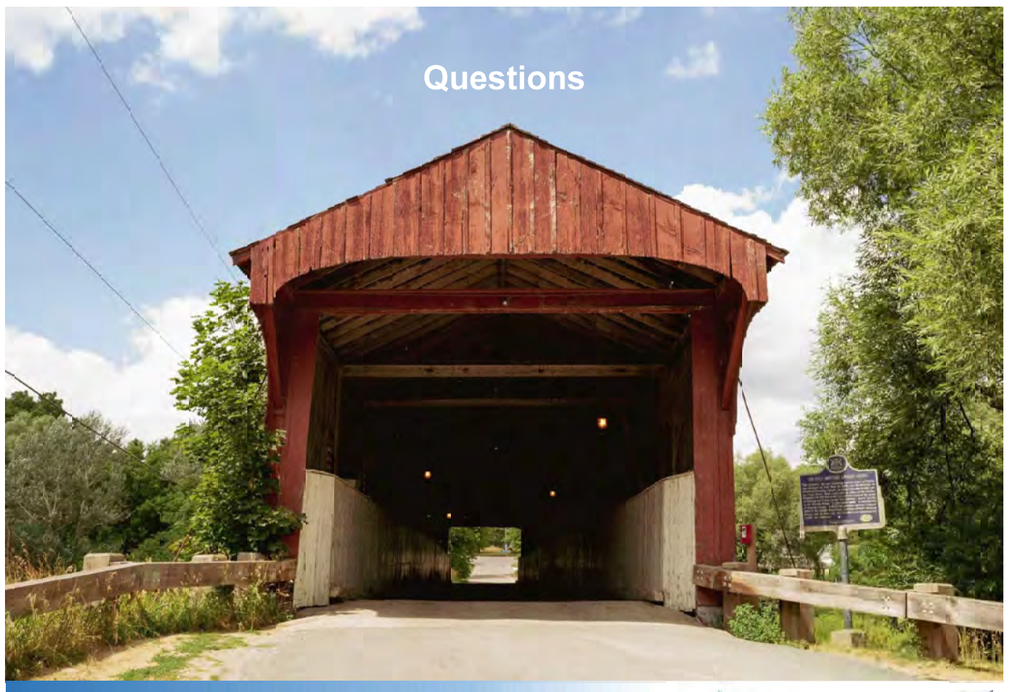


West Montrose Covered Bridge
Project Schedule



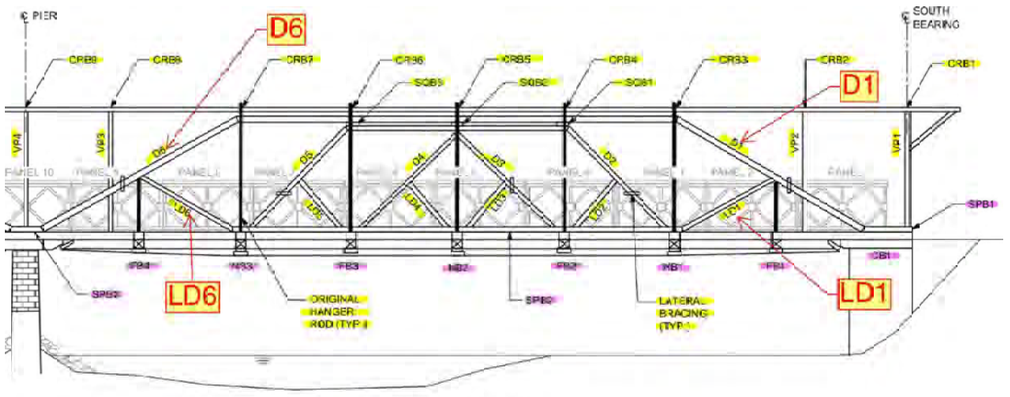
***Note: If the Preferred Alternative is substantially different from Alternative B presented at PCC No.2, additional public consultation will be necessary**





Member Access

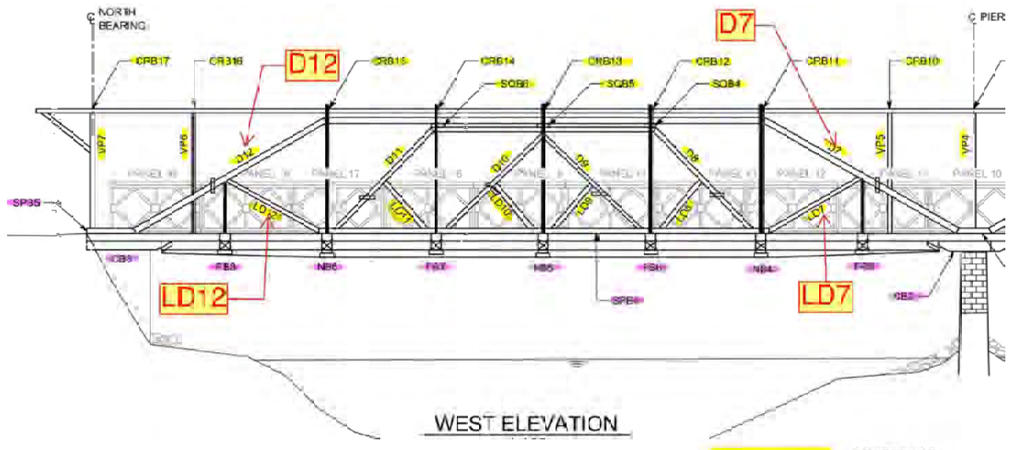
Excerpt from DDA June 2020



Member IDs same on east elevation.

Member Access

Excerpt from DDA June 2020



Member IDs same on east elevation.

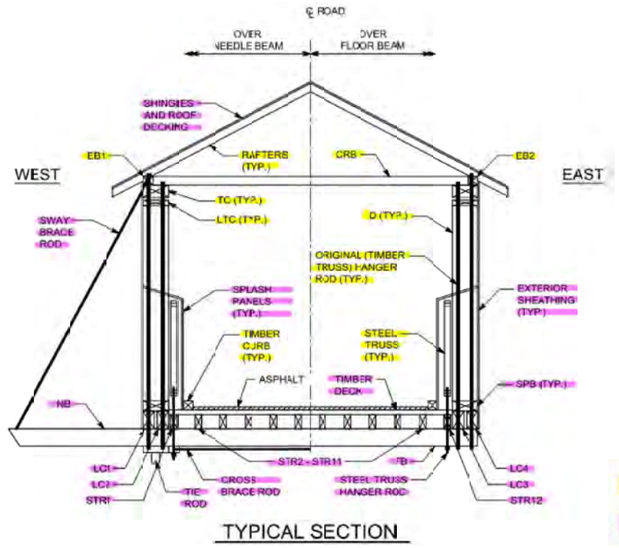
Observations

- Signs of undocumented repairs
- Geometric variation (e.g. uneven width along member)
- Observations of mis-alignment
- Member deflection / tilt / distortion
- Wood Observations: staining, decay, weathering, checks, splits, crushing
- Steel Observations: corrosion

Measurements

- Member dimensions
  - Member length
  - Width and depth at 3 points along member length
- Moisture content in wood member at select points along member
  - Wood strength is dependent on how much moisture it is carrying
- Resistograph reading at select points along member
  - Reads for signs of decay or unsound wood within the section

Member Access



Excerpt from DDA June 2020

Measurements

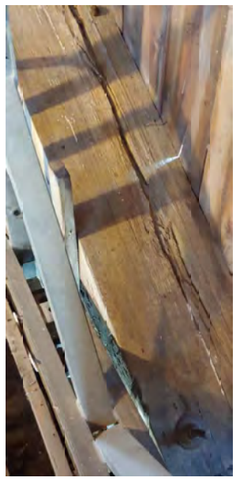
Resistograph Reading
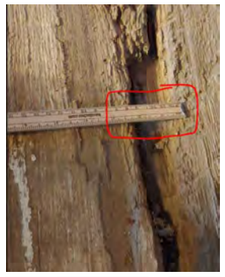


Moisture Content Reading



Observations:

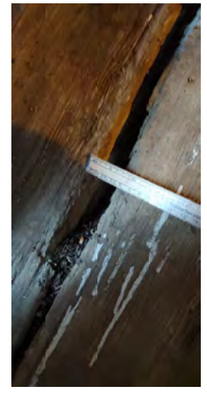
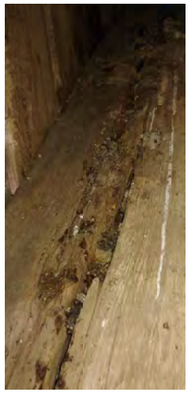






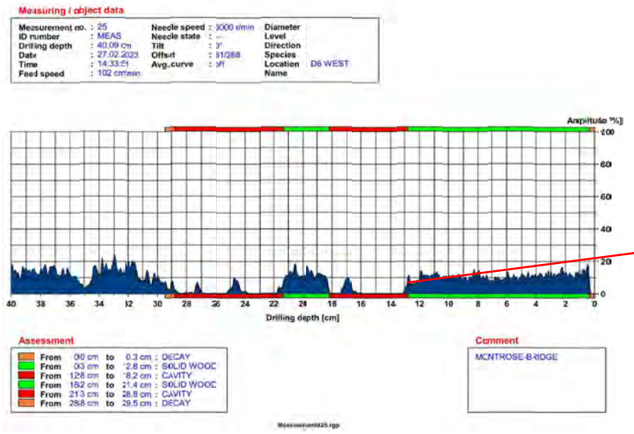
Observations:





Readings:
Sample Resistograph Reading





Climate Change and Bridge Hydraulics

West Montrose Bridge VE Review

Flood Flows and Water Levels at Bridge

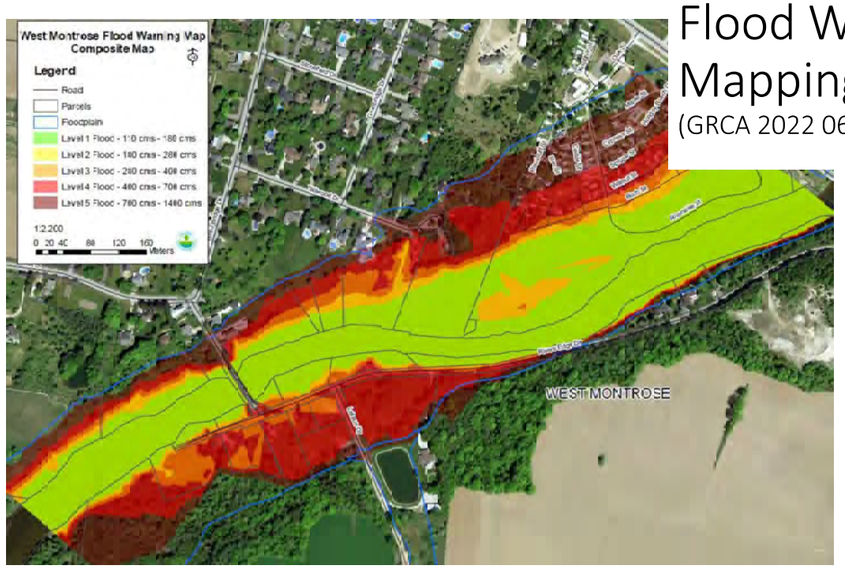
(GRCA 2022 06 29)

Flood Return Period or Event	Flow (m^3/s)	Elevation (m, CGVD 28)	
		Upstream	Downstream
2-yr	331.0	322.41	322.26
5-yr	464.0	322.89	322.68
10-yr	603.0	323.32	323.06
25-yr	718.6	323.62	323.34
50-yr	827.0	323.88	323.57
100-yr	910.0	323.99	323.72
Regional storm	1356.0	324.83	324.44

Regional Storm Floodline at bridge

(GRCA GIS data)

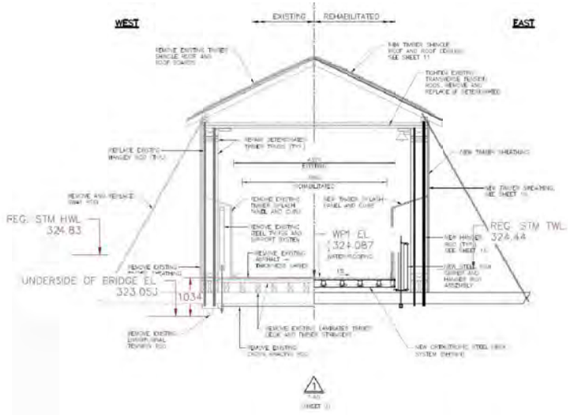




Flood Warning Mapping

(GRCA 2022 06 29)

Potential Uplift at Bridge



- 1 m head is equal to 9.8 kN/m^2
- Upstream head = 1.0 m±
- Downstream head = 0.62 m±.
- Over the entire bridge, the uplift pressure would be about 1,110 kN±

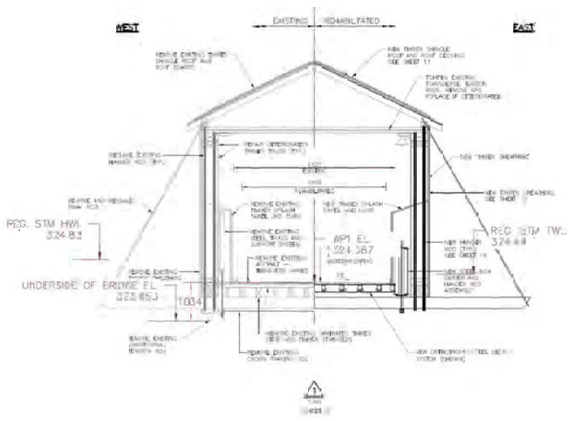
- Underside of bridge elevation (323.053 m) is lower than the 10-year flood head water level (323.32 m)

Ice Jam of February 5, 2019



- Photos taken after firefighters breached the ice jam. Notice ice scar on tree in foreground.

Lateral Forces



- For all floods higher than the 5-year flood (the largest flood that passes under the bridge soffit), there will be lateral pressure forces and drag forces on the bridge (to be determined)
- These flood conditions assume ice-free flow.

Ice Jam of February 5, 2019



- Photos taken after firefighters breached the ice jam. Note ice on banks is close to bridge soffit elevation.

Hydraulic Design Criteria

Design Criteria	Reference	Design Standard	Minimum
Road Class	Region of Waterloo	Collector Road	Collector Road
Design Flood Return Period	MTO	50 years	50 years
Vertical Clearance	MTO	1 m	1 m
Freeboard	MTO	1 m	0.3 m

High Vulnerability - a rating given to a bridge that can be washed away or be significantly damaged during flooding. High vulnerability bridges include log bridges, bridges with timber beams and deck, and light trusses.

Climate Change

Timeline

1750 CE
Industrial Revolution begins in Britain

1896 CE
Svante Arrhenius predicts greenhouse effect

1965 CE
Lyndon Johnson warns of climate change

1988 CE
IPCC established by UN and WMO

MTO Hydrology – Design Criteria

Section 3.3.2: Minimum Clearance for Low Volume Roads		
Road Function	Vulnerability	Clearance (m)
Collector and Arterial	High	> 1.0
	Low	> 0.3

Can Buoyancy of wood Structure be Considered High Vulnerability ?

The West Montrose Covered Bridge is a High Vulnerability bridge. Therefore, the water level used to establish the Clearance shall be the higher of:

- The High Water Level associated with the Design Flow established in Standard WC-1, and;
- The water level caused by ice jams and having a Return Period equal to that of the Design Flood.

Taftsville Bridge Vermont – Hurricane Irene



Figure 0.5a-b Vermont's Taftsville Bridge suffered major damage from Hurricane Irene in 2011. While one span needed to be completely rebuilt, a large percentage of the original hand-hewn truss

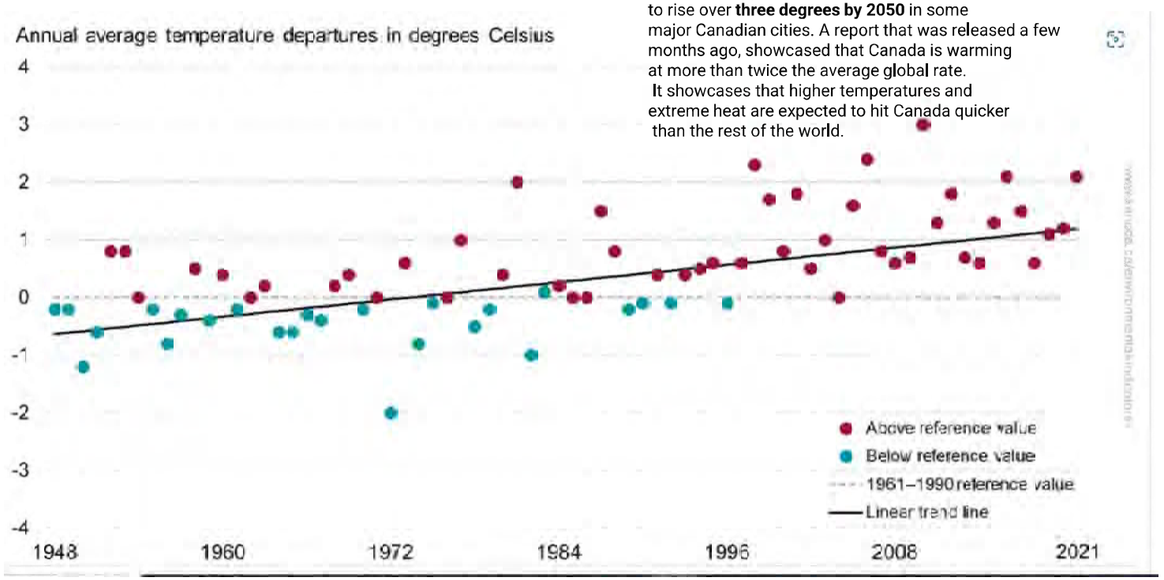
Historical Context of Storm Events

- Calculation of Storm Events considers historical precipitation frequency and watershed model to determine storm flows.
- This is a backwards review of the statistical occurrence of events.
- Rain gauges measure precipitation and models determine storm flows for a range of probabilities (probability distribution based on data from historical events) – again looking backwards in time.
- The methodology does not reflect when the base data is changing in time i.e. climate change – warmer water providing more energy to the storms.

Major Storm Events

- The major storm events for the site reflect summer/ fall hurricane events
- The Eastern North Pacific hurricane season runs from May 15th through November 30th.
- Hurricanes originate in northern Africa weekly in the Sahara Desert travel across the Atlantic Ocean and then travel northerly





Canada's temperatures are expected to rise over **three degrees by 2050** in some major Canadian cities. A report that was released a few months ago, showcased that Canada is warming at more than twice the average global rate. It showcases that higher temperatures and extreme heat are expected to hit Canada quicker than the rest of the world.



NOAA /

Satellite view of Hurricane Florence on Sept. 12, 2018.

Largest Hurricanes

1. Katrina 2005 – $125 billion (B) Category 5
2. Harvey 2017 125 B Category 4
3. Sandy 2012 - $69 B Category 3
4. Ike 2008 -38 B Category 4
5. Andrew 1992 45 B Category 5
6. Wilma 2005 29 B Category 5
7. Ivan 2004 – 26 Billion Category 5
8. Irene 2011 – 16 Billion Category 3
9. Charley 2004 – 17 B Category 4
10. Rita 2005- 19 Billion Category 5

2022 Hurricane Ian $113 Billion (Charley fit inside the eye of Hurricane Ian).

1. Hurricane Katrina

Damage: $125 billion.
Season: 2005.
Category 5 hurricane.
Areas affected: Louisiana, Mississippi, The Bahamas, United States Gulf Coast, South Florida, Northeast, Eastern Canada.

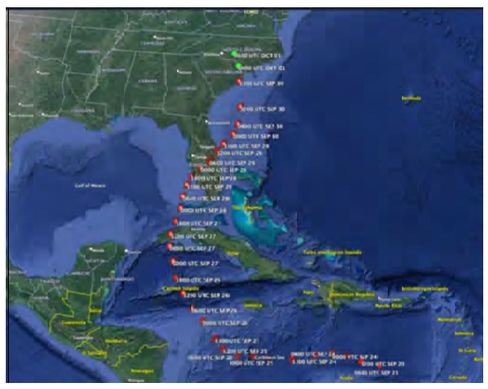


Year 2022

- Europe is experienced its most severe drought in 500 years. One waterbody has dropped to levels not seen in 600 years.
- Significant areas of North America and Europe have been experienced temperatures over 100^0 F (37.8 ^{0}C).
- Greenland experienced a major heat wave this summer shedding 6 billion tons of water/day (300 mm loss of the ice cap) from July 15-17, 2022. The July heat wave in Greenland raised the global sea levels by 1.5 mm. The loss of Arctic and Antarctic ice caps reduces the reflectivity of solar radiation and is accelerating the global heat gain.
- September 2022, Death Valley (USA) reached a record temperature of 127^0 F (52.8 ^{0}C)
- Hurricane Fiona (which may have been Canada's strongest-ever storm) struck the East coast of Canada in 2022 and had the lowest recorded pressure of any storm in Canadian history
- Hurricane Ian striking Florida in September was the 3rd largest hurricane to hit the United States.

Large Hurricane Frequency and magnitudes are increasing as Global Warming Occurs

- Examples Hurricane Ian 2022 third largest hurricane ($113 billion in damage) – reached NY State; Hurricane Sandy reached NYC 2012

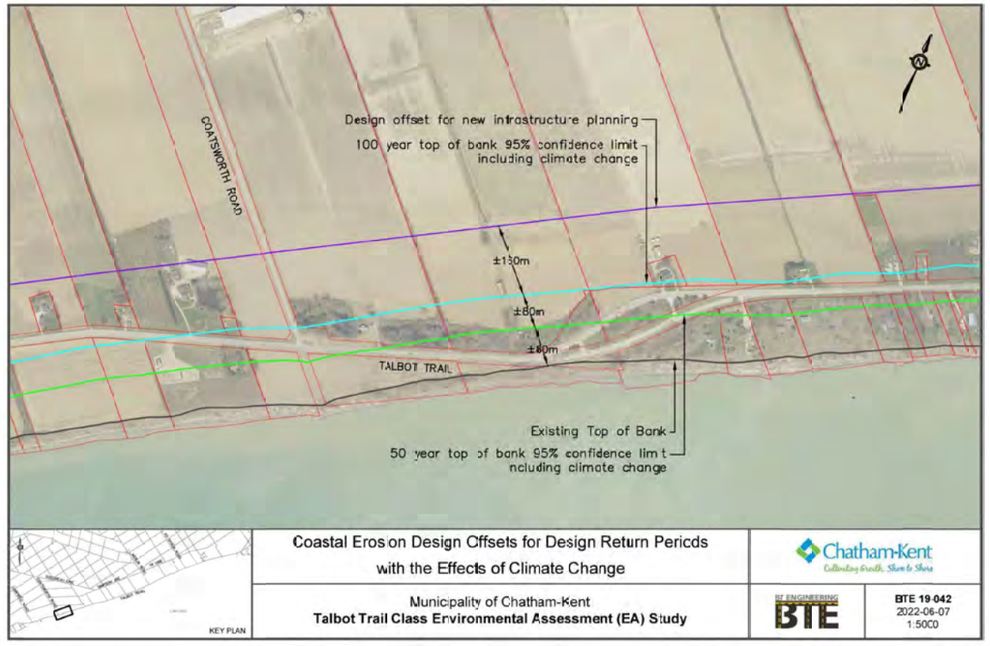




Future (Life of the next Rehab)

- Recent 2022 Research forecasts 2/3 of all glaciers will no longer exist by the turn of the next century – 77 years from today
- Reduced reflectivity accelerates the global heat gain
- Warmer planet = larger and more frequent storms







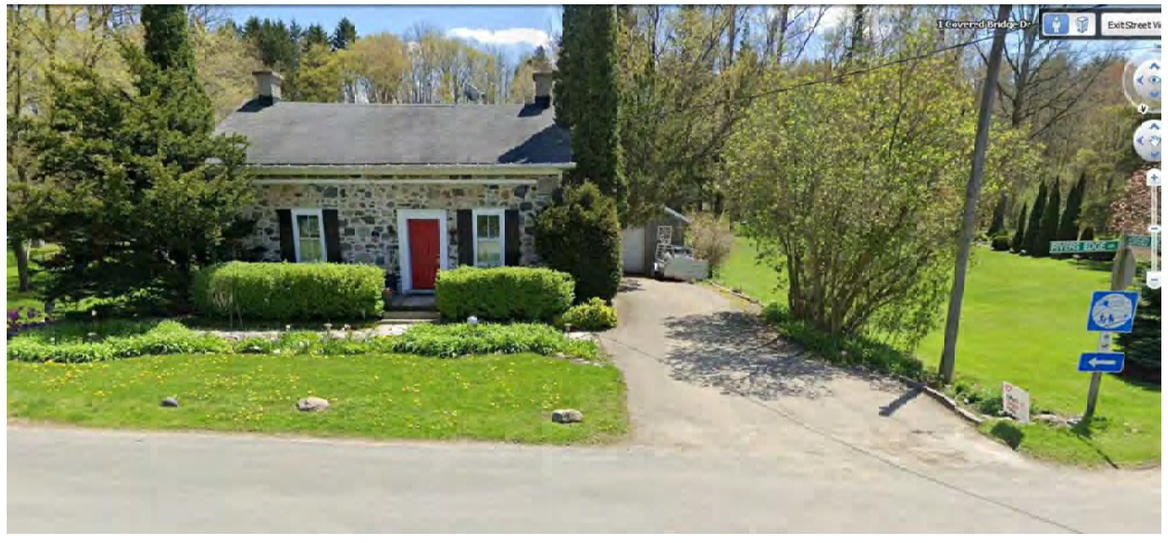


Coastal Erosion (A D Shadd Road)

- **Answer**: The LTVCA has endorsed the Study recommendations including to elevate the zone of development protection to the 100 year limit including the effects of climate change. A key study recommendation in the EA will be to have the MECP amend the current Ontario regulations that provide the conservation authority a tool to limit development (currently 50 years and does not to include climate change). It is a key recommendation that can protect the hazard zone.

Avoid lowering the soffit





Closest Driveway





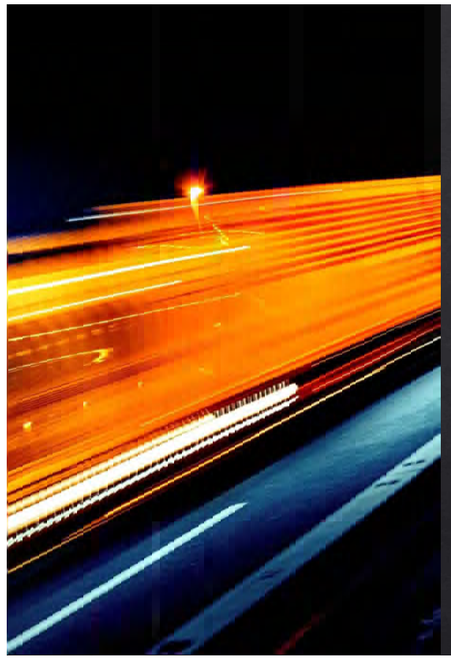
North Approach to the Bridge



Introduction Value Management: Presentation 2: Project Understanding

March 21, 2023

ST ENGINEERING BTE



FAST Alternatives

Technical FAST

How-When Logic

Basic Function-Work Functions

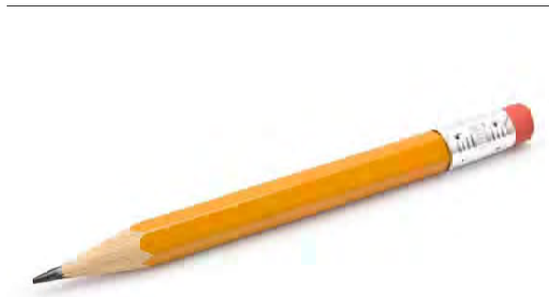
Customer Oriented FAST

Satisfy User

Basic Function-Aesthetic Function

Understanding Basic Functions – Project Understanding





- Technical FAST – Make Marks
- Customer Orientated FAST
  - Satisfy User =Tactile edges, eraser
  - Sell Product = add advertising
  - Worth greater than basic pencil

- Customer Orientated FAST
  - Satisfy User = Create esteem
  - Sell Product = add advertising (White star)
  - Worth $200 greater than basic pen



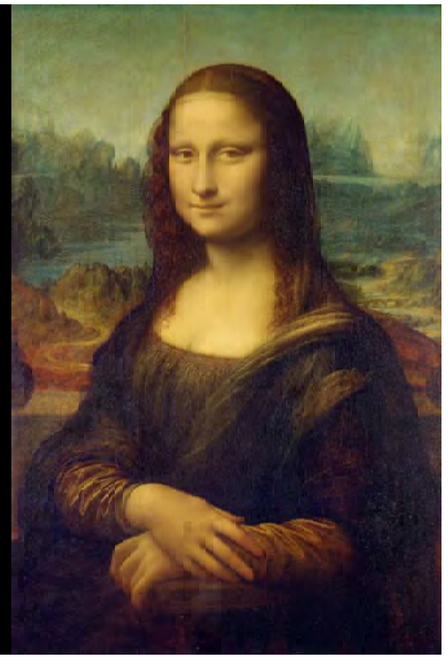
Mona Lisa (1503)

- Cost ?
- Worth?

What is the Function

Portrait –family memory (work function); or

Cultural Treasure (aesthetic function)



New York City

THE HIGH LINE

Bridge or Park



West Block and Windows

- work; or
- art?



Hartland Bridge







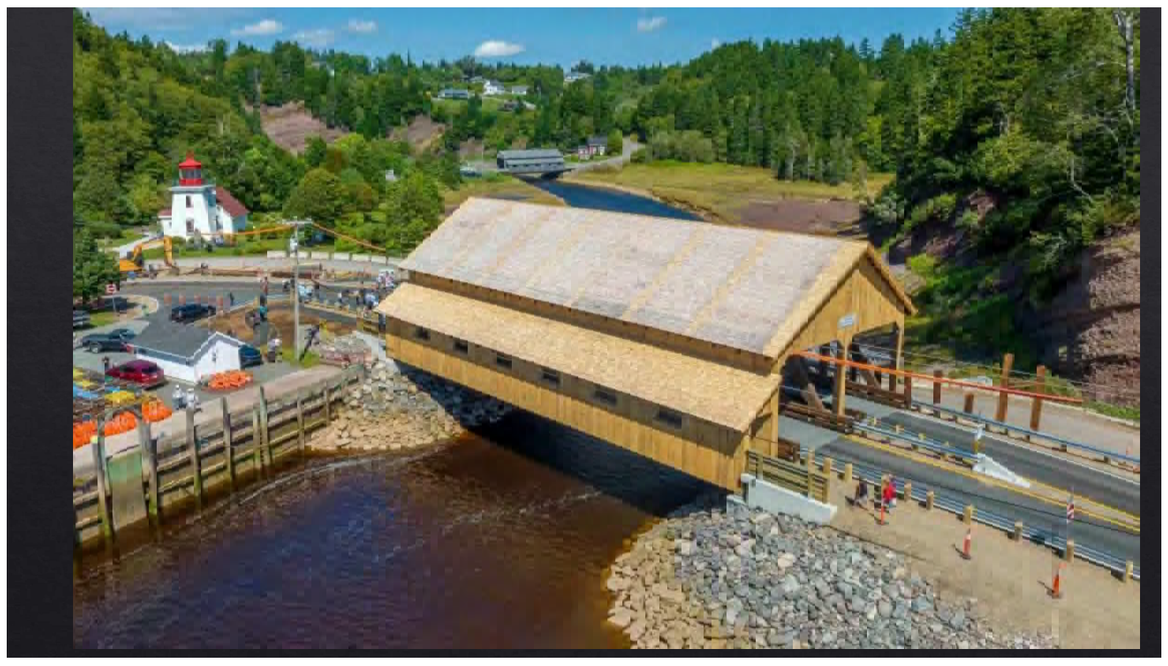
Florenceville-Bristol Bridge





St. Martins Bridge



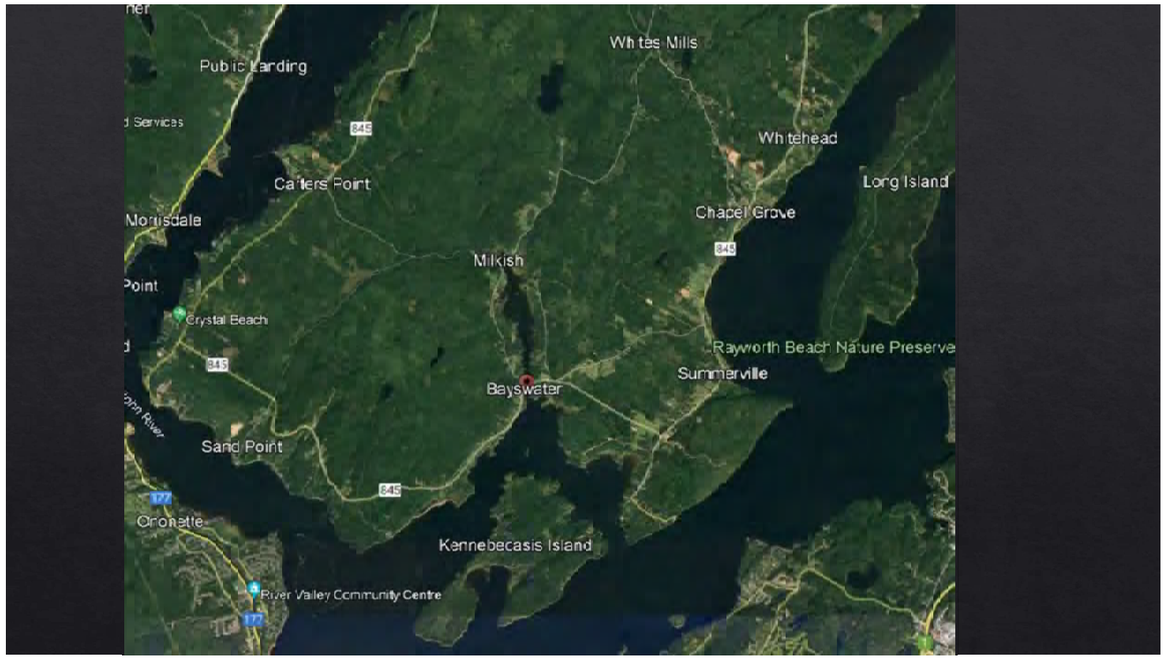








Milkish Inlet Bridge


Whites Mills
Public Landing
Services
845
Whitehead
Carters Point
Long Island
Chapel Grove
Morrisdale
845
Milkish
Point
Crystal Beach
Rayworth Beach Nature Preserve
845
Summerville
Baysweter
Sand Point
845
177
Cronette
Kennebecasis Island
River Valley Community Centre
177






15 t







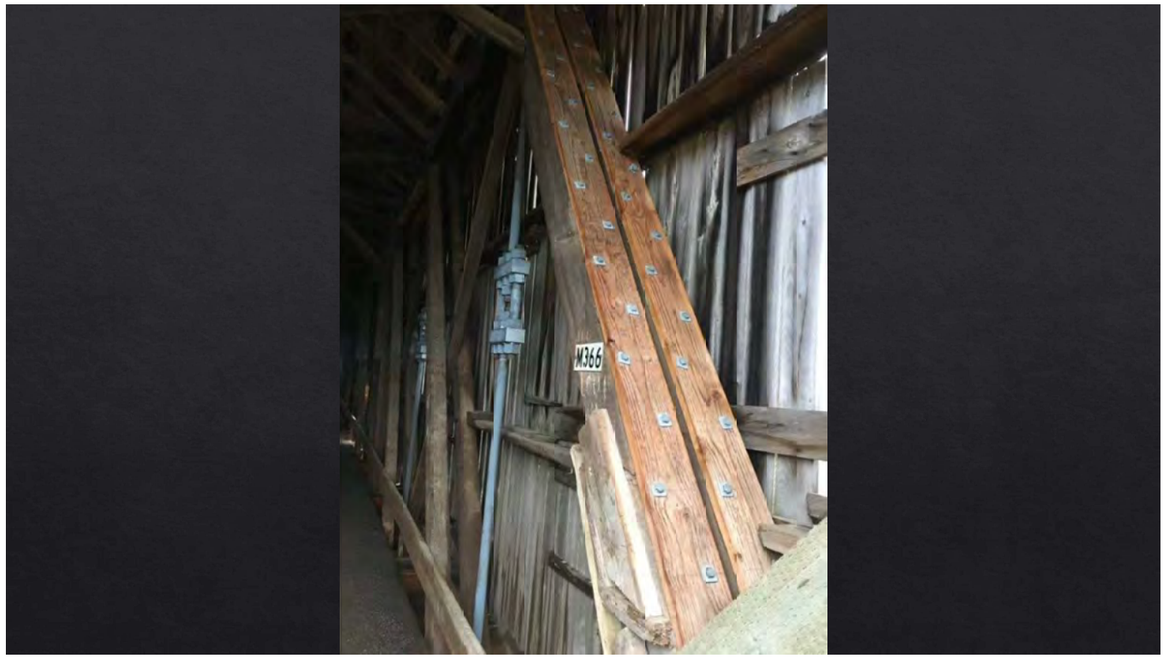

Milkish Inlet #1
Bayswater 1920
4.4 m

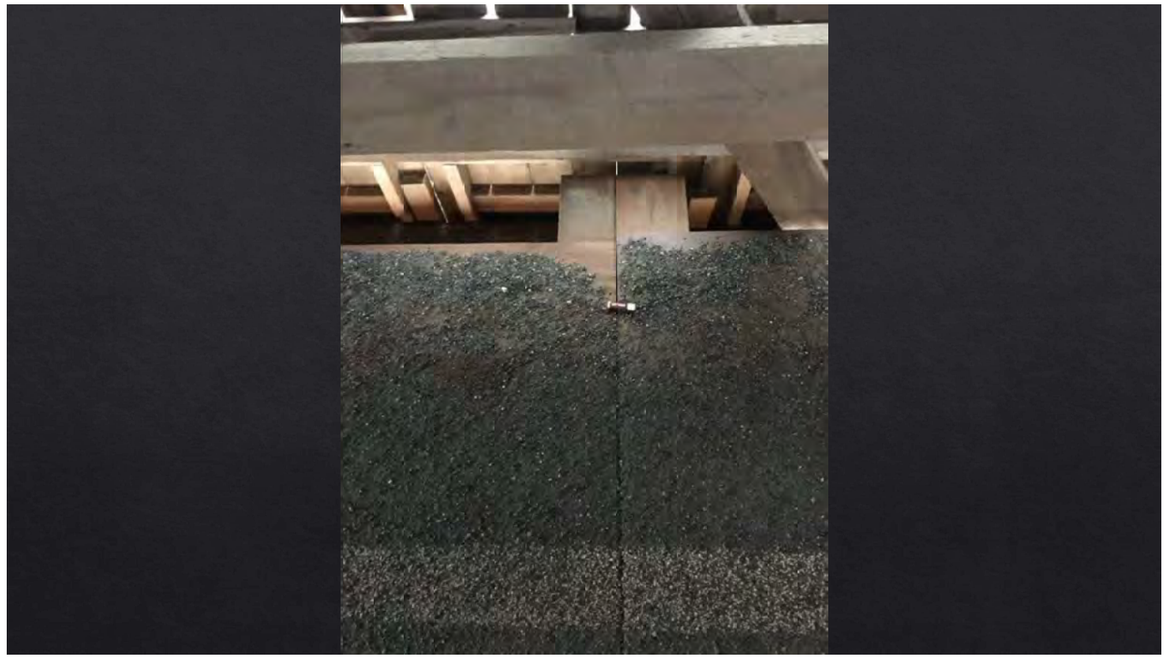

3.5 m
MAXIMUM
15 t



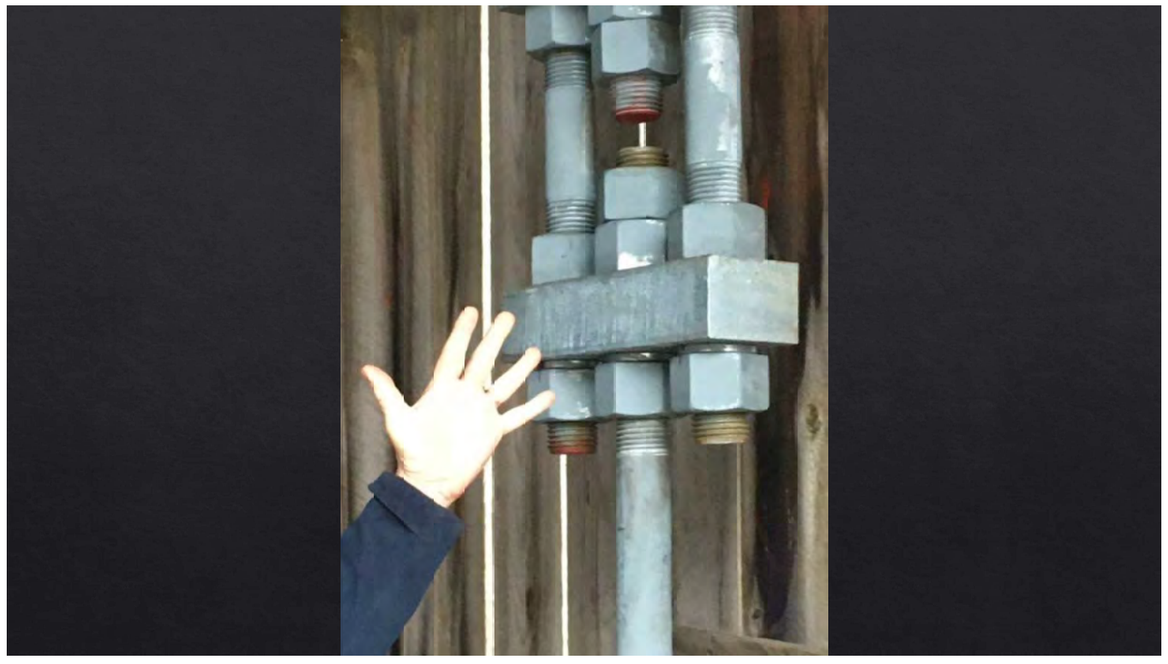





M366





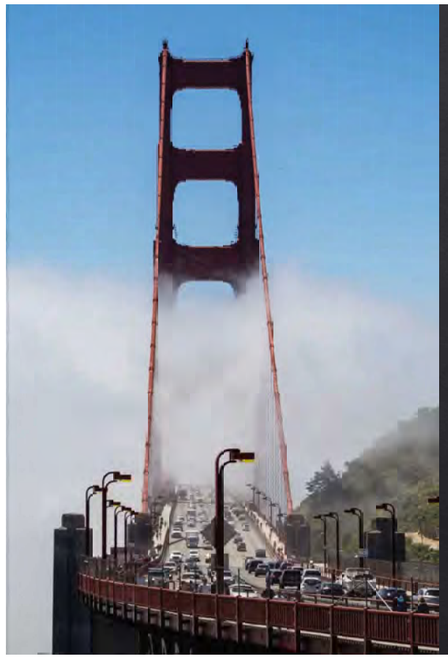



M366


Hit




BC Quick Hit



Driver Height and Weight Restrictions

Lincoln Navigator

- Vehicle – 2700 kg
- Payload Max 725 kg
- Total 3450 kg

- Height 2.03 m



Driver Understanding

- How heavy is your vehicle?
- What restricts vehicles better load limit signage; or vehicle height/width signage





a) by manufacturer's axle rating or default	i. GAWR (if verified), or ii. if GAWR not verified, the lower of: 1. 5,000 kg, and 2. the sum of the maximum tire load ratings
b) by tire width	11 kg × combined tire widths in mm
c) by axle unit description	Single Axle: 9,000 kg

OTHER AXLE MAXIMUMS (LOWEST OF A, B AND C)

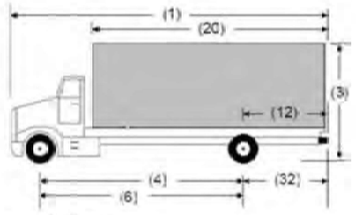
Feature	Weight Limit
a) by manufacturer's axle rating or default	i. GAWR (if verified), or ii. if GAWR not verified, the sum of the maximum tire load ratings
b) by sum of tire widths	10 kg × combined tire widths in mm
c) by axle unit description	Single Axle: 10,000 kg Single Drive Axle (Dual Tires) on Urban Transit Bus: 11,400 kg

ALLOWABLE GROSS VEHICLE WEIGHT

Feature	Weight Limit
Allowable Gross Vehicle Weight:	actual weight on the front axle plus other axle maximums

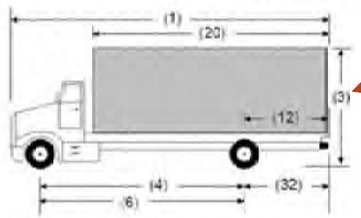
O. Reg. 457/10, s. 29; O. Reg. 16/14, s. 21; O. Reg. 368/17, s. 20; O. Reg. 228/19, s. 22.

SCHEDULE 19
DESIGNATED TRUCK 1 — 2-AXLE TRUCK



Vehicle Description

DESIGNATED TRUCK 1 — 2-AXLE TRUCK



Height 4.1 m

Vehicle Description

Designated Truck 1 is a 2-axle truck with a front single axle and rear single drive axle.

Qualifying Preconditions

Weight – The front axle weight must be at least 30 per cent of the gross vehicle weight at all times.

Equipment and components, see ss. 5, 8

Exceptions

Until December 31, 2025, the dimensional limit for Effective Rear Overhang (12) does not apply if the truck was built before July 1, 2011.

Until December 31, 2025, the dimensional limit for Hitch Offset (32) does not apply if either the truck or the trailer that it is drawing was built before July 1, 2011 or if both were built before July 1, 2011.

An overhanging boom of a rear-facing crane that extends 1.0 metre or less past the rearmost point of the truck is exempt from the dimensional limit for Effective Rear Overhang (12).

DIMENSIONAL LIMIT CHART

Vehicle	Ref.	Feature	Dimensional Limit
Truck	(1)	Length	Max. 12.5m
Truck	(2)	Width	Max. 2.6m
Truck	(3)	Height	Max. 4.15m
Truck	(4)	Inter-axle Spacing	Min. 3.0m



See Rb-63 sign on page 186 - Gross Vehicle Weight

MAXIMUM TONNES Sign (Single Gross Weight) (Rb-63)



Rb-63	600 mm x 750 mm 750 mm x 937.5 mm
Font	FHWA Series C, Helvetica Medium
Colour	Legend & Border – Black Background – White Reflective
Minimum Sheeting	Type III or IV

Gross Vehicle Weight

Do Drivers/farmers Understand their Gross Vehicle Weight



Other Signage
-vehicle spacing
-Pedestrian Occupancy
-Yield to Pedestrians

Appendix D

Creative Idea Write-ups

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	May 15, 2023
Description:	Set load limit at 3 tonnes (posted) and design to a minimum of 5 tonnes	**Alt. No.:**	1
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

The bridge is currently posted for a load limit of 3 tonnes.

Alternative Concept:

The rehabilitated bridge would be designed for a minimum load of 5 tonnes but posted for a maximum load of 3 tonnes.

Advantages:

- Will help reduce chance of bridge being overloaded by overweight vehicles.
- Keeping a posted load limit of 3 tonnes should help discourage heavier vehicles from attempting to cross the bridge.

Disadvantages:

- The additional 2 tonnes capacity beyond the posted 3-tonne load limit will not be used as economically compared to if the bridge load limit was posted and designed to a 5-tonne load limit.

Discussion/Rationale:

It is known that the bridge is occasionally overloaded by overweight vehicles. On some occasions, overweight vehicles have damaged the bridge, particularly the floor beams. Such damage is problematic, not just from a cost perspective, but also from a cost-of-delay perspective. Closure of the bridge for repairs affects the ability of local residents to travel to work. Some local residents are forced to take their horses and buggies down Line 86, along which the shoulders are not sufficiently wide to allow for safe passage. Furthermore, some local residents are completely unable to travel to work because the covered bridge is the only local crossing of the Grand River that is within a reasonable walking distance.

Designing the repairs to the bridge for a 5-tonne load limit will afford the bridge some reserve capacity beyond the posted 3-tonne load limit. This reserve will help limit damage by vehicles that knowingly or unknowingly exceed 3 tonnes weight by a small amount.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Load limit signage on roads adjacent to bridge	**Alt. No.:**	2
		Sheet:	1 of 2

Design Suggestion

Original Concept:

Existing signage shown below:

Hill Street @ Northfield Drive: https://goo.gl/maps/WhvV2EPFiPVka4iH6



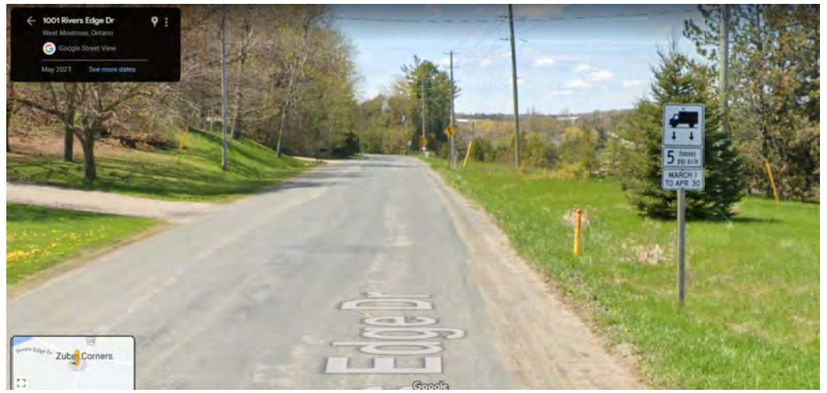
Letson Drive at Katherine Street North: https://goo.gl/maps/QzNRmeZnJuQ9GH42A



Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Load limit signage on roads adjacent to bridge	**Alt. No.:**	2
		Sheet:	2 of 2

River's Edge Drive at Katherine Street North: https://goo.gl/maps/DCZACZBw6NL1Hn4NA



Alternative Concept:

Review signage for load limits on the Regional Roads (5 tonnes per axle).

Discussion/Rationale:

Load limit signs on the roads adjacent to the bridge are posted at 5 tonnes per axle; however, the total load limit on the bridge is 3 tonnes. This could lead to confusion regarding the total load permitted on the bridge. The addition of signs noting the total load limit on the Covered Bridge should be reviewed in consultation with the Township.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Signage for restricted vehicles	**Alt. No.:**	4
		Sheet:	1 of 3

Design Suggestion

Original Concept:

The existing signs indicating the restricted vehicles on the roads leading up to the bridge are depicted below.

Covered Bridge Drive:



North approach of bridge:



Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Signage for restricted vehicles	**Alt. No.:**	4
		Sheet:	2 of 3

South approach of bridge: https://goo.gl/maps/t2Yc9FN6Sr5jvc7M9



River's Edge Drive at Katherine Street North: https://goo.gl/maps/DLyHvfr8hKspbvpz8



Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Signage for restricted vehicles	**Alt. No.:**	4
		Sheet:	3 of 3

River's Edge Drive: https://goo.gl/maps/ihx29QrDjJ6xq7Ms5



Alternative Concept:

Improve signage with a picture sign of vehicle types not permitted.

Discussion/Rationale:

There are pictures of the prohibited vehicle types shown at the immediate approaches on both sides of the bridge.

The other existing signs leading up to the bridge describe the prohibited vehicle types in text only. There is an opportunity to supplement these signs with pictures of prohibited vehicles, similar to the pictures at the immediate bridge approaches.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Provide a 3.3 m vertical clearance limit at the bridge	**Alt. No.:**	5
		Sheet:	1 of 1

Design Suggestion

Original Concept:

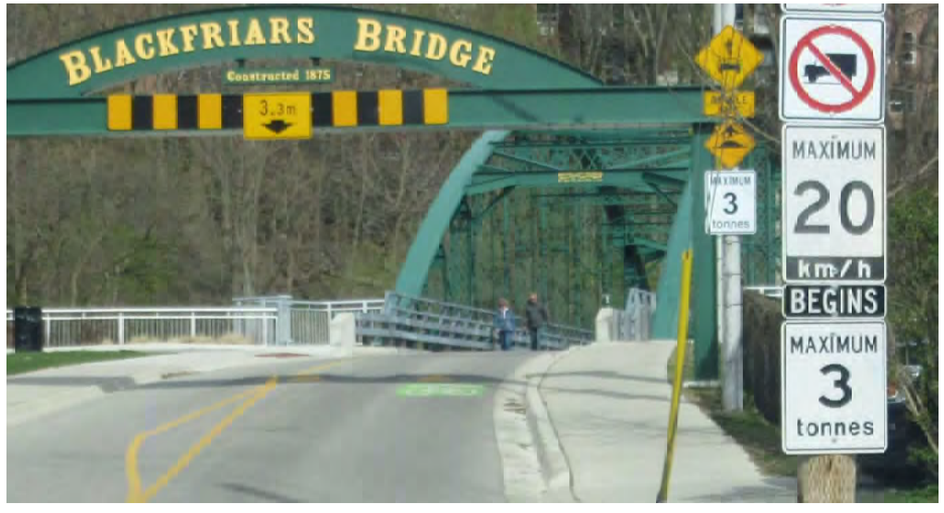
N/A

Alternative Concept:

Provide a vertical clearance limit at the bridge.

Discussion/Rationale:

The recommendation of the workshop is to provide a 3.3 m vertical clearance limit at the bridge using a restrictive overhead barrier that is also aesthetic and reflective of the heritage character of the site. A sample is illustrated below.



It is suggested that the design of this barrier include community input obtained through the Engage website.

The use of vehicle height restriction was considered by the group to be more effective for restricting oversized vehicles than weight restriction signage.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Install vehicle weight sensors in the roads approaching the bridge	**Alt. No.:**	7
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

Rely on load posting signs to limit weight of vehicles crossing bridge.

Alternative Concept:

Install vehicle weight sensors in the approach roadways to alert drivers and the community of approaching overweight vehicles before they cross the bridge.

Advantages:

- Will help reduce the chance of bridge being overloaded by overweight vehicles.
- Opportunity to catch drivers of overweight vehicles and alert them of their actions.

Disadvantages:

- Additional expense to install.
- Will require an alert and enforcement system.
- Believed to offer no legal remedy if an overloaded vehicle does cross the bridge.

Discussion/Rationale:

Installing vehicle weight sensors on the roads approaching the bridge would provide the ability to alert drivers of overweight vehicles (i.e., weights greater than the bridge load posting) that their vehicles are overweight and that they should not cross the bridge. This system requires the ability to alert drivers, likely through the use of flashing lights and/or alert horns/sirens. The alerting process will likely be a nuisance to the local community. Furthermore, an alert system would require enforcement. Enforcement would be difficult because of the short time frame in which an overweight vehicle could drive across the bridge and drive away. It will be very difficult to stop drivers who do not respond to the alert system. Finally, we understand that the police have a difficult time enforcing this sort of violation because the *Highway Traffic Act* does not prescribe a meaningful consequence to offenders.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	May 9, 2023
Description:	Install interior barriers along the road edges to protect the wood trusses from vehicle impacts/ Install safety rail to protect truss from errant vehicles travelling through the bridge/ Interior railing/curb to be low height to see truss from the car	**Alt. No.:**	10/62/63
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

The existing bridge has wood curbs along the road edges.

Alternative Concept:

Install new crash-tested barriers along the road edges to protect the wood trusses against vehicle impact.

Advantages:

- Will protect the trusses better than the existing curbs.
- The new barriers would be crash-tested for the magnitude of impact that could reasonably be expected to occur inside the bridge.
- The new barriers would make the bridge compliant with the bridge code.

Disadvantages:

- New barriers will be taller than the existing curbs, impacting the view of the wood trusses from the roadway.
- New barriers would be more expensive than new curbs.

Discussion/Rationale:

The wood trusses are the primary load-carrying system on the bridge. Installing new crash-tested barriers along the road edges to protect the trusses against vehicle impact would help prevent catastrophic failure of the bridge, thus improving safety and protecting the heritage structure. New barriers would also help reduce injury severity to vehicle passengers in the event of an accident.

New barriers are required by the Bridge Code. It is anticipated that the barriers would need to meet Test Level 2 crash-testing requirements, which is the least severe test level used by the Bridge Code. Timber barriers would be possible in this case to match the aesthetic of the bridge. The barriers will have to be 0.68 m in height above the deck to meet code requirements. It is preferrable for the barriers to not exceed this height so that the truss is as visible as possible from passing cars.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	March 31, 2023
Description:	DDA Structural Alternative B	**Alt. No.:**	11
		Sheet:	1 of 2

Design Suggestion

Original Concept:

Remove the existing steel Bailey trusses. Reinforce existing timber trusses with additional timber (of same species) on compression members and fibre-reinforced polymers (FRP) on tension members (i.e., truss bottom chord). Remove the existing longitudinal tensioning rods on the soffit of the bridge.

Alternative Concept:

Reinforce the existing compression members with engineered timber materials for additional strength. Reinforce the existing tension members with steel instead of FRP.

Discussion/Rationale:

Idea proposed was presented during Public Consultation Center No. 2. It was considered slightly preferrable to DDA Alternative A.

It would be aesthetically pleasing to remove the existing steel components in the bridge and expose the timber trusses.

The rehabilitation method is invasive. Heavy modifications to the existing timber truss may be difficult to remove in the future.

The truss structures are non-redundant.

Potential changes to the overall bridge dimensions (i.e., increase in bridge height): Depending on the size of the bottom chord reinforcement, the external cladding will need to be extended to hide this additional bottom chord depth. The bridge height will also potentially increase due to the larger depth bottom chord.

FRP are not ductile. Steel will perform better in this scenario.

Existing longitudinal tensioning rods can be removed to provide a small increase to hydraulic clearance; however, existing crossing bracings in the deck will still protrude from the bridge soffit.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	March 31, 2023
Description:	DDA Structural Alternative B	**Alt. No.:**	11
		Sheet:	2 of 2





Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	March 31, 2023
Description:	DDA Structural Alternative A	**Alt. No.:**	12
		Sheet:	1 of 2

Design Suggestion

Original Concept:

Alternative Concept:

Remove existing steel Bailey trusses and replace them with 2 new custom-designed and torsionally-stable steel box girders. New box girders are to be designed to withstand all loads experienced by the bridge. The bridge deck will be supported by new steel floor beams connected to the box girders.

Discussion/Rationale:

There will be minimal changes to the bridge appearance in the bridge interior (new girders will be hidden by white splash panels currently within the interior of the bridge).

New box girders provide a secondary load path should the existing timber structure system fail.

New steel box girders and steel floor beams will be visible from the bridge soffit (i.e., will be visible to kayakers).

Existing longitudinal tensioning rods can be removed to provide a small increase to hydraulic clearance. However, existing crossing bracings in the deck will still protrude from the bridge soffit.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	March 31, 2023
Description:	DDA Structural Alternative A	**Alt. No.:**	12
		Sheet:	2 of 2





Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Reduce the sag in the bridge to improve hydraulic clearance	**Alt. No.:**	13
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

The existing bridge has sagged significantly over its service life due to elastic and creep deflections. The sag has reduced the hydraulic clearance by approximately 120mm at midspan.

Alternative Concept:

Lift the bridge and remove the sag to improve the hydraulic clearance.

Advantages:

- Improved hydraulic clearance will make the bridge less susceptible to hydraulic forces during flood events.
- Secondary benefits are improved aesthetic appearance and road surface rideability.

Disadvantages:

- Expensive to jack and temporarily support superstructure so that sag can be removed.
- The fix would only be short term. Elastic and creep deflections will occur again.
- Risk of timber joint failure given the use of specialty fitted connections in the original design.

Discussion/Rationale:

The wood trusses have sagged due to both elastic and creep deflections. For wood, the creep (i.e., long-term time-dependent) deflections are about equal to the elastic deflections.

The sag on the bridge could be reduced by lifting the wood trusses and temporarily supporting them using stiff beam elements positioned within the road width. The truss nodes and members could then be manipulated as necessary to eliminate the sag.

Reducing the sag introduces a major risk of damaging or failing some of the truss node connections. Many of these connections used in the original design were specialty fitted connections. The rotational capacity of these connections is unknown. Reducing the sag would introduce rotations into these connections, and hence the risk of joint damage/failure.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Reduce the sag in the bridge to improve hydraulic clearance	**Alt. No.:**	13
		Sheet:	2 of 1

Reducing the sag would only be a short-term achievement. The wood trusses are believed to have been constructed level, without any camber (i.e., upward deflected shape at installation). Restoring the trusses to a level position would likely be the maximum possible reduction in sag without imposing rotations on the truss nodes that they have never experienced. Accordingly, the sag would not be eliminated because the elastic deflections due to the bridge self-weight would cause immediate sag after the bridge was lowered down from the temporary support beams. Furthermore, the creep deflections, which would be roughly equal to the elastic deflections, would occur again in time. Therefore, it is not possible to reduce the sag in the long term.

The improvement to the hydraulic clearance afforded by reducing the sag is expected to be very minimal. Therefore, reducing the sag is likely a low value solution that is not worth pursuing.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Raise the bridge at the south abutment to match the height at the centre pier	**Alt. No.:**	14
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

Maintain the existing abutment elevations

Alternative Concept:

Raise the bridge at the south abutment to the elevation of the top of the existing pier, to provide additional vertical clearance for floods.

Existing elevation of top of south abutment = 323.769 m.

Existing elevation of top of pier = 323.899 m.

Gain = 0.130 m.

Advantages:	**Disadvantages:**
• Additional vertical clearance will increase the flood flow at which the water will reach the soffit from 515 m^3/s to 560 m^3/s	• Flat profile between abutment and pier • Increases the grade between the bridge abutment and the intersection

Discussion/Rationale:

Since the bridge is vulnerable to flooding, an increase in soffit elevation will reduce the exposure to flooding.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	May 5, 2023
Description:	Replace exterior cladding as needed (i.e., not entire replacement)	**Alt. No.:**	15
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

No replacement strategies had been defined for the exterior cladding during the Preliminary Design.

Alternative Concept:

Replace exterior cladding panels as required.

Discussion/Rationale:

In this scenario, only obviously damaged or missing components of the cladding would be replaced. The material would be selected to match the species and size of the cladding board. The style of cladding has been noted to differ along the length of the bridge, likely to due replacements over the decades. Two styles have been observed: board-and-batten and tongue-and-groove.

At a minimum, cladding locations that currently allow rain, snow and animals to enter the enclosed bridge deck would be prioritized for replacement. Locations that currently trap moisture against the bridge structure would have to be investigated and retrofitted. Depending on the location, the style of cladding of the existing cladding may be replaced with similar style if appropriate.

Note that access to the primary structure may be required during structural retrofits which would require the removal of the existing cladding. In this case, cladding components would likely break, as they are pried off the structure (nailed in place) and would therefore require replacement.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	May 5, 2023
Description:	Replace all exterior cladding (similar, if feasible, to 1880s design) to reduce future maintenance requirements	**Alt. No.:**	16
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

No replacement strategies had been defined for the exterior cladding during the Preliminary Design.

Alternative Concept:

Replace all exterior cladding panels, regardless of condition, to reduce future maintenance requirements.

Discussion/Rationale:

Given the difficulty of creating access to replace cladding components, and from a maintenance perspective, it would be preferable to replace all the cladding at once to start a fresh cycle of maintenance and take advantage of mobilized access and trades.

The original intent of the rural barn builders and exhibited in the bridge by the Baer Brothers who constructed the bridge should be used as a guide. The bridge was constructed so that the exposed exterior components could more easily be repaired/replaced as they weathered with the interior timber structure remaining protected from deterioration. Therefore, replacing the exterior cladding would be in keeping with this thinking.

The material would be selected to match the species and size of the cladding board. The style of cladding has been noted to differ along the length of the bridge, likely to due replacements over the decades. Two styles have been observed: board-and-batten and tongue-and-groove. A decision would be needed to choose the preferred style of cladding, keeping in mind best practices to allow the free flow of air around the boards and between the board and the main structure to prevent moisture from becoming trapped which could lead to premature deterioration of the cladding and the structure.

Note that access to the primary structure may be required during structural retrofits which would require the removal of the existing cladding. In this case, cladding components would likely break, as they are pried off the structure (nailed in place) and would therefore require replacement.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	May 5, 2023
Description:	Detailed survey of cladding to determine condition of each board. Create a design criterion for the board replacement.	**Alt. No.:**	17
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

No replacement strategies had been defined for the exterior cladding during the Preliminary Design.

Alternative Concept:

Create a design criteria sheet for exterior cladding panel replacement. Conduct a detailed survey of the cladding to determine the condition of each board and use the design criteria sheet to determine the replacement panels.

Discussion/Rationale:

An option would be to selectively replace cladding boards following a detailed inspection of the cladding. Observations of broken boards, deterioration, insect or animal attack and other features would be made along the length of the bridge. A detailed process would be developed to look at each board from top to bottom, with full access from the exterior and where possible from the interior. Since the boards are relatively thin, using a moisture meter and resistograph would not be practical, thus limiting the survey to visual and some tactile observations.

Two drawbacks of this scenario:

1) Some areas with deterioration may go undetected in the survey; and
2) Mobilizing access for the survey inspection would be similar in scope and cost to the access required to fully replace the cladding.

Additionally, since access to the primary structure may be required during structural retrofits, cladding would need to be removed to provide access. In this case, cladding components would likely break, as they are pried off the structure (nailed in place) and would therefore require replacement.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Salvage some existing bridge components that require replacement for on-site display	**Alt. No.:**	19
		Sheet:	1 of 1

Design Suggestion

Original Concept:

N/A

Alternative Concept:

Salvage existing bridge components for on-site display.

Discussion/Rationale:

Components of the existing bridge are recommended for replacement, due to their condition or structural integrity. The re-use of these components may be considered in an interpretive conservation feature. For example, the replaced timber components could be re-used in non-structural elements such as signage, a storyboard, or other decorative displays. A local example is the use of part of the steel truss from the historical Badley Bridge in Elora, Ontario, which is now a public art installation in the downtown.



Some of the cladding boards from the exterior that will be replaced that are still in decent condition could be used to finish the gable ends of the bridge. The amount of material needed is not large, but it would be an example of retaining and reusing sound original material (and when these boards deteriorate in the future they could be more easily accessed from the road for replacement).

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Maintain current gross external dimensions on the bridge to the greatest extent possible / Strengthen bridge but maintain original dimensions of the bridge	**Alt. No.:**	20/21
		Sheet:	1 of 1

Design Suggestion

Original Concept:

Alternative B proposed a 300-600 mm increase in truss height to reinforce the bottom chord members with fibre reinforced polymer (FRP) reinforcement.

Alternative Concept:

Consider alternatives that maintain the existing gross external dimensions of the bridge.

Discussion/Rationale:

The size and setting of the bridge are part of the heritage designation. While the bridge has evolved over time, the VE team recognizes the importance of maintaining the existing dimensions. This also eliminates the need for extend the exterior cladding, which may have a visual impact on the bridge.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Remove Bailey truss and affix timber reinforcement on sides of bottom chords (Modified Alternative B)	**Alt. No.:**	22
		Sheet:	1 of 2

VM Proposal Summary

Original Concept:

Alternative B proposes to remove the Bailey trusses and reinforce the bottom face of the bottom chords with FRP reinforcement.

Alternative Concept:

Continue to remove the Bailey trusses, but reinforce the bottom chord members with timber reinforcement, as side-face reinforcement is not in conflict with the existing floor beams.

Advantages:	**Disadvantages:**
• Strengthening material is sympathetic to original material (i.e., strengthen timber with timber) • Easily reversible • Allows for continuity of reinforcement without conflicting with floor beams • Timber reinforcement will afford greater axial stiffness to bottom chords than will FRP reinforcement • Eliminates any thermal movement conflicts between original and strengthening materials • Reinforcement can be performed by more contractors than can be FRP reinforcement (i.e. more competitive bids)	• None

Discussion/Rationale:

Alternative B was the preferred alternative identified by the Environmental Assessment (EA). It is predicated on strengthening the timber members with FRP reinforcement. It is not clear why FRP was the preferred material.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Remove Bailey truss and affix timber reinforcement on sides of bottom chords (Modified Alternative B)	**Alt. No.:**	22
		Sheet:	2 of 2

Substituting timber reinforcement for the FRP reinforcement has significant advantages and no drawbacks. It appears that strengthening with timber was not considered during the EA. It is recommended to pursue this alternative, which is a modification of Alternative B.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Sandwich connection with steel plate between boards (instead of FRP)	**Alt. No.:**	25
		Sheet:	1 of 2

VM Proposal Summary

Original Concept:

Alternative B proposes to reinforce the timber elements with FRP reinforcement sandwiched between boards.

Alternative Concept:

Substitute the FRP reinforcement with steel plate reinforcement, also sandwiched between boards.

Advantages:	**Disadvantages:**
• Strengthening material is more sympathetic to original design than FRP (i.e., original design used steel rods and plates) • Easily reversible • Affords ductility to structure, unlike FRP • Steel reinforcement will afford greater axial stiffness to bottom chords than FRP reinforcement • Eliminates any thermal movement conflicts between original and strengthening materials • Reinforcement can be performed by more contractors than FRP reinforcement (i.e., more competitive bids)	• Significant difference in coefficients of thermal expansion for wood and steel will limit the length over which reinforcement can be used before thermal stresses outweigh the benefit of reinforcement

Discussion/Rationale:

Alternative B was the preferred alternative identified by the Environmental Assessment (EA). It is predicated on strengthening the timber members with FRP reinforcement. It is not clear why FRP was the preferred material.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Sandwich connection with steel plate between boards (instead of FRP)	**Alt. No.:**	25
		Sheet:	2 of 2

Substituting steel reinforcement for the FRP reinforcement has significant advantages. The drawback is the thermal incompatibility between steel and wood, which could result in thermal restraint stresses that work against the beneficial effect of strengthening. It appears that strengthening with steel was not considered during the EA. It is recommended to further review this alternative, which is a modified form of Alternative B.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	March 31, 2023
Description:	Pedestrian walkway on the outside of the bridge across the needle beams (during construction)	**Alt. No.:**	31
		Sheet:	1 of 2

Design Suggestion

Original Concept:

Provide a pedestrian/cyclist accessway during construction on the exterior of the bridge.

Alternative Concept:

Shut off bridge to all traffic (including pedestrians/cyclists) during construction and use temporary work platform on the exterior of the bridge for pedestrians/cyclists.

Discussion/Rationale:

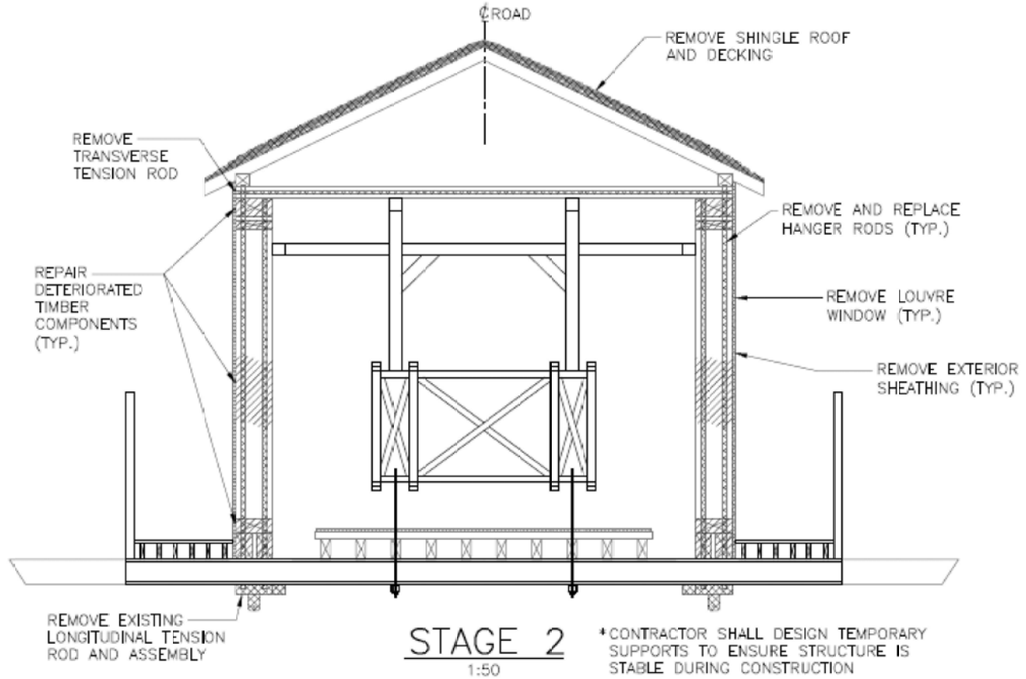
Due to the need to complete work on the exterior of the bridge (i.e., cladding replacement), the Contractor is expected to construct a temporary work platform on the exterior of the bridge. During construction, DDA proposes utilizing this platform when the Contractor is not utilizing it as a temporary access through the construction zone.

The bridge continues to serve the community as a convenient way to cross the Grand River. The next available crossing is located at Highway 86 (a 2 km detour). There are also potential marathon/cycling events which include this bridge as a part of the route (to be confirmed).

The temporary work platform must be supported on another floor beam system since the existing bridge needle beams are spaced too far apart and are likely not strong enough to support a temporary work platform.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	March 31, 2023
Description:	Pedestrian walkway on the outside of the bridge across the needle beams (during construction)	**Alt. No.:**	31
		Sheet:	2 of 2



Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	May 15, 2023
Description:	Inverted suspension cable system (inverted bowstring)	**Alt. No.:**	32
		Sheet:	1 of 2

VM Proposal Summary

Original Concept:

Previous strengthening concepts for the bridge have included both strengthening of the existing truss members and the addition of steel girders to carry the loads.

Alternative Concept:

An alternative strengthening concept is to install a suspension cable system along each truss following an inverted bowstring profile.

Advantages:

- Will not add significant dead load to the bridge relative to a new steel girder.
- The cable can also be used as part of the temporary support systems to relieve the truss of its existing loads.
- May also be able to function as a lateral brace for the existing truss top chord members.

Disadvantages:

- Requires the addition of a long strut at the top chord level to enable the cable system to be self-anchoring.

Discussion/Rationale:

The environmental assessment identified two strengthening options for the bridge:

1) Strengthen the bridge by addition of new steel box girders that would relieve the existing timber trusses of most of their loads.
2) Strengthen the existing timber truss members with fibre-reinforced polymer reinforcement.

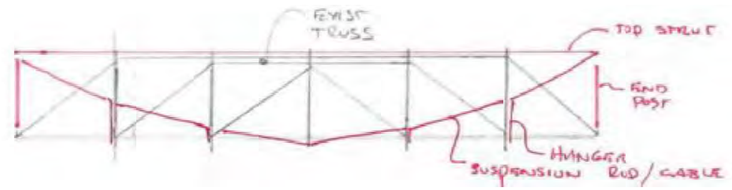
A third option exists in the form of installing a suspension cable system that would relieve the existing timber trusses of some of their load. The cable would be installed to follow an inverted bowstring profile. Hanger rods or cables would be used to carry vertical loads from the floor beams up to the suspension cable. The cable would be self-anchoring via a long top strut positioned above the top chords of the timber trusses. This strut could be steel or timber. The strut would equilibrate the horizontal component

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	May 15, 2023
Description:	Inverted suspension cable system (inverted bowstring)	**Alt. No.:**	32
		Sheet:	2 of 2

of force in the cable. The vertical component of force in the cable would be equilibrated by vertical posts positioned at each end of the truss spans. The posts would also hold up the top strut member. The posts could be steel or timber. The following image depicts the suspension cable concept.



The suspension cable system should be an inexpensive means to strengthen the existing timber trusses. It would also double as a temporary support system during construction, as tensioning the cables would lift the trusses and relieve them of some load.

The top strut and posts could be designed to have sufficient out-of-plane stiffness to act as a lateral brace for the timber truss top chord members, possibly further increasing the capacity of the structure.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Dry system for fire suppression	**Alt. No.:**	34
		Sheet:	1 of 1

Design Suggestion

Original Concept:

N/A

Alternative Concept:

Implement a dry system for fire suppression.

Discussion/Rationale:

This idea is to protect the asset from severe damage and destruction. Loss from fire damage due to vandalism or lightning is a high risk based on the dry water content of the wooden structure. Alternatives discussed at the workshop included: a dry hydrant (using the river as a source of water for the Fire Department); a buried cistern to supply water to a sprinkler system; or the use of a dry suppression system from sprinklers.

Based on the speed of fire spreading in a dry timber structure, the automated response from a sprinkler system is preferred. An automatic dry pipe sprinkler system with a reservoir and diesel pump will best serve this site. Preliminary sizing of a system is a 500 US gpm pump and reservoir with 30,000 gallons of water storage.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	May 5, 2023
Description:	Treat timbers with fire retardants.	**Alt. No.:**	35
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

N/A

Alternative Concept:

Treat timbers with fire retardants.

Discussion/Rationale:

Fire retardant treatments are available for timber. A topical treatment is available for larger timber, brushed or sprayed on. For smaller members, such as cladding boards, pressure treatments are available and preferred to fully impregnate the timbers. A survey of the various chemicals used for treatment would be required to determine their benefits and drawbacks. Some potential concerns may be potential exposure to humans and wildlife (including fish habitat below the bridge) to chemicals through the air, or by touching or leaching of the chemicals, if they are toxic (to be determined). If a suitable treatment is available, reducing flame spread and/or self-extinguishing any flames would be of benefit to the longevity of the bridge.

Recommend pursuing different options for using fire retardants in specific components such as cladding, roof framing, and the main structure.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Steepen driveway to 8% and determine how much this allows the bridge to be raised	**Alt. No.:**	43
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

Maintain the south approach grade as is. The existing grade is approximately -7.05%. Existing WP 3 elevation is 324.087 m.

Alternative Concept:

Steepen the south approach to -8.00% and determine how much this allows the bridge to be raised.

Advantages:

- Additional vertical clearance will increase the flood flow at which the water will reach the soffit from 515 m^3/s to 560 m^3/s.

Disadvantages:

- Flat profile between abutment and pier
- Increases the grade between the bridge abutment and the intersection

Discussion/Rationale:

From a LiDAR profile of the south approach, a slope of 8% would allow the abutment WP elevation to be raised by 0.18 m, to 324.267 m.

The result would be a larger increase in the south abutment elevation than proposed in VE Idea 14.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Two-way stop at the south end and a stop sign at the north end	**Alt. No.:**	46
		Sheet:	1 of 1

Design Suggestion

Original Concept:

Approaching the bridge, southbound Covered Bridge Drive and westbound Rivers Edge Drive are controlled with Yield to Oncoming Traffic signs and eastbound Rivers Edge Drive are controlled by a stop sign.







Alternative Concept:

Replace the existing Yield to Oncoming Traffic signs with stop signs, creating a two-way stop (eastbound and westbound) on the south side of the bridge. On the north side of the river, southbound traffic would be required to stop prior to entering the covered bridge.

Discussion/Rationale:

The existing stop control on the eastbound approach to the T intersection is not a common configuration; however, Rivers Edge Road has no exit west of Covered Bridge Drive and only provides access to two houses.

Requiring all motorists to stop as they approach the bridge may result in a minor reduction in travel speeds entering the structure. On westbound Rivers Edge Drive, motorists stopped at the proposed stop sign would be unable to see oncoming traffic crossing the bridge so they would still need to enter the intersection, pulling forward before they can achieve a sightline across the bridge.

We are not aware of any major problems with the existing yield control given the limited volume of traffic which uses the covered bridge to cross the river. The existing Yield to On-Coming Traffic signs seems to define the right-of-way more clearly for motorists.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 5, 2023
Description:	Tree clearing to improve visibility	**Alt. No.:**	48
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

N/A

Alternative Concept:

Tree clearing to improve visibility of the bridge from the southeast.

Discussion/Rationale:

Clearing trees to the southeast of the bridge is desirable. The bridge is a cultural heritage designated structure and a landmark of the community. Currently, the bridge can only be viewed in its entirety from the southwest and from the Grand River (boaters/watercraft). Removal of these trees would provide an additional viewing direction. A clear line of sight of the bridge from the southeast is preferable for tourists to appreciate this cultural heritage asset.



Southeast view obstructed by trees



Southeast view obstructed by trees

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Educational storyboard on the evolution of bridge technology employed in this bridge / Salvage materials of the bridge for an interactive storyboard	**Alt. No.:**	51/52
		Sheet:	1 of

Design Suggestion

Original Concept:

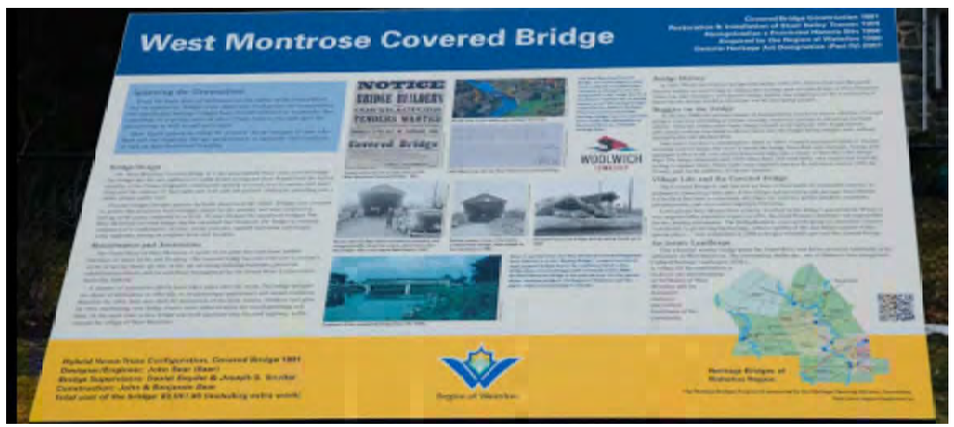
N/A

Alternative Concept:

Consider creating a storyboard to describe the evolution of the bridge modifications and technology used to date. The storyboard could be made of salvaged materials from the bridge.

Discussion/Rationale:

The existing storyboard at Letson Park, shown below, describes the history of the West Montrose Covered Bridge. An additional interpretive sign could be created to describe the evolution of the bridge since 1881 and the technology used in the rehabilitation of the bridge, including the proposed 2023/24 works. The interpretive sign could include components of the bridge that require removal but may be salvaged and reused to highlight the past construction techniques and materials.



Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Provisions for horse and buggies	**Alt. No.:**	54
		Sheet:	1 of 1

Design Suggestion

Original Concept:

n/a - Line 86 currently has paved shoulders between Katherine Street and Covered Bridge Drive, except for over the bridge crossing the river.

Alternative Concept:

During construction, provide a dedicated lane on Line 86 for horse and buggies (remove a lane for vehicular traffic).

Discussion/Rationale:

Given the volume of vehicular and truck traffic on Line 86, removing a lane of vehicular traffic is not recommended. The queuing would be extensive and back up to and through the Katherine Street intersection. This would have negative impacts of traffic infiltration into adjacent neighbourhoods and safety issues.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 17, 2023
Description:	Line 86 Speed Limit	**Alt. No.:**	55
		Sheet:	1 of 1

Design Suggestion

Original Concept:

n/a

Alternative Concept:

Reduce speed on Line 86 during construction for use as a detour.

Discussion/Rationale:

Region staff generally recommend that speed limits be set at or about the average speed because this is most likely to produce a uniformly moving traffic stream. Traffic flowing at a uniform speed results in increased safety and fewer collisions. With uniform speed, drivers are less impatient, pass less often, and are less likely to tailgate, which reduces both head-on and rear-end collisions.

In general, it is very difficult to control speed. Speed limit signs do not slow down traffic. Research has shown that most drivers travel at a speed they consider to be comfortable, regardless of posted speed limits. Studies, undertaken “before” and “after” revised speed limits have been undertaken in the Region of Waterloo, and have shown that there are no significant changes in average vehicle speeds following the posting of the signs. Research elsewhere indicates similar conclusions.

Staff assessed the 5-year collision history along Line 86 between Katherine Street and Oak Street and between Oak Street and Middlebrook Road/ Covered Bridge Drive. During this period, staff did not identify any usual collision patterns associated with speeding. The above roadways, within their respective midblock sections, currently rank 1738 and 1550 respectively for collisions out of 3342 locations assessed during this period.

This section of Line 86 is located in a rural area and it is difficult to install physical roadway features that will have an effect on traffic.

Based on our review, reducing the posted 80km/h posted speed limit is not recommended. Staff will continue to monitor traffic operations along Line 86 through the duration of construction and should concerns arise or persist, staff will revisit the concern and take appropriate action.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	May 5, 2023
Description:	Maintain the exterior red colour	**Alt. No.:**	56
		Sheet:	1 of 1

Design Suggestion

Original Concept:

N/A

Alternative Concept:

Maintain the existing red colour on the exterior of the bridge.

Discussion/Rationale:

Part of the evolution of the bridge was the later addition of red paint on the exterior cladding. Although not part of the original design, painting the bridge red has not diminished its heritage significance but has added an attribute that has heritage value. Maintaining the red colour is a recommended conservation approach.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Use wooden curbs as splash guards for the wood trusses	**Alt. No.:**	58
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

The existing bridge makes use of a wood plank splash guard to protect the steel Bailey trusses and the lower portion of the wood trusses from splashing caused by passing vehicles.

Alternative Concept:

Install wooden curbs in the rehabilitated structure to act as splash guards for the wood trusses.

Advantages:

- Using wood curbs is sympathetic to the existing design
- Easily reversible
- Inexpensive

Disadvantages:

- Bridge code requires crash-tested barriers, which means the curbs won't qualify based on height requirements
- A curb is a low-height object, which may not afford much protection from splashing

Discussion/Rationale:

The existing structure has benefited from the addition of wood plank splash guards. Adding protection to the rehabilitated structure would help prolong the life of the structure. A wood curb is an inexpensive splash guard that is sympathetic to the existing design.

The problem with wood curbs is that they would likely have a maximum height of 300mm (i.e., 12"x12" timber curbs). This height is likely too shallow to adequately protect the trusses from splashing. Furthermore, they won't satisfy the bridge code, which requires the use of crash-tested barriers. It is anticipated that a test level 2 barrier will be required for the West Montrose Covered Bridge. Test level 2 has the least stringent geometric and strength requirements of barriers required by the code. As a minimum, TL-2 barriers must be 0.68m in height. A curb would not be able to achieve that dimension. With this in mind, a closed rail TL-2 barrier would act as a better splash guard than a timber curb because it would provide more height. Therefore, timber curbs are not recommended as splash guards.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Move louvers back to the original height to allow more daylight / Restore window vents to original size	**Alt. No.:**	59/77
		Sheet:	1 of 3

VM Proposal Summary

Original Concept:

Maintain existing dimensions of the louvers.

Alternative Concept:

The bridge recommendations present an opportunity to restore the windows/louvers to the original dimensions.

Advantages:	**Disadvantages:**
• Restore original dimensions of elements.	• N/A

Discussion/Rationale:

Historical photos show approximately 7 slats in the windows which are recommended to be restored. The team should investigate if the original window size has been maintained and covered inside the bridge when the Bailey Truss was implemented, or if it has been modified.

With the removal of the interior finishings, there is an opportunity to research and investigate the original louver details and restore the opening.

Cost Summary	**Capital Cost**	**Future Costs**	**Life Cycle Cost**
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Move louvers back to the original height to allow more daylight / Restore window vents to original size	**Alt. No.:**	59/77
		Sheet:	2 of 3

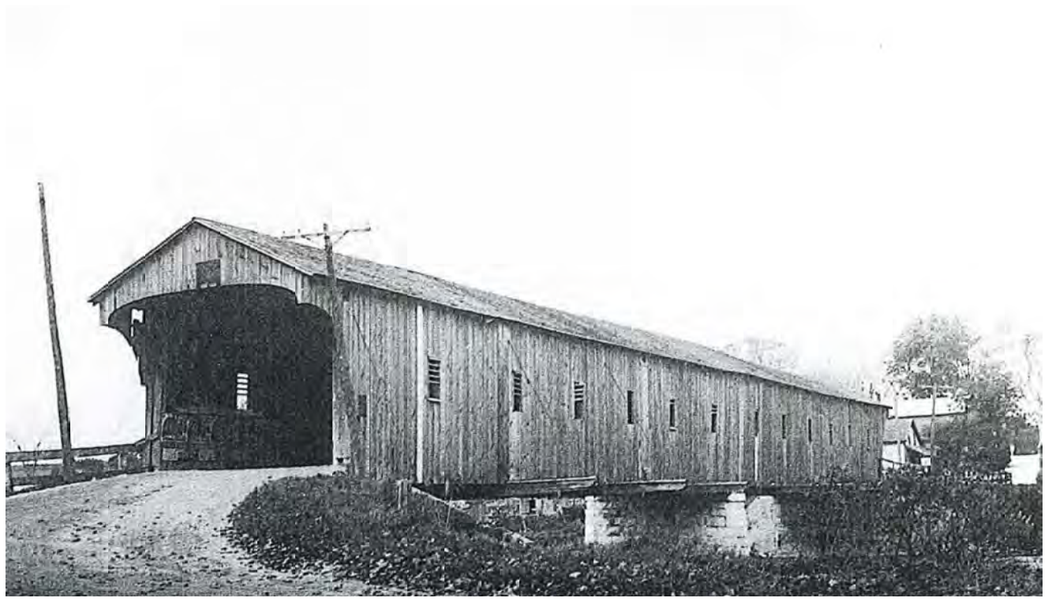
Sketch – Original Concept



Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Move louvers back to the original height to allow more daylight / Restore window vents to original size	**Alt. No.:**	59/77
		Sheet:	3 of 3

Sketch – Alternative Concept



Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Prequalification of Bidders	**Alt. No.:**	64
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

Traditional bidding process in design-bid-build contracts is not to prequalify bidders.

Alternative Concept:

Prequalify bidders so that only contractors with sufficient experience rehabilitating heritage wood structures can be awarded the contract.

Advantages:

- Should improve quality of construction
- Should preclude underqualified contractors

Disadvantages:

- Administrative costs for prequalification
- Determining the requisite level of experience for prequalification is somewhat inexact and could result in competent contractors accidentally being omitted from bidding
- Reduces number of bidders, which could result in higher bids

Discussion/Rationale:

The bridge is of significant heritage value. The quality of the rehabilitation work must be high. Prequalifying bidders is a simple measure that should improve the quality of the rehabilitation. It is recommended to pursue prequalification of bidders.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	New cedar shingle roof	**Alt. No.:**	66
		Sheet:	1 of 2

VM Proposal Summary

Original Concept:

N/A

Alternative Concept:

Replace the roof with new cedar shingles.

Advantages:

- Maintain heritage attributes.

Disadvantages:

- N/A

Discussion/Rationale:

The historic materiality of the bridge is that a wooden timber structure and the idea recommends the use of cedar shingles.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	New cedar shingle roof	**Alt. No.:**	66
		Sheet:	2 of 2



Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Hydrotechnical forecasting to consider climate change	**Alt. No.:**	67
		Sheet:	1 of 1

Design Suggestion

Original Concept:

Maintain status quo.

Alternative Concept:

Examine the potential effects of climate change on the severity and frequency of floods at the site.

Discussion/Rationale:

To be able to assess the long-term risk of flooding at the site, the effect of climate change on future floods should be assessed.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Keep existing approach grades	**Alt. No.:**	68
		Sheet:	1 of 1

Design Suggestion

Original Concept:

Maintain status quo.

Alternative Concept:

If the bridge elevations are changed, maintain the existing grades at the approaches.

Discussion/Rationale:

It may be possible to raise the south abutment and maintain the grade of the south approach (7.1%). In that case, the grade at the intersection would be raised to accommodate the change. Based on the calculations in VE Idea 14, the grade at the intersection would be raised by 0.130 m.

The effect of the change in the elevation at the adjoining properties would require detailed examination.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	March 31, 2023
Description:	Strengthen piers/abutments for increased hydraulic pressure	**Alt. No.:**	69
		Sheet:	1 of 1

Design Suggestion

Original Concept:

Alternative Concept:

Increase the lateral force and uplift capacity of the bridge substructure to withstand hydraulic loading during flood events.

Discussion/Rationale:

The possibility exists to increase the load capacity of the existing bridge substructure (in terms of uplift, lateral, and bearing forces). This can be accomplished by installing micro piles and tying the bridge substructure to the new pile foundation.

Additional reinforcement may need to be installed into the piers and abutments to ensure that the loads from the bridge can be transferred to the new piles.

Uplift restraint in bearings and uplift resistance in the bridge structure must be accounted for by the superstructure designer.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Design floor structure for hydraulic pressure	**Alt. No.:**	70
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

The original structure is not believed to have been designed to resist hydraulic pressures that would arise due to partial submersion in a flood event.

Alternative Concept:

Design the rehabilitated floor system for hydraulic pressures that would arise due to partial submersion in a flood event.

Advantages:

- Will protect structure against serious flood damage
- Will improve longevity of structure
- Likely easily reversible

Disadvantages:

- Strengthening adds additional cost
- Strengthening may be difficult to achieve using materials and structural systems that are sympathetic to the original design

Discussion/Rationale:

The existing structure is understood to be vulnerable to flood loading. It is understood that partial submersion is likely to occur during storm events exceeding a 5-year return period. Protecting the structure against flooding is critical to ensuring its longevity.

Raising the structure to avoid partial submersion is understood to be too difficult to achieve due to grading restrictions at the ends of the bridge. Accordingly, strengthening against hydraulic pressure is necessary.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Tie-down superstructure	**Alt. No.:**	71
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

The original structure is not believed to have been designed to resist hydraulic uplift that would arise due to partial submersion in a flood event.

Alternative Concept:

Design tie-downs for the superstructure to resist uplift pressures that would arise due to partial submersion in a flood event.

Advantages:	**Disadvantages:**
• Will protect structure against serious flood damage • Will improve longevity of structure • Likely easily reversible	• Strengthening adds additional cost • Strengthening may be difficult to achieve using materials and structural systems that are sympathetic to the original design

Discussion/Rationale:

The existing structure is understood to be vulnerable to flood loading. It is understood that partial submersion is likely to occur during storm events exceeding a 5-year return period. Protecting the structure against flooding is critical to ensuring its longevity.

Raising the structure to avoid partial submersion is understood to be too difficult to achieve due to grading restrictions at the ends of the bridge. Accordingly, tying down the superstructure to resist hydraulic uplift pressures is necessary.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Install roof anchors for future maintenance access	**Alt. No.:**	72
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

The existing roof does not have roof anchors.

Alternative Concept:

Working on the roof of the bridge requires workers to tie-off using a fall arrest system due to the height hazard. Installing permanent anchors for tying-off would improve future maintenance access.

Advantages:	**Disadvantages:**
• Improves future maintenance access • Permanent anchors are typically safer than temporary anchors • Easily reversible	• Adding anchors adds additional cost

Discussion/Rationale:

The roof of the bridge will require ongoing maintenance and eventual future replacement. Having permanent anchors for workers to tie off to will greatly improve access to the roof and worker safety. It is recommended to include these anchors in the design.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Create a working group with GRCA to review policies and downstream jamming mitigation	**Alt. No.:**	74
		Sheet:	1 of 1

Design Suggestion

Original Concept:

Maintain status quo.

Alternative Concept:

Create a group working with GRCA specific to the bridge site to review policies regarding modifications to the riverbed and channel upstream of the bridge in order to reduce ice jamming which may impact the bridge.

Discussion/Rationale:

There is a concern that changes that have taken place in the riverbed river channel near the bridge because of past high flows, which have created an island in the river that could affect the ice jamming potential.

The working group would examine the potential effect of the river conditions on the flooding of residences in the area and the bridge.

This initiative is beyond the scope of the bridge rehabilitation contract but should be considered as a separate initiative. It requires river engineering expertise.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Increase exposure of the truss from the inside of the bridge	**Alt. No.:**	76
		Sheet:	1 of 2

Design Suggestion

Original Concept:

Alternative B is the preferred alternative that was shown to the public. It includes:

- Removal of existing steel Bailey Trusses and reinforcing the existing Timber Trusses.
- Reinforcing the original structural timber truss and floor beam support system.
- FRP reinforcement was specifically considered during this stage.

Alternative Concept:

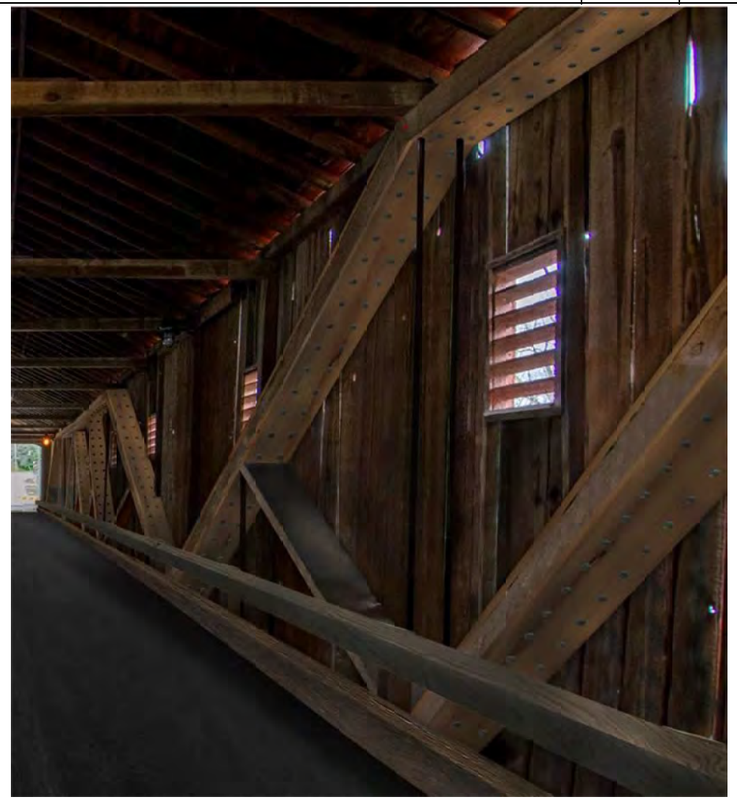
The preferred alternative may change, depending on the results of the Value Engineering workshop and evaluation of alternatives by the Project Team. However, increasing the exposure of the truss from the inside of the bridge should be a consideration for any alternative carried forward.

Discussion/Rationale:

Increasing the exposure of the truss from the inside enhances the experience of the user by revealing the rare timber construction details and historic technology and engineering and materials of the bridge. This is a rare and iconic covered bridge in Ontario.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Increase exposure of the truss from the inside of the bridge	**Alt. No.:**	76
		Sheet:	2 of 2



Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 8, 2023
Description:	New work should be distinguishable from, compatible with and subordinate to the heritage structure, and reversible where possible	**Alt. No.:**	78
		Sheet:	1 of 1

Design Suggestion

Original Concept:

N/A

Alternative Concept:

The Standards and Guidelines for the Conservation of Historic Places in Canada, Standard 11 states:

- Conserve the heritage value and character-defining elements when creating any new additions to an historic place or any related new construction. Make the new work physically and visually compatible with, subordinate to, and distinguishable from the historic place.

Discussion/Rationale:

The preferred solution will involve new materials to meet current needs while leaving as much as possible of the historic features. Where new work is visible it should be "subordinate" to the original design. This means that it does not need to be entirely hidden from view.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	May 15, 2023
Description:	Selectively replace severely damaged truss members	**Alt. No.:**	79
		Sheet:	1 of 1

VM Proposal Summary

Original Concept:

The previously identified rehabilitation alternatives have looked at strengthening the existing wood truss members.

Alternative Concept:

The existing condition of the wood truss members may be such that some of them are severely deteriorated to the point where replacement is necessary, to avoid excessive reinforcement that would diminish the aesthetic of the structure.

Advantages:

- Will improve strength and reliability of truss members that are replaced.
- Is another option for designers that could help minimize costs and impacts to aesthetics.

Disadvantages:

- Replacing members is not reversible.

Discussion/Rationale:

The top and bottom chords have been observed to have some deterioration and permanent sag. Once the structural evaluation of the bridge is completed, it is likely that some components, in their original condition, with or without deterioration, will not meet the minimum requirements of the current highway Bridge Code. In this case, the truss elements would need to be reinforced or replaced. In some cases, reinforcement of timbers is not possible, and the most suitable alternative is to replace them entirely. Any replaced components would be of similar or better species and grade and alternatives such as glued-laminated and/or pressure-treated timber could be considered.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Maintain floor beam unique appearance under the bridge to the extent possible because this is unique to this truss design	**Alt. No.:**	81
		Sheet:	1 of 2

VM Proposal Summary

Original Concept:

Alternative B is the preferred alternative that was shown to the public. It includes:

- Removal of existing steel Bailey trusses and reinforcing the existing timber trusses with FRP reinforcement. Reinforcement of the underside of the bottom chord members was indicated. The floor beams are positioned underneath the bottom chords. It is unclear how the bottom chord FRP reinforcement will be continuous at the floor beam locations. Concern was raised that the floor beams would have to be repositioned to allow for continuous FRP reinforcement along the underside of the bottom chords, thus altering the rare condition of covered bridge floor beams being positioned under the bottom chord members.

Alternative Concept:

Examine alternative reinforcement concepts, including reinforcing the side faces of the floor beams instead of the bottom face, thereby allow continuous reinforcement that is not in conflict with the floor beams.

Advantages:

- Maintain heritage view from the river.
- Maintaining position of floor beams under bottom chords will preserve heritage value of bridge
- Not having to reposition the floor beams will reduce construction risk
- Precludes need to lengthen external cladding by not changing the depth of the bottom chord members
- Precludes raising deck in the event that the floor beams were to be positioned on the top faces of the bottom chord members

Disadvantages:

- Applying this constraint limits the potential efficiency of bottom chord reinforcement

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 13, 2023
Description:	Maintain floor beam unique appearance under the bridge to the extent possible because this is unique to this truss design	**Alt. No.:**	81
		Sheet:	2 of 2

Discussion/Rationale:

Continuous bottom chord reinforcement positioned on the underside of the bottom chord members will conflict with the floor beams. Making the reinforcement continuous would require relocating the floor beams to likely the top side of the bottom chord members, thus raising the top of deck elevation, which will present grading challenges at the ends of the bridge.

Reinforcing the bottom face of the chords would also require having to lengthen the external cladding, which could have visual impact.

Therefore, maintaining the position of the floor beams will preclude several geometric and visual problems.

Any improvements/structural upgrades to modify the underside should ensure the original unique construction methods and configuration are not entirely lost to view. Respect the original appearance through careful planning of alternations to make sure they comply with Standard 11 of the Standards and Guidelines.

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Accept removal of the Bailey Bridge and adding lower splash guard	**Alt. No.:**	82
		Sheet:	1 of 3

VM Proposal Summary

Original Concept:

Alternative B is the preferred alternative that was shown to the public. It includes:

- Removal of existing steel Bailey Trusses and reinforcing the existing timber trusses.
- Reinforcing the original structural timber truss and floor beam support system.
- Fibre Reinforced Polymer (FRP) reinforcement was specifically considered during this stage.

Alternative Concept:

Maintain the recommendation to remove the Bailey Truss but implement a splash guard to protect the trusses from water splashing.

Advantages:	**Disadvantages:**
• The Bailey Bridge does not add heritage value and can be removed. • Materials may be re-used as an interpretive device.	• The Bailey Bridge Truss is a utilitarian and quick solution that does not comply with heritage standards.

Discussion/Rationale:

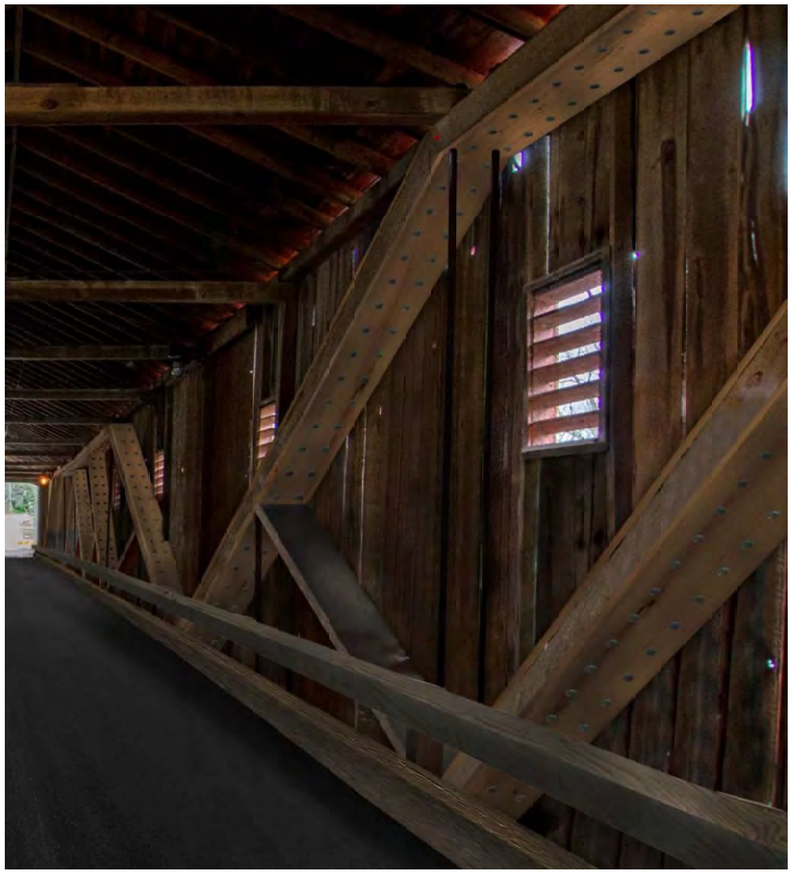
The removal of the Bailey Bridge is acceptable from a heritage perspective, as the Bailey Truss does not add heritage value. The removal of the Bailey Bridge would expose the timber trusses, and a short splash guard is recommended to protect the timber trusses.

Cost Summary	Capital Cost	Future Costs	Life Cycle Cost
Original Concept:	$0	$0	$0
Alternative Concept:	$0	$0	$0
VM Proposal Savings:	$0	$0	$0

Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Accept removal of the Bailey Bridge and adding lower splash guard	**Alt. No.:**	82
		Sheet:	2 of 3

Sketch – Original Concept



Value Management

Project:	West Montrose Covered Bridge Value Engineering Study	**Date:**	April 12, 2023
Description:	Accept removal of the Bailey Bridge and adding lower splash guard	**Alt. No.:**	82
		Sheet:	3 of 3

Sketch – Alternative Concept

Similar concept: a snow guard and splash guard on a bridge.



Appendix L

Analysis and Evaluation Report

Analysis and Evaluation Report

Region of Waterloo
West Montrose Covered Bridge - Timber Truss Assessment and Design Assignment

Township of Woolwich

July 2024

Submitted by:
BT Engineering Inc.
509 Talbot Street
London, ON N6A 2S5
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Appendix D Technically Preferred Alternative

1.0 INTRODUCTION

Entuitive and BT Engineering Inc. (BTE) are undertaking the detail design assignment for the West Montrose Covered Bridge rehabilitation in Guelph, Ontario. The West Montrose Covered Bridge is a two-span covered timber bridge constructed in 1881 and is the last remaining covered vehicular bridge in Ontario. Major rehabilitation was done by MTO between 1950 and 1965 which included the addition of a steel Bailey truss. As the original wooden trusses age, they are shedding more load to the Bailey trusses which cannot carry the entire load of the bridge. Additionally, the deteriorated condition of the existing wood structure is such that rehabilitation is required to preserve the longevity of the structure.

1.1 Study Introduction

The Region of Waterloo undertook additional major rehabilitations to upgrade the Bailey trusses, replace various wood components, reconstruct the northwest bearing seats, and replace cracked timber floor beams. The 2017 timber condition assessment report noted numerous locations with high moisture content, many over the fibre saturation point of wood, creating conditions suitable for decay. At that time, defects in the timber components such as splits, checks, decay, mold, decayed internal pockets, cavities, and decay in pressure treated components were present. Leaks in the roof and walls break the first line of defense for the covered bridge while high flood levels jeopardize the deck structure. In the 5 years since the assessment report, it is expected that the decay and deterioration have progressed. Remediation of the structure will be required to remove sources of moisture, provide detailing to prevent the accumulation of moisture, and repair timber components and connectors in part or in whole.

1.2 Background

The Region of Waterloo initiated a Schedule A+ Municipal Class Environmental Assessment (EA) for the bridge rehabilitation and retained Doug Dixon & Associates (DDA) to complete the EA on the Region's behalf. Two rounds of public consultation have taken place. The first round of public consultation in October 2021 presented a preferred alternative with steel girder reinforcing, and reinstatement of the internal cladding materials. Following the first public consultation, a second alternative was developed which includes strengthening the timber truss and removal of the interior cladding material. This timber restoration alternative was presented as the Preferred Alternative in the latest round of public consultation in June 2022.

1.3 Study Area

The Study Area is located in the Township of Woolwich, as illustrated in **Figure 1**.

1.4 Class Environmental Process

The Study was originally initiated as a Schedule A+ Environmental Assessment (EA). A Schedule A+ project is pre-approved; however, the public has to be advised prior to project implementation. Following the recommendations from the Multi-Attribute Trade-off System (MATS) Evaluation and results of the meeting, the Study is being elevated to a Schedule C Municipal Class EA based on the scope and complexity of the project as well as the estimated capital cost of the project.

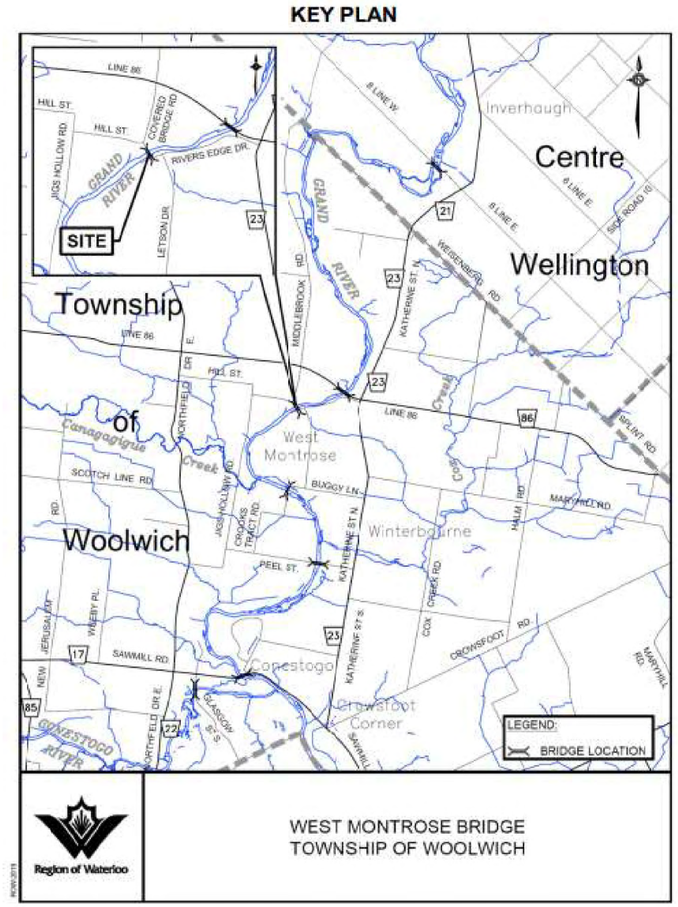


Figure 1: Study Area

2.0 PRELIMINARY DESIGN ALTERNATIVES

This section describes the evaluation of the Preliminary Design Alternatives carried forward.

2.1 Key Issues

Key issues identified during the previous stages of this study, as well as during public consultation events, include:

- Heritage designation of the bridge and need to retain heritage attributes, as much as possible;
- Avoidance of reduction in waterway opening;
- Consideration of climate change affecting regional storm events;
- Hydraulic Vulnerability (MTO Low Vulnerability is 0.3m clearance to soffit, and High Vulnerability is 1.0 m clearance to soffit);
- Age of structure and wood material;
- Sag and plumbness of the structure;
- Design criteria for posted load limit;
- Aesthetics of the planking (cladding) of the exterior of the bridge associated with any rehabilitation; and
- Construction platform across the watercourse.

2.2 Preliminary Design Alternatives

Several alternatives were generated as bridge rehabilitation techniques that could accommodate the travel demand within the Study Area, as well as retain the heritage attributes of the bridge.

In developing Preliminary Design Alternatives, several general principles and objectives were considered for West Montrose Covered Bridge rehabilitation. These include:

- Retention of heritage attributes and respecting the heritage designations of the bridge; and
- Consideration of increasing the design load while maintaining the posted load limit of 3 tonnes.

Preliminary Design Alternatives carried forward are described as follows:

Alternative A New Steel Girders:

Strengthen bridge by addition of two new steel box girders to replace the Bailey trusses (15 tonnes).

- Disengage the existing Bailey trusses from supporting timber trusses and replace with 2 new steel girders and new steel floor beams;
- New steel members will carry all loads acting on bridge even as wood trusses deteriorate;
- Wood trusses remain as secondary structure and ornamentation instead of acting as primary structure;
- Aesthetically similar to the existing bridge with the exception of the bridge soffit; and
- Presented as Alternative A at Public Consultation Centre (PCC) No. 2.

Alternative B FRP Strips:

- Reinforce existing wood members using FRP strips bonded to wood and remove Bailey trusses;
- Not reversible and results in 80 mm to 300 mm increase in bridge height; and
- Presented as Alternative B at PCC No. 2.

Alternative C Wood Repairs:

The distinguishing factor for all C alternatives is the design vehicular live load and corresponding strengthening needs for repairing specific wood truss members.

- Alternative C1 Wood Repairs (12 tonnes);
- Alternative C2 Wood Repairs (10 tonnes);
- Alternative C3 Wood Repairs (8 tonnes); and
- Alternative C4 Wood Repairs (6 tonnes).

A table comparing the elements of the Preliminary Design Alternatives is in **Appendix B**.

3.0 EVALUATION OF ALTERNATIVES

The evaluation approach is based on the “Weighted Additive Method” which focuses on the differences between the alternatives, addresses the complexity of the base data collected, and provides a traceable decision-making process. In addition, the method allows quick sensitivity tests to be performed because of the matrix configuration of the assessment and the use of numerical scores to measure the impact of the alternatives. The sensitivity tests are also documented in this report. This approach is consistent with the Ministry of the Environment, Conservation and Parks (MECP) practices for the evaluation of numerous and complex alternatives, or for contentious projects. Using the “Weighted Additive Method”, overall scores are assigned to each alternative and the alternative with the highest score is selected as the preferred alternative to complete the evaluation.

The steps shown below, as described in the Evaluation Methodology report included in **Appendix A**, are being followed by the Technical Advisory Committee (TAC) to arrive at an overall score for each alternative.

- Collection of data/environmental inventories;
- Development of a long list of reasonable alternatives (including coarse screening alternatives that are unfeasible or unreasonable in comparison to those being carried forward);
- Development of a long list of global evaluation criteria/performance sub-factors;
- Short listing of sub-factors to those where there are meaningful differences among the alternatives to be compared;
- Establishing Social Utility Functions (Performance Factors or Function Forms) for the short-listed sub-factors;
- Weighting of Evaluation Criteria (assigning importance based on the specific set of alternatives);
- Rating of Alternatives (based on average Project Team weights);
- Sensitivity Testing;
- Selection of Technically Preferred Alternative;
- Public Review (PCC No. 3); and
- Recommendations and presentation of a Recommended Plan.

This systematic approach is consistent with MECP practices for the evaluation of numerous and complex alternatives. These steps are briefly described in the following sections.

3.1 Evaluation Criteria

The initial task in the evaluation is to develop evaluation criteria from which alternatives will be assessed. This process includes the identification of "global" groups of factors followed by the selection of a number of "local" sub-factors under the global groups.

3.1.1 Global Evaluation Factors

As an initial step, the evaluation criteria were grouped into broad categories, or factors, established to describe the study specific engineering and environmental concerns. Four factors were selected which were used for each evaluation.

These global factors were:

- Heritage;
- Structural;
- Social Environment; and
- Cost.

3.1.2 Evaluation Sub-Factors

Within each of these categories (factor groups) are sub-factors which define the measure and the relative differences of magnitude of impact. The sub-factors were developed from a long list created by the Study Team. Where there were no measurable or meaningful differences between alternatives, and it is agreed that the alternatives are generally equal with respect to this criterion, then the sub-factor is not carried forward. When the Evaluation Team considered the impacts were double counted among one or more criteria, then only one criterion was selected to be carried forward.

The sub-factors that were not carried forward are listed in **Appendix A**. For a sub-factor to be carried forward, the sub-factor must:

- Be a measure of a meaningful difference among alternatives;
- Capture a measurable difference among alternatives;
- Not "double count" the effect that was measured under another sub-factor; and
- Describe a difference in performance or an effect on the natural or social environment that the Technical Advisory Committee considered necessary to be included in the decision-making process.

The selection of the sub-factors to address the goal of the study, are comprehensive enough to describe all aspects of the effects of the project, and do not double-count sub-factors.

3.1.3 Short Listed Criteria

Sub-factors selected to evaluate the alternatives including their definitions, measurements and utility scores are described in **Appendix C**.

3.1.4 Results (Preferred Preliminary Design Alternative)

The Evaluation Team members were responsible for completing separate weighting exercises which provided independent perspectives of the relative importance of factor groups and sub-factors for each specific evaluation. The results of the weighting exercise are illustrated below in **Figure 2** and **Figure 3**. The Technically Preferred Alternative (TPA) is **Alternative C2 Wood Repairs (10 tonnes),** refer to **Appendix D**.

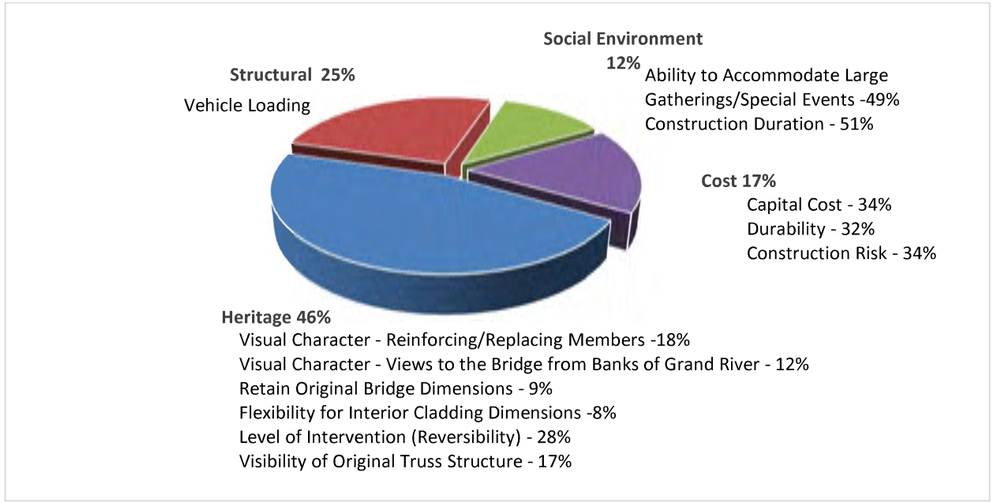


Figure 2: Global Factors and Sub-factor Average Weights

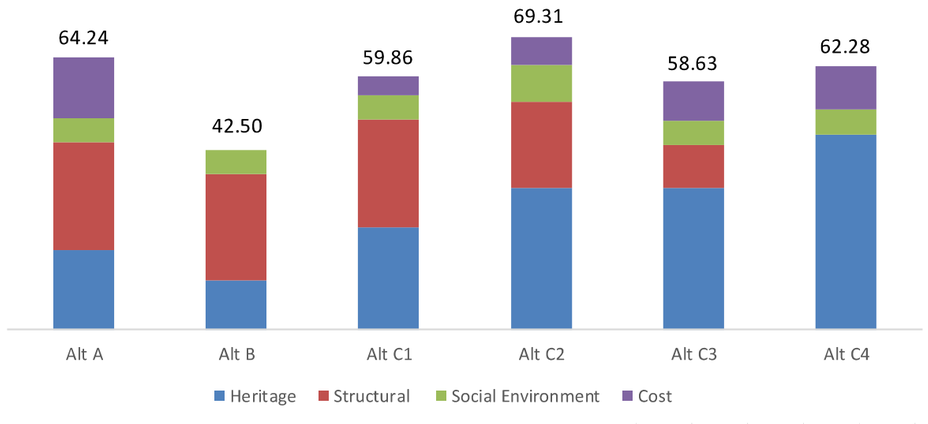


Figure 3: Scores (Average Weights of Evaluation Team)

3.1.5 Sensitivity Testing

It should be recognized that the scope of the evaluation and determination of weights for the evaluation criteria are a matter of professional judgment. Accordingly, it is considered essential to conduct sensitivity testing to determine if the nature of the evaluation is sensitive to the weights assigned to each criterion.

There is a spread of values among the groups of evaluators for the selection of weights. The range is dependent on the value judgment of individuals and specialists. Using the average of the group does not necessarily capture what the standard deviation was among the individual scores. Therefore, sensitivity testing is conducted to test a range of weights either higher or lower than the group's average.

For this study an independent test was undertaken which placed greater or less emphasis on a global factor and redistributing the weight to the other factors using the average values of the TAC. A separate test was completed for each factor using the highest weight given by anyone in the TAC as well as the lowest weight.

Following this methodology, a series of tests were completed varying the weight for each global factor. The three tests included:

- Average TAC Weight;
- Highest Weight in a factor group by any TAC member; and
- Lowest Weight in a factor group by any TAC member.

Following this series of tests, the results were reviewed to assess whether the preferred alternative changed when the weights were varied.

This information alone is not the only justification for selecting a particular alternative, but it provides a level of confidence in the selection and the ability to assess trade-offs. This information is considered and used in the decision-making process before a TPA is recommended to be carried forward. The results of the sensitivity testing will be presented at PCC No. 3 and are shown in **Table 1**. The results indicate there are trade-offs with Alternative C2, which consistently came second or third. Where there was a high weight placed on heritage and social environment factors the third ranked Alternative C4 ranked number 1 and where there was a low weight on heritage and social environment factors the second ranked Alternative A ranked number 1. Where there was a high weight on structural and cost factors Alternative A ranked number 1 and with a low weight on structural and cost factors Alternative C4 ranked number 1. However, using the average weights provides the best overall performing alternative in all categories, except Cost. Alternative C2 is recommended to be carried forward as the Technically Preferred Alternative (TPA).

Table 1: Sensitivity Testing

		Alt A	Alt B	Alt C1	Alt C2	Alt C3	Alt C4
FACTORS	WEIGHT	64.24	42.50	59.86	69.31	58.63	62.28
TAC Weights		2	6	4	1	5	3
Heritage	High	5	6	4	2	3	1
	Low	1	6	5	3	4	2
Structural	High	1	4	2	3	6	5
	Low	4	6	5	2	3	1
Social Environment	High	2	6	5	3	4	1
	Low	1	6	5	3	4	2
Cost	High	1	6	5	3	4	2
	Low	2	6	4	3	5	1

3.1.6 West Montrose Covered Bridge Technically Preferred Alternative

The following is a general list of the proposed improvements for the preferred alternative:

- Overall strengthen bridge by repairs to specific wood truss members;
- Design vehicular live load is 10 tonnes;
- Primary Structural System: Existing wood trusses;
- Bailey Bridge: Permanently removed;
- Roof: Replace in kind (i.e., cedar shingles underlain by wood planks and rafters);
- Exterior Cladding: Replace with new sawn wood planks with battens;
- Interior Cladding:
- Curbs/Barriers: New sawn wood curbs with scuppers;
- Wearing Surface: Replace in kind (i.e., tar and chip surface);
- Deck: Replace in kind (i.e., nail-laminated wood deck);
- Stringers: Replace in kind (i.e., sawn wood stringers);
- Floor Beams: Replace with larger sawn wood floor beams;
- Needle Beams: Replace with larger sawn wood needle beams;
- Lower Top Chord: Make composite with top chord by adding wood plate between top chord and lower top chord and fastening together;
- Bottom Chord: Replace with new sawn wood chord;
- End Diagonals: Repair by fastening on new 4” (89mm) thick wood plank to increase member cross-section;
- Hanger Rods: Replace with new steel rods;
- Top Lateral (Overhead) Bracing: Add solid sawn timbers (choice to be based on detailed connection design) to form lateral truss in plane of top chords;

- Bottom Lateral Bracing: Replace in kind (i.e., steel threaded rods with turnbuckles);
- Bolster Beams: Replace with elastomeric bearings on concrete pedestals (more durable than replacing in kind, but less sympathetic to heritage);
- Repair Strategy for Checks and Splits in Existing Wood Members: Inject with epoxy resin and reinforce with screws;
- Approach to Sag Correction: Reduce sag;
- Approach to Rack (i.e., cross section out of square) Correction: Eliminate racking by means of replumbing trusses. Additional means of rack prevention will be investigated including replacement of tie beams at top chord level and/or installation of ship’s knees (some ship’s knees already exist);
- Fire protection: Apply fire-retardant to all existing wood surfaces; apply pressure-impregnated fire retardant to all new cladding and roof elements;
- Wood Preservative: Incise and pressure-treat all new cladding and roof elements with permissible wood preservative (likely water-borne preservative);
- Paint: Match existing colour;
- Percentage of Vehicular Live Load Carried by Existing Wood Trusses: 100%; and
- Percentage of Existing Wood Trusses Remaining: +/- 60%.

4.0 NEXT STEPS

Following the endorsement of the Technically Preferred Alternative (TPA) the next steps include:

- Refinements to the TPA;
- Presentation to Regional Council;
- Presentation to Township Council;
- Public Consultation Centre;
- Finalize the Recommended Plan; and
- Detail design.

Appendix A

Evaluation Methodology Report

Region of Waterloo



Evaluation Methodology Report

West Montrose Covered Bridge Rehabilitation

July 2024

Submitted by:
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1.0 INTRODUCTION

The Region of Waterloo has retained Entuitive in Joint Venture (JV) with BT Engineering Inc. (BTE) to undertake the detail design for the West Montrose Covered Bridge rehabilitation in Guelph, Ontario. The West Montrose Covered Bridge is a two-span covered timber bridge constructed in 1881 and is the last remaining covered vehicular bridge in Ontario. Major rehabilitation was done by MTO between 1950 and 1965, which included the addition of a steel Bailey truss. As the original wooden trusses age, they are shedding more load to the Bailey trusses which cannot carry the entire load of the bridge.

This document describes the evaluation approach that was utilized for this study. The Analysis and Evaluation process is based on the Ministry of the Environment, Conservation and Park's (MECP) Evaluation Methods in Environmental Assessment.[1]

An evaluation method may be defined as a formal procedure for establishing an order of preference among alternatives. The use of a formal evaluation method has two main advantages: it provides a better basis for decision-making than would otherwise exist and it results in reasons for decisions that, on examination, can be traced.

The selection of an evaluation method should consider the following generic factors:

- Various evaluation methods have different capabilities which support different planning processes that may be better suited to a particular project or stage of a project.
- With any particular process, all the steps (such as identifying alternatives, selecting criteria, consulting and involving interested parties, as well as evaluating) must be reasonable and provide a systematic assessment of the net effects of the project.

The selection of the appropriate evaluation methodology depends upon the:

- Complexity of the decision-making.
- Number of alternatives.
- Number of criteria.
- Sensitivity of the decision.

These issues are described in the following sections which explain the rationale for utilizing the most appropriate evaluation methodology in each stage of the environmental assessment study.

[1] Evaluation Methods in Environmental Assessment, Ministry of Environment, 1990.

2.0 STUDY AREA

The Study Area is illustrated in **Figure 1**.

The Region of Waterloo initiated a Schedule A+ Municipal Class Environmental Assessment (EA) for the bridge rehabilitation and retained Doug Dixon & Associates (DDA) to complete the EA on the Region's behalf. Two rounds of public consultation have taken place. The first round of public consultation in October 2021 presented a preferred alternative with steel girder reinforcing, and reinstatement of the internal cladding materials. Following the first public consultation, a second alternative was developed which includes strengthening the timber truss and removal of the interior cladding material. This timber restoration alternative was presented as the Preferred Alternative in the latest round of public consultation in June 2022. Entuitive-BTE team developed a third alternative that was presented to the public in November 2023.

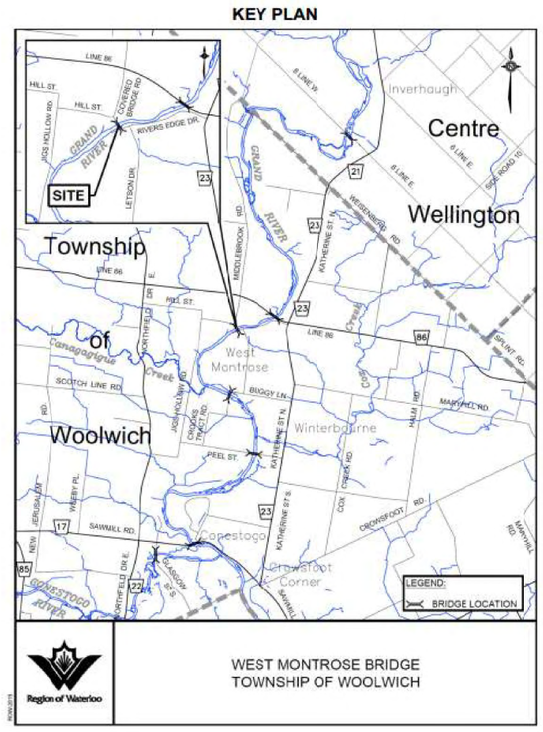


Figure 1: Study Area

3.0 QUALITATIVE EVALUATION METHODOLOGY

A qualitative evaluation method involves describing impacts in narrative terms, or through qualitative measures, without the explicit specification of criteria, ratings or weights. This method is widely used in EAs to assess "Alternative Planning Solutions". For example, an EA involving the selection of a corridor might evaluate alternative routes in considerable detail using a quantitative evaluation approach; however, the evaluation of "Alternatives To" might be done using a simpler qualitative approach. See **Table 1** for a sample qualitative evaluation.

A challenge of the qualitative approach is the difficulty in recognizing when an evaluation will involve an intuitive choice and have general support (public), i.e., a simple decision easily accepted. A qualitative approach may also be perceived as less defensible and could be subject to criticism. Should the public or stakeholders question these early project decisions, additional information may be required to substantiate or detail the rationale later in the project.

Some advantages of using a qualitative approach over a quantitative approach include: greater simplicity, reduced time and cost, and ease of presentation to the public. A qualitative approach is often used to evaluate alternatives where there is a straightforward conclusion and low public concern. The qualitative approach is also suitable where there are few alternatives and few criteria where there are measurable and meaningful differences between alternatives being considered, or where criteria are difficult to measure and rate numerically.

Table 1: Sample Qualitative Evaluation

Factor Group	Intersection Alternatives		
	Alternative 1 Two Leg Stop Control	**Alternative 2 Three Leg Stop Control**	**Alternative 3 Roundabout**
Transportation			
Traffic Operations	-	-	✓
Safety	-	-	✓
Property/Land Use			
Property Impacts	✓	✓	×
Natural Environment			
Impacts to Natural Environment	-	-	-
Social/Cultural			
Social Environment	-	-	✓

Table 1: Sample Qualitative Evaluation			
Factor Group	**Intersection Alternatives**		
	Alternative 1 Two Leg Stop Control	**Alternative 2 Three Leg Stop Control**	**Alternative 3 Roundabout**
Cost	✓	✓	-
Evaluation Results	×	×	✓ Carried forward
✓ Good in Comparison	- Fair/Equal in Comparison	× Poor in Comparison	Preferred Alternative

Where there are few criteria, such as in **Table 1**, it is generally acceptable to use a qualitative analysis because the trade-offs are clear and understandable. The more rigorous definition of the attributes of each alternative, as would be possible using a quantitative approach, is not required because there are a limited number of evaluation factors.

For this study, the qualitative approach will be used to assess Alternatives to the Undertaking.

The use of a more comprehensive evaluation technique becomes necessary as the complexity increases (i.e., number of alternatives and number of criteria). In these situations, as described in **Section 4.0**, this study will utilize a quantitative approach.

4.0 QUANTITATIVE EVALUATION METHODOLOGY

Key principles of the *Environmental Assessment* (EA) *Act* and MECP's Guidelines on Environmental Assessment Planning and Approval are that there be accountability and traceability. A quantitative evaluation method allows both of these key principles to be addressed. A quantitative method based on the "Weighted Additive Method" will be used for this study and is also referred to as the "Multi-Attribute Trade-off System" (MATS).

The Weighted Additive Method has proven to be well suited for the evaluation of complex groups of alternatives. The methodology allows for sensitivity testing and the ability to answer "what if" questions. It is used on projects where the decision-making process is faced with either a large number of alternatives or a large number of competing criteria for the alternatives being evaluated.

The Weighted Additive Method is consistent with MECP practices for the evaluation of alternatives. It uses an analytical approach that measures scores based on a mathematical relationship, i.e., the degree of subjectivity by the evaluators (i.e., the Technical Advisory Committee (TAC)) is minimized. The quantitative method allows sensitivity tests to be performed to determine whether the highest ranked alternative is affected by changing the

weights (perspective of importance) of the assessment factors, which provides an opportunity to assess the trade-offs involved in the evaluation.

For this study, preliminary design alternatives will be evaluated and scores assigned to each of the various assessment factors, and a sensitivity-testing program will be completed and the results presented to the public and external agencies.

When using the Weighted Additive Method, each member of the TAC assigns a weight to the global factors and sub-factors. The Average TAC Weight is assigned to each of the alternatives. The alternative with the highest score is selected as the Technically Preferred Alternative (TPA).

This systematic approach for the study includes the following steps:

- Collection of data/environmental inventories.
- Development of a long list of reasonable alternatives (including coarse screening alternatives that are not feasible or unreasonable in comparison to those being carried forward).
- Public Consultation.
- Development of a long list of global evaluation criteria/performance sub-factors.
- Short listing of sub-factors to those where there are meaningful differences among the alternatives to be evaluated.
- Establishing Social Utility Functions (Performance Factors or Function Forms) for the short-listed sub-factors.
- Weighting of Evaluation Criteria (assigning importance based on the specific set of alternatives).
- Rating of Alternatives.
- Sensitivity Testing.
- Selection of TPA.
- Public consultation.
- Detail Design Alternatives.
- Refinements to the Technically Preferred Design (TPD).
- Recommended Plan.

These steps, as they relate to this project, are briefly described in the following sections.

4.1 Evaluation Criteria – Factors

The initial step in the evaluation is to develop evaluation criteria from which alternatives will be assessed. This is a two-step process that involves the selection of a "global" group of factors and a number of "local" sub-factors under the global groups.

The global factors groups will be presented to the public and, following this consultation, will be accepted as describing the broad definition of the environment to be evaluated. Global factors considered for this study may include:

- Traffic and Transportation.
- Natural Environment.
- Cultural Environment.
- Socio-Economic Environment.
- Land Use and Property.
- Cost.

While these factor groups are the starting point for the evaluation, one or more factors may be removed if it is determined that there is no sub-factor in this category i.e., there is not a meaningful and measurable difference between the alternatives being assessed in this category. When a particular factor is carried forward, then one or more sub-factors are considered under this group. These sub-factors are the individual descriptors for the evaluation. The selection of the sub-factors is very important to the decision-making process because they must adequately describe the issue to be evaluated and the alternatives being compared. See

Table 2 for a sample preliminary listing of sub-factors. Any information regarding an alternative, where there are differences among alternatives, is incorporated into the decision-making process by including it as a sub-factor. The benefit to incorporating two levels of evaluation criteria (global factors and local sub-factors) is to avoid unbalancing the evaluation (that could occur by adding more criteria under one group). Weights are assigned to the global factors to minimize the possibility of skewing the results by selecting a large number of sub-factors in one particular factor group.

Table 2: Long List of Evaluation Criteria

FACTORS AND SUB-FACTORS	UNIT	Carried Forward	Remarks
CULTURAL ENVIRONMENT			
Heritage			
Impact on adjacent built resources	0-10	X	No impact
Impact on Landscape	0-10	X	No impact
Impact on the bridge as a landmark	0-10	X	No impact – bridge retained, heritage attributes are defined in other sub-factors
Impact on water bodies or features	0-10	X	No impact
Impact on use/traditional practices	0-10	X	No impact – all alternatives retain vehicular, horse and buggy and pedestrian movements
Impact on land patterns/land forms	0-10	X	No impact
Impact on topography	0-10	X	No impact
Impact on views	0-10	X	See "Retain wood cladding dimensions"
Impact on circulation patterns	0-10	X	No impact
Impact on historical attributes of the bridge			
Retain original location of the bridge	0-10	X	No impact
Retain original dimensions	Yes/No	X	No impact
Retain original truss configuration	Yes/No	X	No impact
Retain pier location	Yes/No	X	No impact
Retain wood cladding dimensions	Yes/No	X	No impact
Retain louvred window openings and number of openings	Yes/No	X	No impact
Retain single gable roof	Yes/No	X	No impact
Lighting impacts (existing 5 interior sodium vapour lamps)	0-10	X	No impact
Retain view of bridge from the north bank of the Grand River	0-10	X	See "Retain original truss dimension"
Retain view of bridge from the south bank of the Grand River	0-10	X	See "Retain original truss dimension"
Retain view of bridge from the river (i.e. below deck)	0-10	X	
Retain Bailey Bridge	Yes/No	X	

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FACTORS AND SUB-FACTORS	UNIT	Carried Forward	Remarks
Impact on design value of the existing bridge	0-10	X	No impact
Aesthetics			
Visual appeal	0-10	X	No impact
Visual intrusion/landscape effects	0-10	X	No impact
Design harmonization	0-10	X	No impact
Lighting and decorative features	0-10	X	See Heritage Attribute
Gateway characteristics	Yes/No	X	No impact
Influence of alignment	0-10	X	No impact
Influence of building materials	0-10	X	No impact
Layout of substructure	0-10	X	No impact
Superstructure type	Yes/No	X	No impact
Visual Character - Reinforcing/Replacing Members	High/Medium/Low	✓	
Visual Character - Views to the Bridge from Banks of Grand River	Yes/No	✓	
Retain Original Bridge Dimensions	Yes/No	✓	
Flexibility for Interior Cladding Dimensions	Yes/No	✓	
Level of Intervention (Reversibility)	High/Medium/Low	✓	
Visibility of Original Truss Structure	High/Medium/Low	✓	
Floor System	Steel / Wood	✓	
Altering of heritage character - sandwiching vertical truss members with new planks and steel fasteners	0-10	X	No impact
Bottom chord reinforcement	0-10	X	No impact
Vertical tie rods through existing truss	0-10	X	No impact

FACTORS AND SUB-FACTORS	UNIT	Carried Forward	Remarks
Change in bridge dimensions - increased height of bridge	0-10	X	No impact
Change in bridge dimensions - increased height of bridge	0-10	X	No impact
Aesthetics—how visually appealing is the proposed alternative?		X	No impact
Archaeological Potential		X	No impact
Cultural Landscape Impacted		X	No impact
STRUCTURAL		X	No impact
Compliance with design standards		X	No impact
Level of redundancy		X	No impact
Structural integrity		X	No impact
Longevity		X	No impact
Constructability—consideration for the complexity or ease of the construction process and approval requirements.		X	No impact
Risk of Loss due to structural materials		X	Steel Beam vs Wood
New Exterior Cladding		X	No, all equal
New Interior Cladding/splash panels		X	No, all equal
Reversible/Irreversible		X	No, all equal
Bailey Bridge		X	No, all equal
New exterior bridge truck height restrictor		X	No, all equal
Vehicle Loading		✓	
Cedar shingle roof, use of steel is not carried forward		X	No, all equal
Red painted exterior, white painted interior cladding		X	No, all equal
Reuse of existing lighting		X	No, all equal

FACTORS AND SUB-FACTORS	UNIT	Carried Forward	Remarks
Fire suppression system		X	No, all equal
Strengthening of individual truss components with new boards and fasteners		X	No, all equal
Visual Character		X	No, all equal
Altering of heritage character - sandwiching vertical truss members with new planks and steel fasteners		X	No, all equal
Bottom chord reinforcement		X	No, all equal
Vertical tie rods through existing truss		X	No, all equal
Change in bridge dimensions - increased height of bridge		X	No, all equal
"Buoyancy (we do not want buoyancy)		X	Steel reduces buoyancy
Vertical force and lateral force"		X	
New stringers		X	No, all equal
New timber floor beams (where required)		X	No, all equal
New timber needle beams (where required)		X	No, all equal
New glue laminated decking		X	No, all equal
New cross bracing under structure		X	No, all equal
Thin asphalt overlay on new deck (5 mm)		X	No, all equal
Louvered opening maintained		X	No, all equal
Concrete cap on pier		X	No, all equal
In-water rock protection around pier		X	No, all equal
Loading on piers and abutments		X	No, all equal
Redundancy		X	No, all equal
Pedestrian detour over needle beams		X	No, all equal

FACTORS AND SUB-FACTORS	UNIT	Carried Forward	Remarks
TRANSPORTATION			
Potential for queuing onto Covered Bridge Drive and River's Edge Drive		X	No, all equal
Sight distance at the bridge		X	No, all equal
Ability to accommodate farm vehicles		X	No, all equal
Ability to accommodate horse-and-buggy traffic		X	No, all equal
Entrances within the influence of the bridge		X	No, all equal
Reconfigured entrances		X	No, all equal
Ability to Accommodation Active Transportation		X	No, all equal
NATURAL ENVIRONMENT			
Resiliency to Climate Change		X	No, all equal
Susceptibility to floods		X	No, all equal
Sustainability—which alternative requires less energy to construct and produces the least amount of greenhouse gas emissions?		X	No, all equal
Possible Aquatic Species at Risk		X	No, all equal
Possible Terrestrial Species at Risk		X	No, all equal
Cold/Cool water fish habitat impacted		X	No, all equal
Wildlife habitat impacted		X	No, all equal
Floodplain impacted		X	No, all equal
SOCIAL ENVIRONMENT			
Visual Intrusion to Adjacent Residents	number	X	No, all equal
Sound Level Increases	number	X	No, all equal
Potential for People to View Bridge	Yes/No	X	No, all equal

FACTORS AND SUB-FACTORS	UNIT	Carried Forward	Remarks
Ability to Accommodate Large Gatherings/Special Events	High/Medium/Low	✓	
Construction Duration	No. months	✓	
LAND USE AND PROPERTY			
Residential Property Required	ha	X	No, all equal
Residential Buy-out	number	X	No, all equal
Partial Residential Property Impacted	number	X	No, all equal
COSTS			
Capital Costs	$/million	✓	
Durability	High/Low	✓	
Construction Risk	High/Low	✓	
Operating Costs	$/million		

Generally, the process begins by establishing a long list of potential sub-factors through discussions with the public, community associations, the TAC and interest groups or from previous studies of the same nature. Then, for each group of alternatives being evaluated, the sub-factors are reviewed and screened by eliminating those that are considered equal among alternatives being considered as well as those that do not apply to the Study Area, based on the site inventories carried out.

Error! Reference source not found. provides a sample of a typical Global Factor, Sub-Factor, Unit and Utility Function Type from a Transportation Study. Similar Global Factor, Sub-factor and Utility functions will be developed for this study.

4.2 Factor and Sub-factor Weights

The selection of weights for the factors and the sub-factors is based on assessments by the TAC of their relative importance. Within a group of factors, inevitably there is an ordering, with some factors having more importance than others. This is accounted for by each individual assigning a weight to each factor, which is reflected in the "Factor Weight" and "Sub-Factor Weight" columns. An example of typical results is shown in **Table 4**.

Table 3: Typical Evaluation Factor and Sub-Factors

Global Factor	Sub-Factor	Unit	Utility Function Type
Traffic and Transportation	• Level of Service (LOS)	Letter (A, B, C, D, E or F)	Stepped Function
	• Number of conflicts	Number	Linear
	• Number of intersections	Number	Linear
	• Number of entrances	Number	Linear
	• Out-of-way travel	Minutes	Linear
	• Flexibility for staged construction	Yes/No	Dichotomous
	• Ease to implement detour for new structure	Yes/No	Dichotomous
	• Design consistency	Yes/No	Dichotomous
	• Ability to stage construction	Yes/No	Dichotomous

Table 4: Sample TAC Average Weights for a Factor Group and Sub-Factors

Factors	TAC	
	Factor Weight	Sub-Factor Weight
Traffic and Transportation	40.9%	
• Level of Service (LOS)		27.6%
• Number of conflicts		13.5%
• Number of intersections		7.3%
• Number of entrances		6.1%
• Out-of-way travel		2.6%
• Flexibility for staged construction		9.6%
• Ease to implement detour for new structure		13.9%

Table 4: Sample TAC Average Weights for a Factor Group and Sub-Factors		
Factors	**TAC**	
	Factor Weight	**Sub-Factor Weight**
• Design consistency		9.2%
• Ability to stage construction		10.2%
	Total	**100%**

As shown in **Table 4** in this example, the group of evaluators judged the Traffic and Transportation Factor Group to be valued at 40.9% of the overall importance of the decision between the alternatives being considered.

Within each Factor Group the sum of the percentage weights of all sub-factors listed under each factor totals 100%. As shown in **Table 4** several of the sub-factors were judged to be more important/less important when compared to each other for this specific evaluation of alternatives being considered.

The weights for each factor and sub-factor are determined by averaging the weights assigned by the TAC (Evaluation Committee). Each member gives a judgement of the importance of each global factor and local sub-factor (a percentage value) based on their personal assessment and professional judgement, considering the net effects and input of stakeholders and the public.

There is usually a range of perspectives in deciding the weights (importance) of factors and sub-factors. Every person assigning weights has a personal perspective and understanding of the scope of the project. Hence, there is an advantage to having a diversified team of professionals with varied backgrounds performing the evaluation.

An example of the weighting of each of the global factors is shown in **Figure 2**. The weighting of sub-factors within each factor group would be a similar distribution among the available sub-factors.

4.3 Social Utility Functions

The Weighted Additive Method used to evaluate alternatives relates the performance or attractiveness of alternatives using a mathematical relationship. This includes two variables: the first is the raw data or measured or modelled data, and the second is the utility or utility score, which is the measure of attractiveness of the alternative.

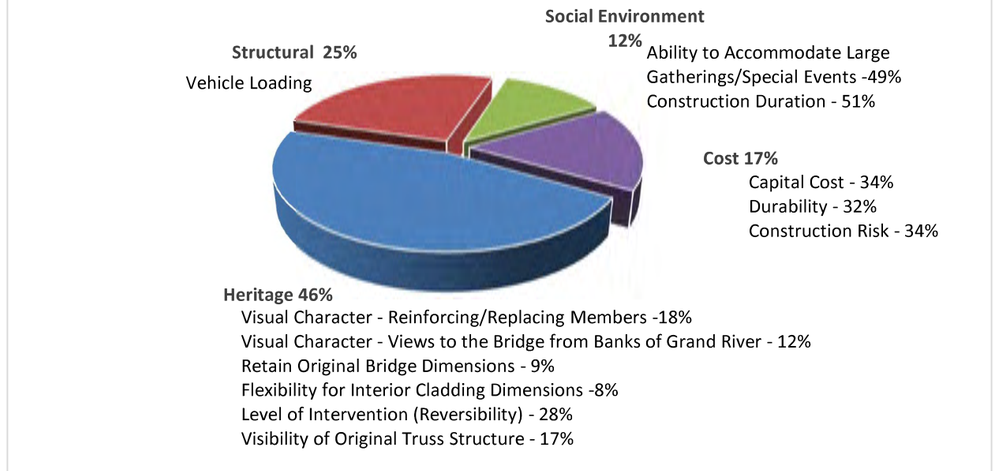


Figure 2: Sample Weighting of Global Factors

For this project, the relationship between these two variables is described, as shown in **Figure 3**, by either a dichotomous, stepped, or linear social utility function. A dimensionless utility score between zero (0) and 1 is assigned to an alternative for each sub-factor. The shape of this function can vary from linear to stepped or exponential and is defined by a subject area specialist.

The use of utility curves or functions is a step that transforms each of the measured effects to a dimensionless number and measure of utility. This step is required because the effects of each sub-factor are measured in different units (length, area, time, volume, dollars etc.). To produce a mathematical measure of the performance, each effect is translated to a measure of utility. The combined effect or performance of each alternative is a measure of utility (attractiveness) which is a dimensionless measure. The utility function (also commonly described as performance factor or function form) defines the relationship of effect to the attractiveness (utility). These utility functions are defined by subject area specialists in their field of study.

Examples of Social Utility Functions for the “Ease of Maintenance” sub-factor definition are shown in **Figure 4**.

A dichotomous utility function enables the decision-maker to establish criteria that presents an “either–or” situation (desirable or undesirable, negative or positive, present or absent). If it is decided beforehand that a “yes” answer is desirable, then a utility score of one would be assigned to this criterion, otherwise zero would be assigned. One or zero are the available alternatives; no other utility score is available.

A linear function is used to convert scores for sub-factors that have varying measurements. Given a measurement, a unique utility score between zero and one can be assigned to a sub-factor. The slope of the linear utility function can be negative or positive depending on the desirability of the impact.

Figure 3: Sample Utility Functions

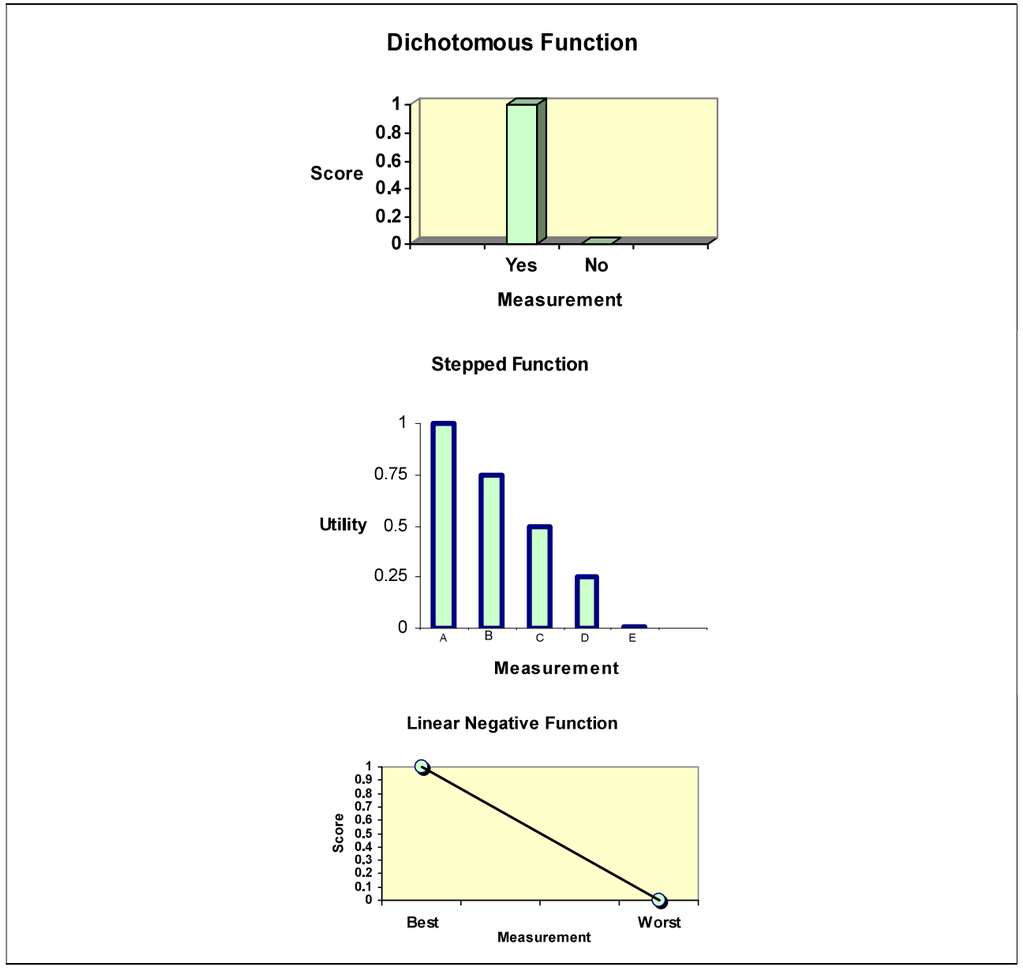
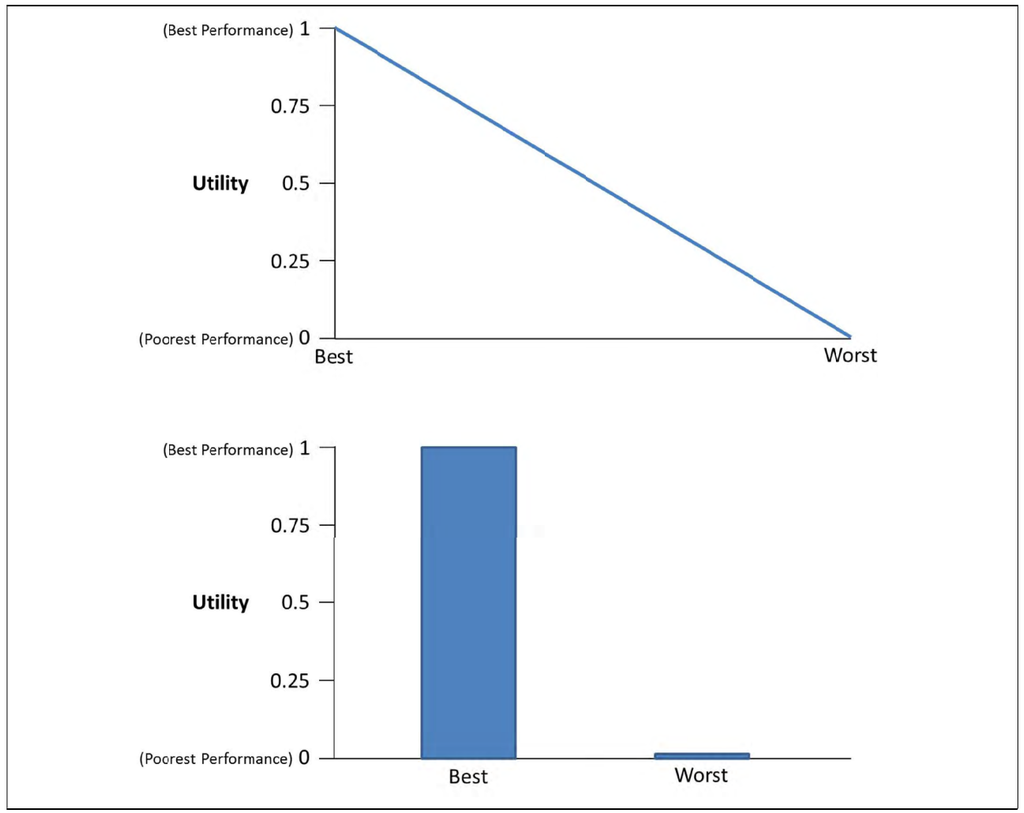


Figure 4: Social Utility Function



4.4 Weighted Score

The total un-weighted utility score of a given alternative can be expressed as:

$U(\text{Alternative A}) = \varnothing_1 X_1 + \varnothing_2 X_2 \ldots\ldots + \varnothing_n X_n$, where

U (A) = Total un-weighted utility score for Alternative A

$\varnothing_1$ = attractiveness with respect to parameters

X_1 = measurement of parameter X

Weighted scores are computed using the weights selected by the TAC. The weighted score for each alternative under a specific sub-factor is calculated as follows:

(weighted score) = (utility score x [(factor weight) x (sub-factor weight)])

Using this approach, a generic weighted attractiveness function can be expressed as:

U_w (Alternative A) = $U_1W_1 + U_2W_2 + \ldots. + U_nW_n$

OR

U_w (Alternative A) = $W_1\varnothing_1X_1 + W_2\varnothing_2X_2 \ldots. + W_n\varnothing_nX_n$

Where: U = Total un-weighted utility score for Alternative A

U_w (A) = Total weighted utility score for Alternative A

W_1= Weighted parameter (factor weight x sub-factor weight)

$\varnothing_1$ = Attractiveness with respect to parameter 1

X_1 = Measurement of parameter

The weighted scores of all the sub-factors are then added to give total score for each alternative.

$$U_w(A) = \sum_{X=1}^{n} W_n\varnothing_nX_n$$

4.5 Rating Alternatives

Following the selection of evaluation factors and sub-factors, measurements of the impacts are made using topographic plans, field surveys, and numerical modelling. These measurements result in data being available under each of the evaluation criteria from which ratings are made for each alternative.

The Weighted Additive Method focuses on the differences of the alternative, addresses the complexity of the base data collected and provides a traceable and defensible decision-making process. This process is a numerical calculation where alternative scores are determined through the use of a mathematical relationship to equate impacts to scores. It avoids subjective opinions of scores for alternatives because the team does not estimate the score for an alternative.

The scores for each alternative under each of the respective sub-factors are normalized based on measured impacts. Social utility functions are defined to relate impacts to the attractiveness of an alternative. This means that under each sub-factor, the alternative receives an un-weighted rating of between zero and one based on these measurements. The mathematical relationships for calculating scores are developed in consultation with the TAC.

4.6 Sensitivity Testing Program

It should be recognized that the scope of the evaluation and determination of weights for the evaluation criteria are a matter of personal and professional judgement. Accordingly, it is

desirable to conduct sensitivity testing to determine the effect of changing weights assigned to each criterion.

To test how sensitive the outcome of the evaluation is with respect to the assigned weights (i.e., would the result have changed if different weights were used), a sensitivity testing program is undertaken. This results in greater confidence in the selection process and reduces the potential that the average weights bias the outcome of the evaluation.

Often, there is a diversity of opinion in the group as to what weight is appropriate for a factor or sub-factor. When an average weight is used to capture the preferences of the group it loses valuable information on the range of values of the group. To test the range of perspective of the TAC, the highest and lowest weights suggested by anyone in the group are defined as a reasonable range of weights to test. A series of sensitivity tests are performed for the evaluation of alternatives. This allows the team an opportunity to assess the outcome of the evaluation if different weights (different perspectives of importance) are assigned to the factors and sub-factors from the average weights defined by the TAC members. In this way, trade-offs can be identified, credibility can be achieved with the public, and "what if" questions can be answered quickly. See **Figure 5** for an example of the typical range of project team weights and **Table 5** for a sample ranking of alternatives.

Following the above methodology, a series of tests can be performed varying the weights for each global factor. These tests include:

- Average TAC Team Weight
- Highest Weight by any Team Member
- Lowest Weight by any Team Member

Following this series of tests, the results can be reviewed to assess whether the preferred alternative changes when the weights are varied.

Using this information alone is not the only justification for selecting a particular alternative, but it does provide a level of confidence in the selection. This information is used in the decision-making process before the TPAs are recommended to be carried forward.

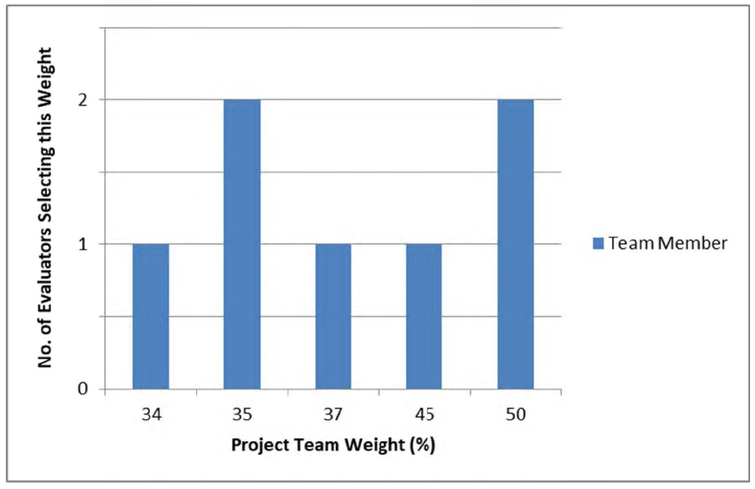


Figure 5: Sample Range of Weights for Traffic and Transportation

Table 5: Sample Ranking of Alternatives					
Testing	**Weight**	**Alt 1A**	**Alt 1A'**	**Alt 1B**	**Alt 1C**
TAC Average Team Scores	N/A	2	1	3	4
High Traffic and Transportation	65%	2	1	3	4
Low Traffic and Transportation	30%	2	1	3	4
High Natural Environment	20%	2	1	3	4
Low Natural Environment	5%	1	2	3	4
High Economic Environment	30%	1	2	3	4
Low Economic Environment	5%	2	1	3	4

4.7 Selection of Technically Preferred Alternative(s)

The TPA(s) identifies the preferred solution by considering the technical analysis, environmental considerations and comments of all study participants.

The TPA(s) is then presented to the public and external stakeholders. This allows for any comments or questions regarding the proposed design.

It should be recognized that the information and conclusions obtained using the evaluation method are only tools used to assist in the evaluation process and identifying trade-offs. In the end, it is the TAC (Evaluation Committee) which makes the final decision on the selection of the TPA(s), using both the information obtained throughout the evaluation process and their individual experience and expertise, and through additional input from senior management on funding availability or other program constraints.

The principles and methodology of the EA process assist the TAC in the analysis and evaluation of alternatives and the selection of the TPA. The public and government agencies have the opportunity to provide input throughout the course of the study.

GLOSSARY OF TERMS

AASHTO	American Association of State and Highway Transportation Officials
Adjacent	Adjacent indicates lying near MTO or Municipal roadway rights-of-way, although not necessarily contiguous to them.
Aesthetics	Methods of providing visual relief and appealing characteristics to planned noise barriers thorough the application of landscaping designs.
Alternative	Well-defined and distinct course of action that fulfils a given set of requirements. The EA Act distinguishes between "Alternatives to the Undertaking" and "Alternative Methods of Carrying out the Undertaking".
Coarse Screening	Initial screening of a group of alternatives. Also see Screening.
COH	Community Open House
Criterion (Criteria)	Explicit feature or consideration used for comparison of alternatives.
Dichotomous Utility Function	A utility function that represents a desirable or undesirable response from a criterion (yes/no, present/absent, true/false).
Dimensionless Number	A number that does not have a unit of measurement, such as length (m), time (s), mass (kg) associated with it. Examples include Utility Score and Overall Score.
Do Nothing Alternative	This alternative is a mandatory requirement of the Class EA. This alternative is the null or no action alternative and it becomes the baseline to which all alternatives are compared.
Double Counting	Unintentional accounting for a particular factor or attribute more than once in the evaluation.
EA	Environmental Assessment
Evaluation	The outcome of a process that appraises the advantages and disadvantages of alternatives.
Evaluation Criteria	See Criteria.
Evaluation Process	The process involving the identification of criteria, rating of predicted impacts, assignment of weights to criteria, aggregation of weights, and rating to produce an ordering of preference of alternatives.
Factor	See Global Factors.
Freeway	Freeway is defined as an existing completed, partially developed (staged) or proposed divided highway with full control of access and grade separated intersections. This definition may include some highways that are not officially designated as freeways.
Function Form	See Utility Function
Global Factors	The main categories of factors, (i.e. Transportation, Economic Environment, Natural Environment, Social and Cultural, Land Use and Property and Cost). All sub-factors are components or a subset of global factors.
Linear Utility Function	A function that can be defined using a linear equation of the form: y = a + bx, where y is the dependent variable (raw score) x is the independent variable (measurement) b is the slope of the function, and a is the y intercept, normalized in this study to be equal to one or zero
Matrix	A rectangular array of criteria and values.
MATS	Multi-Attribute Trade-off System
MECP	Ministry of the Environment, Conservation and Parks
Mitigation	Taking actions that either remove or alleviate to some degree the negative impacts associated with the implementation of alternatives.
MTO	Ministry of Transportation of Ontario
Overall Score	The final value of an alternative's score derived by summing all of the weighted scores.
Performance Factor	See Utility Function
Ranking	The ordering of alternatives from first to last for comparison purposes.

Raw Data	The measurement of the impact, or measured data, under each criterion.
Risk	Probability that a given outcome will or will not materialize. Distinct from uncertainty in that the alternative outcomes are known or defined and that the probability of each is measurable.
Screening	Process of eliminating alternatives from further consideration, which do not meet minimum conditions or categorical requirements.
Sensitivity Tests	A series of tests to assess the robustness of the evaluation and alternative scores.
Step Function	A utility function can be defined by several linear functions within separate ranges that have a slope equal to zero. For this study, two step functions are used: Case A: y = 1, for x = desirable and y = 0, for x = undesirable Case B: y = 1 for x = desirable, y = 0.5 for x = medium performance and y = o for x = undesirable
Sub-factor	A single criterion used for the evaluation. Each sub-factor is grouped under one of the factors.
TAC	Technical Advisory Committee
TPA	Technically Preferred Alternative
Traceability	Characteristic of an evaluation process which enables its development and implementation to be followed with ease.
Transportation Environmental Study Report (TESR)	This report is prepared in compliance with the EA Act requirements and the Ministry of the Environment and Climate Change for acceptance, approval, informational or monitoring purposes and the public record.
Utility Function	A function (linear, step, dichotomous) that represents the Utility Score versus the criterion measurement or desirableness.
Utility Score	The “y” value derived from the Utility Function of the measurement of the impact induced by a particular alternative’s criterion. A measurement of the usefulness or attractiveness of an alternative with respect to an individual evaluation criterion based on its measured effect (a number between 0 and 1). The utility score is dimensionless.

Weight	The importance attributed to a criterion relative to other criteria. The value of the weight is expressed in a percentage and the sum of all criterion weights is equal to 100%.
Weighted Additive Method	The method used in the quantitative evaluation of alternatives, which reduces the project’s numerous criteria into a dimensionless number for each alternative suitable for comparison.
Weighted Score	A raw score that has been multiplied by the criterion weights. The weighted scores reflect the social value or importance of the specific group providing weights.

Appendix B

Preliminary Design Alternatives

ENTUITIVE BTE

Alternative A:

- Disengage the existing Bailey trusses from supporting timber trusses and replace with 2 new steel girders and new steel floor beams
- New steel members will carry all loads acting on bridge even as wood trusses deteriorate
- Wood trusses remain as secondary structure and ornamentation instead of acting as primary structure
- Aesthetically similar to the existing bridge with the exception of the bridge soffit
- Presented as Alternative A at PCC #2

BT ENGINEERING BTE

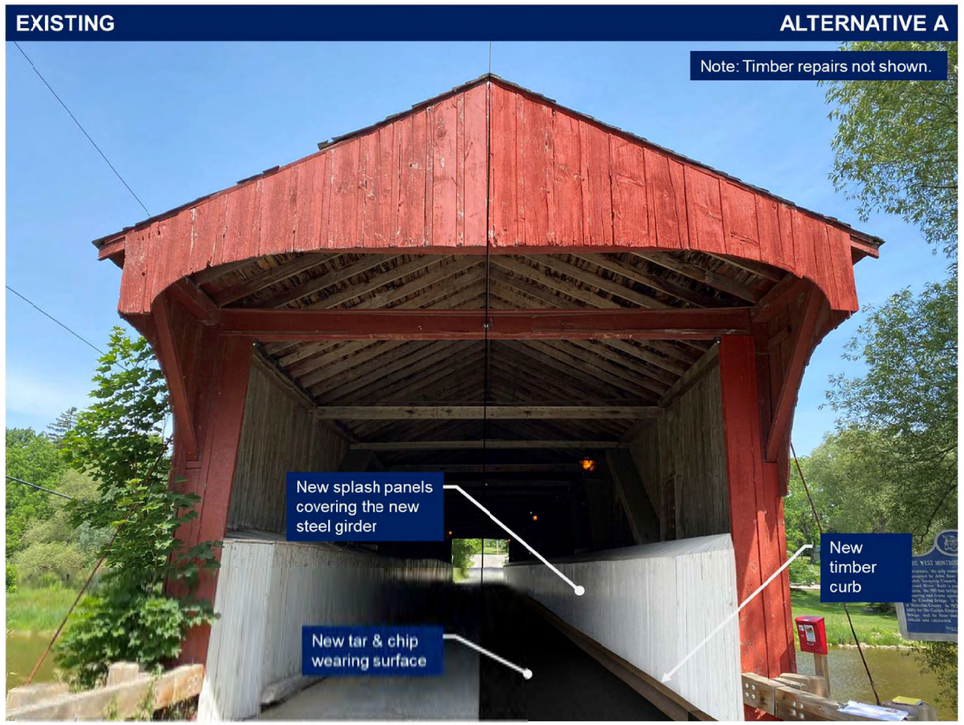


Figure C5: Front View – Existing and Alternative A (Steel Girder Reinforcement)



Figure C2: Elevation View – Existing and Alternative A (Steel Girder Reinforcement)



Figure C2: Elevation View – Existing and Alternative A (Steel Girder Reinforcement)

Alternative B:

- Reinforce existing wood members using FRP strips bonded to wood and remove Bailey trusses
- Not reversible and results in ~300mm increase in bridge height
- Presented as Alternative B at PCC #2

Milkish Inlet Covered Bridge Example

Milkish Inlet Covered Bridge Example

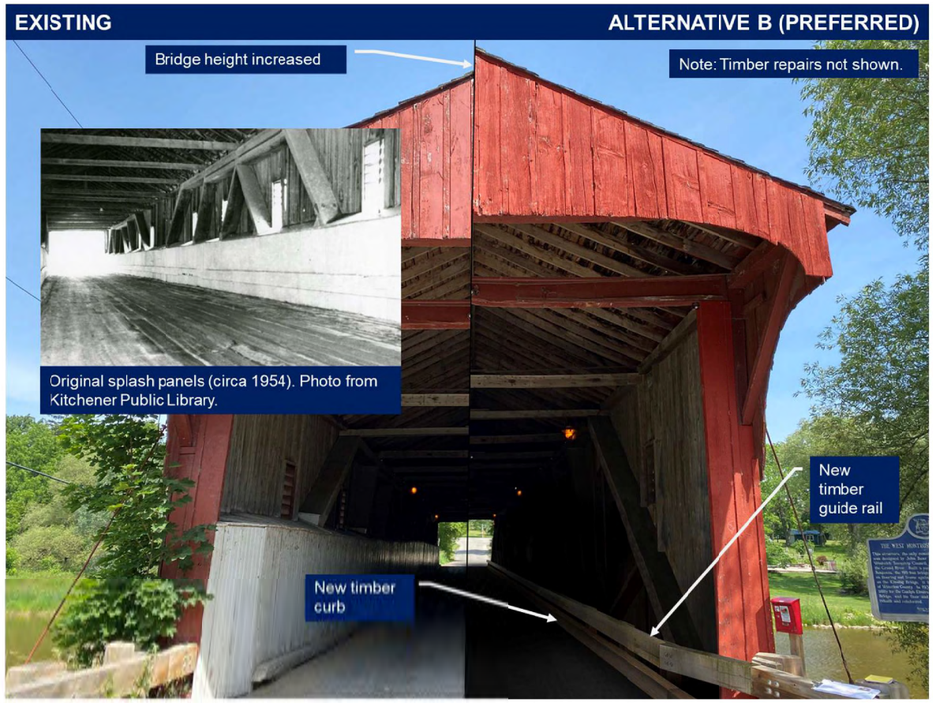


Figure C6: Front View – Existing and Alternative B (Timber Truss Reinforcement)

West Montrose Covered Bridge Rehabilitation PCC#2 Information Package June, 2022



Figure C6: Front View – Existing and Alternative B (Timber Truss Reinforcement)

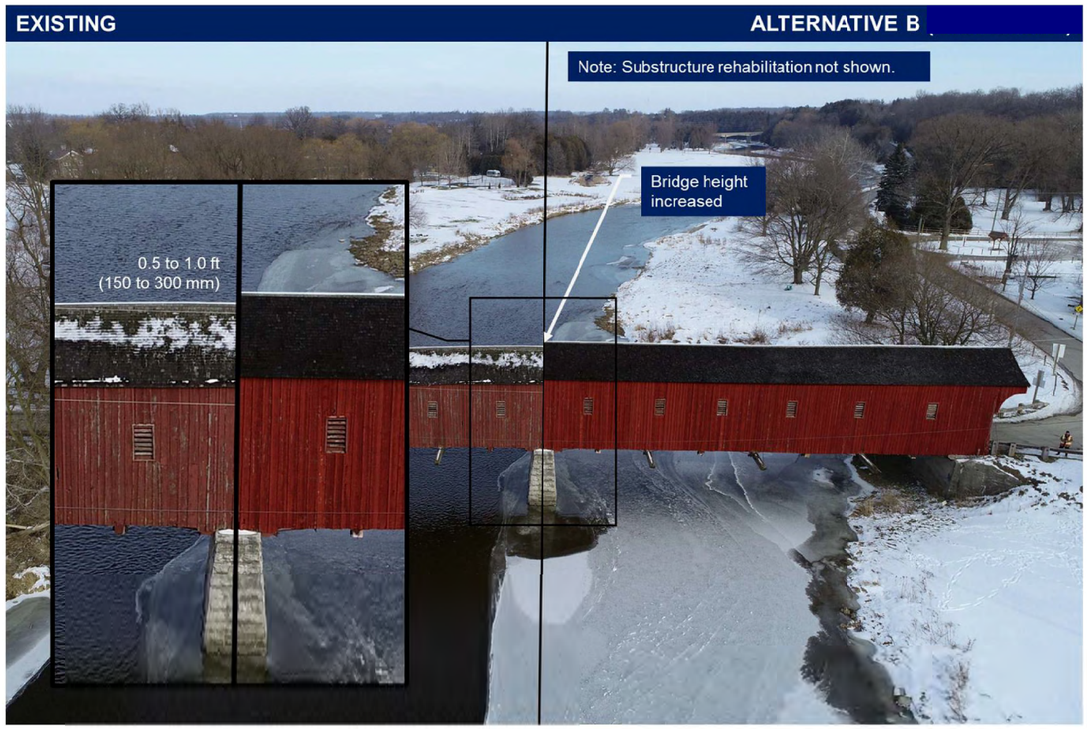


Figure C3: Elevation View – Existing and Alternative B (Timber Truss Reinforcement)

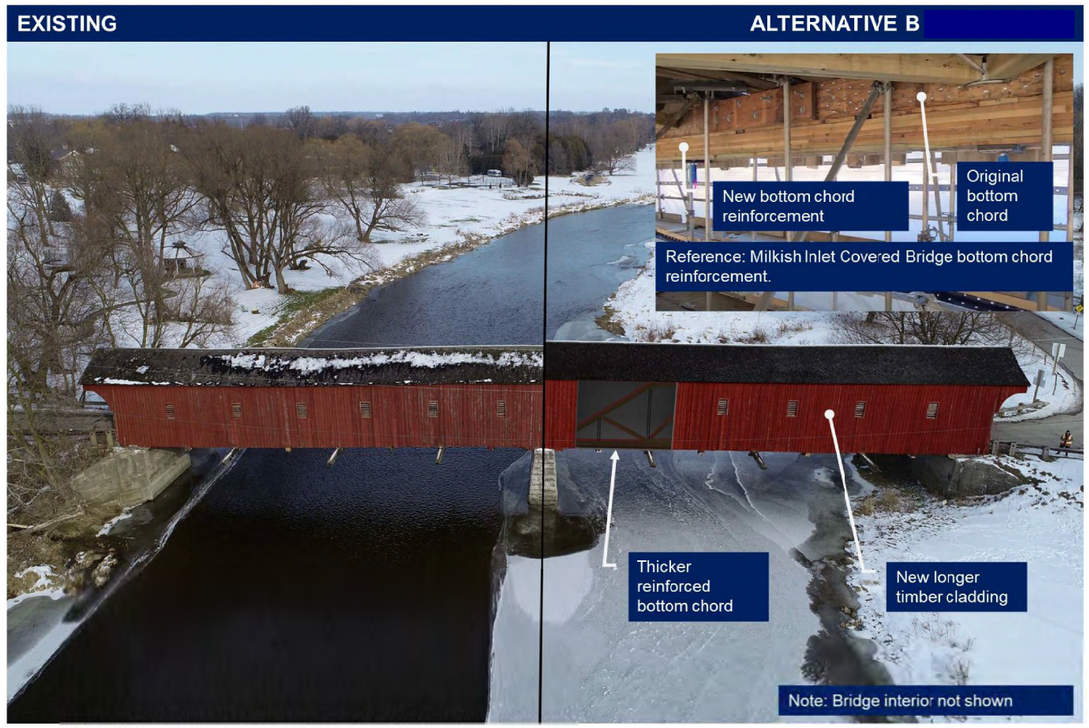
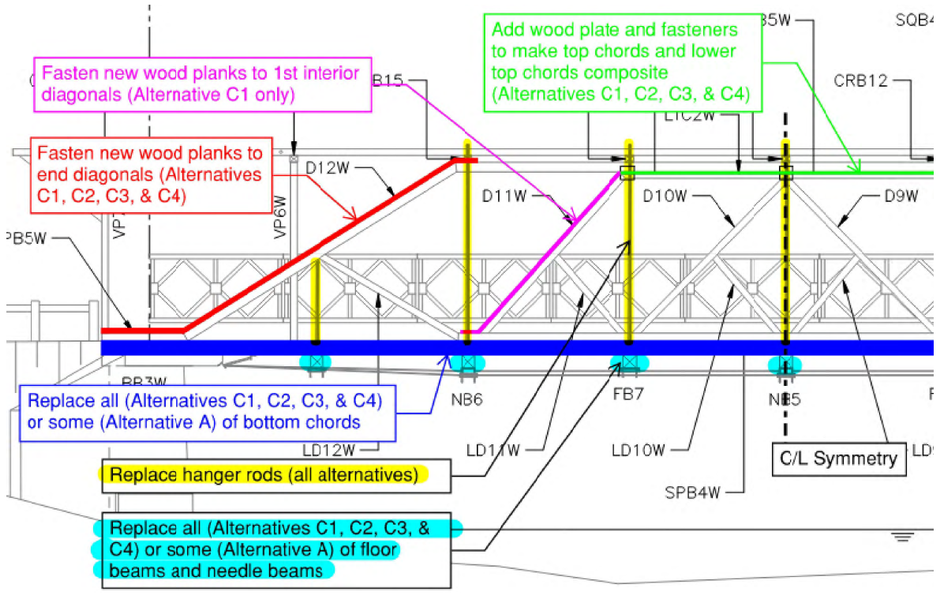


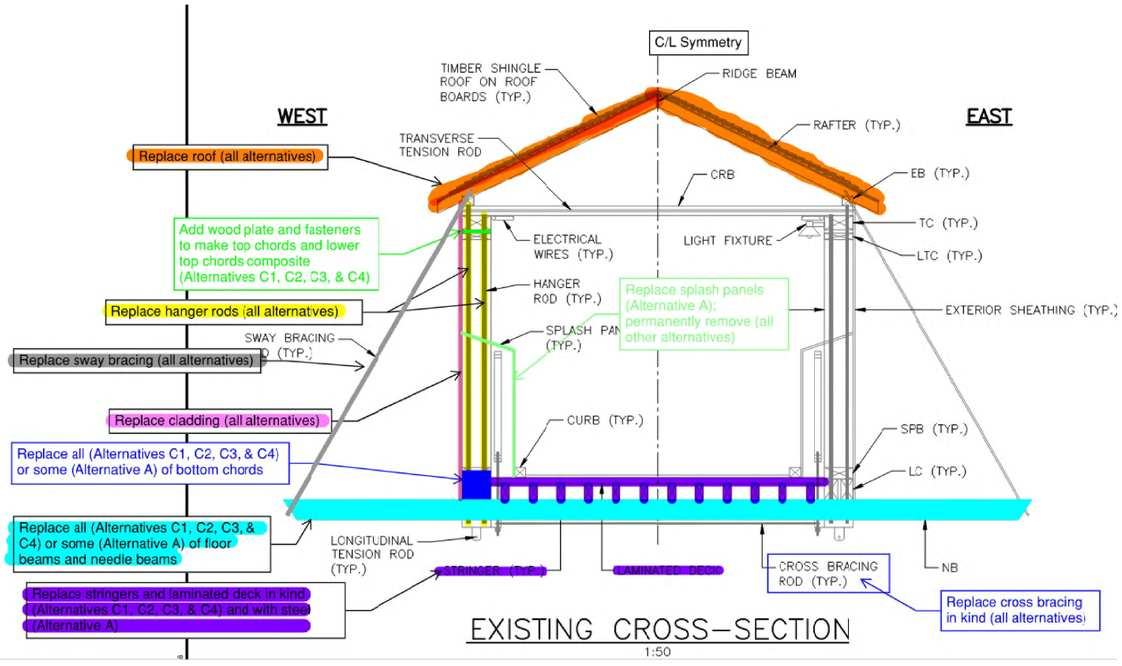
Figure C4: Elevation View – Existing and Alternative B (Timber Truss Reinforcement)

Alternative C:

- Repair and strengthen existing members to enable wood trusses to support full weight of bridge with Bailey trusses removed
- Repair and strengthen existing members with new wood and steel elements sympathetic to the original design concept
- Repairs to wooden truss members to achieve a design vehicular live load limit of :
  - C1 – 12 tonnes
  - C2 (Preferred) – 10 tonnes
  - C3 – 8 tonnes
  - C4 – 6 tonnes

Examples of Anticipated Repairs





EXISTING CROSS–SECTION
1:50

Appendix C

Sub-factor Definitions

BT ENGINEERING
BTE

West Montrose Covered Bridge Alternatives

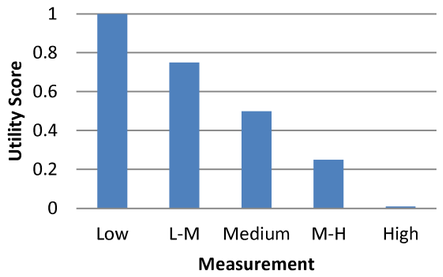
Alternative Number	Description
Do Nothing	Not carried forward based on structural condition assessment
Alternative A	New Steel Girders (Bailey Truss Substitute)
Alternative B	Strips
Alternative C1	Strengthen Bridge by Wood Repairs (12 tonnes)
Alternative C2	Strengthen Bridge by Wood Repairs (10 tonnes)
Alternative C3	Strengthen Bridge by Wood Repairs (8 tonnes)
Alternative C4	Strengthen Bridge by Wood Repairs (6 tonnes)

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Construction Duration 11
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Durability 13
Construction Risk 14

Heritage

Visual Character – Reinforcing/Replacing Members



Definition: Heritage attributes that contribute to the cultural heritage value of the bridge include:

- the original location of the bridge in the Village of West Montrose spanning the Grand River;
- the original dimensions of the bridge, 208 feet in length and 17 feet wide;
- the original truss configuration, a hybrid Queen Post – Howe timber configuration, reinforced by a recycled 1944 Bailey steel truss structure;
- the central pier;
- the wood exterior sheathing and interior panelling, punctuated by louvered window openings;
- the shingle gable roof;
- the system of illumination by decorative electric interior lamps; and
- views to and into the bridge from the north and south banks of the Grand River.

Alternatives that maintain the heritage attributes are preferred.

The first attribute that is subject to change based on the range of alternatives is the original truss configuration. To increase the structural loading capacity of the bridge, more members require reinforcement/replacement to accommodate the structural load. Alternatives that impact the least number of members are preferred to retain the heritage truss members which will be visible to the public (demonstrating the heritage artifact).

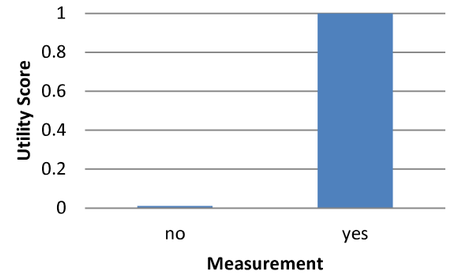
Mitigation: Reducing the method of reinforcement of members to avoid bolted connections.

Alternatives:

Alternative	Impact	Utility Score
Alternative A New Steel Girders	Low-Medium	0.75
Alternative B FRP Strips	High	0
Alternative C1 Wood Repairs (12 tonnes) (Sawn wood)	High	0
Alternative C2 Wood Repairs (10 tonnes) (Sawn wood)	Medium	0.5
Alternative C3 Wood Repairs (8 tonnes) (Sawn wood)	Medium	0.5
Alternative C4 Wood Repairs (6 tonnes) (Sawn wood)	Low	1

Heritage

Visual Character – Views to the Bridge from Banks of Grand River



Definition: Heritage attributes that contribute to the cultural heritage value of the bridge include:

- the original location of the bridge in the Village of West Montrose spanning the Grand River;
- the original dimensions of the bridge, 208 feet in length and 17 feet wide;
- the original truss configuration, a hybrid Queen Post – Howe timber configuration, reinforced by a recycled 1944 Bailey steel truss structure;
- the central pier;
- the wood exterior sheathing and interior panelling, punctuated by louvered window openings;
- the shingle gable roof;
- the system of illumination by decorative electric interior lamps;
- views to and into the bridge from the north and south banks of the Grand River.

Alternatives that maintain the heritage attributes are preferred.

The second attribute that is subject to change based on the range of alternatives is the view of the bridge from the north and south banks of the Grand River. The increase in height for Alternative B would change the overall historic and heritage view.

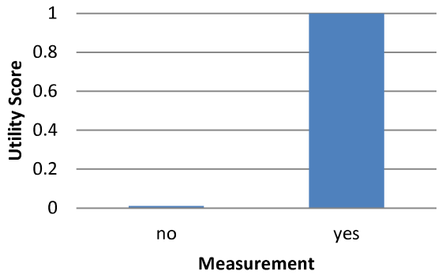
Mitigation: N/A

Alternatives:

Alternative	Yes/No	Utility Score
Alternative A New Steel Girders	Yes	1
Alternative B FRP Strips	No	0
Alternative C1 Wood Repairs (12 tonnes)	Yes	1
Alternative C2 Wood Repairs (10 tonnes)	Yes	1
Alternative C3 Wood Repairs (8 tonnes)	Yes	1
Alternative C4 Wood Repairs (6 tonnes)	Yes	1

Heritage

Retain Original Bridge Dimensions



Definition: The dimensions of the bridge are heritage attributes of the bridge. Alternative B would require an increase in overall height to accommodate the FRP strips. Alternatives that do not change the overall dimensions are preferred.

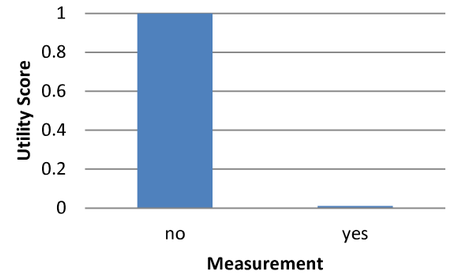
Mitigation: N/A

Alternatives:

Alternative	Yes/No	Utility Score
Alternative A New Steel Girders	Yes	1
Alternative B FRP Strips	No	0
Alternative C1 Wood Repairs (12 tonnes)	Yes	1
Alternative C2 Wood Repairs (10 tonnes)	Yes	1
Alternative C3 Wood Repairs (8 tonnes)	Yes	1
Alternative C4 Wood Repairs (6 tonnes)	Yes	1

Heritage

Flexibility for Interior Cladding Dimensions



Definition: The interior cladding has changed as new components were added to the interior of the bridge. However, the interior cladding is a heritage attribute. Alternatives that allow for the flexibility to change the interior cladding dimensions are preferred. Alternative A maintains the interior cladding, but the dimensions are fixed for the steel girders.

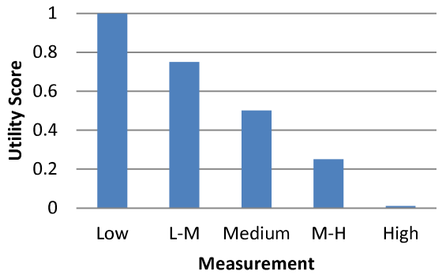
Mitigation: The interior cladding can be reinstated for all alternatives, to provide interpretation of the historic and heritage cladding.
Alternatives B and C1 to C4 have the opportunity to include horizontal interior cladding at the ends and remove interior cladding from the middle of the bridge. The benefit of this is that it does not allow wildlife to nest within the cladding and be shielded from maintenance crews.

Alternatives:

Alternative	Yes/No	Utility Score
Alternative A New Steel Girders	Yes	0
Alternative B FRP Strips	No	1
Alternative C1 Wood Repairs (12 tonnes)	No	1
Alternative C2 Wood Repairs (10 tonnes)	No	1
Alternative C3 Wood Repairs (8 tonnes)	No	1
Alternative C4 Wood Repairs (6 tonnes)	No	1

Heritage

Level of Intervention (Reversibility)



Definition: Due to the structural deterioration of some elements of the bridge, there is some level of intervention required for all alternatives. However, alternatives with the least amount of intervention are preferred (i.e. alternatives that replace the least number of members, as required).

Provincial Cultural Heritage Recommended Approach for Heritage Bridges

The following conservation options are regarded as appropriate in managing interventions on heritage bridges. They are arranged according to level or degree of intervention from minimum to maximum. They are to be applied in rank order such that Option 1 must be shown to be non-viable before Option 2 can be considered and so on. Rehabilitation is preferable to replacement.

1. Retention of existing bridge with no major modifications undertaken.
2. Restoration of missing or deteriorated elements where physical or documentary evidence (e.g., photographs or drawings) exists for their design.
3. Retention of existing bridge with sympathetic modification.
4. Retention of existing bridge with sympathetically designed new structure in proximity.
5. Retention of existing bridge no longer in use for vehicular purposes but adapted for a new use. For example, prohibiting vehicle or restricting truck traffic or adapting for pedestrian walkways, cycle paths, scenic viewing, etc.
6. Retention of bridge as a heritage monument for viewing purposes only.
7. Relocation of smaller, lighter single span bridges to an appropriate new site for continued use (see 4) or adaptive re-use (see 5).
8. Bridge removal and replacement with a sympathetically designed structure.
    a) Where possible, salvage elements/members of bridge for incorporation into new structure or for future conservation work or displays.
    b) Undertake full recording and documentation of existing structure.

This is a designated heritage bridge and therefore is a special case in regard to rehabilitating the structure. The guiding philosophy is:

> "What is the best conservation approach to safeguard the heritage attributes of the bridge, rather than applying modern structural engineering standards (for pedestrians or vehicles) to this structure?"

Alternative C4 which reflects the least intrusion and lowest strengthening of the original wooden truss is preferred. C4 would refurbish the bridge following Structural recommendations (replacing necessary damaged/deteriorated members and vertical tension ties, etc.). (**This follows the guideline to retain as much heritage fabric as possible and make any additions minimal and reversible**). This follows the best practices for heritage conservation.

Mitigation: Limit the number of truss members to be replaced and reinforcement or replacement with materials that are respective of the heritage attributes are preferred.

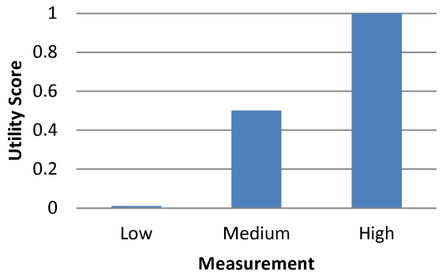
The primary associated mitigation is to restrict oversized vehicles from entering the bridge and avoid triggering greater strengthening that requires more structural intrusion/intervention of the historic truss. The bridge will be posted for 3 tonnes gross vehicle weights. The mitigation to ensure no heavy loads greater than the original associated loads of the original design include:

- Overhead restrictors of large vehicles (3.3 m height restriction);
- Weight detection and restriction for large axle weights (off bridge axle trap, barrier arm or lights for real time detection). Eliminates the need to design intrusions for gross vehicle loads above 6 tonnes;
- Signage to limit the occupancy of pedestrians on the bridge (below 50 persons) about 3600 kg of pedestrians or about the signed load limit of the bridge;
- Restrictions on events (dinners, carol singing) to pedestrian loading less than 50 persons;
- Avoid the use of modern materials that were not used in the original construction; and
- Desirable to reflect the character with the original 1881 structural design construction.

Alternatives:

Alternative	High/ Medium/ Low	Utility Score
Alternative A New Steel Girders	Medium-High	0.25
Alternative B FRP Strips	High	0
Alternative C1 Wood Repairs (12 tonnes)	Medium-High	0.25
Alternative C2 Wood Repairs (10 tonnes)	Medium	0.5
Alternative C3 Wood Repairs (8 tonnes)	Medium	0.5
Alternative C4 Wood Repairs (6 tonnes)	Low	1

Heritage
Visibility of Original Truss Structure



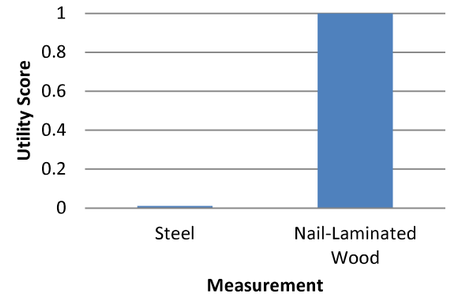
Definition: The truss structure is a heritage attribute. Alternatives that retain the truss structure, and provide opportunities for improved visibility of the structure, are preferred. The new steel girders obscure the truss from the top of the steel beam down, and would be most visible from a car.

Mitigation: N/A

Alternatives:

Alternative	H/M/L	Utility Score
Alternative A New Steel Girders	Low	0
Alternative B FRP Strips	Medium	0.5
Alternative C1 Wood Repairs (12 tonnes)	Medium	0.5
Alternative C2 Wood Repairs (10 tonnes)	Medium	0.75
Alternative C3 Wood Repairs (8 tonnes)	Medium	0.75
Alternative C4 Wood Repairs (6 tonnes)	High	1

Heritage
Floor System



Definition: Retention of the original needle beam and floor beams and view from below the bridge is preferred. Alternative A includes a steel floor beam and all other alternatives use sawn wood floor beams. All alternatives are defined to have a nailed timber deck with tar and chip surface.

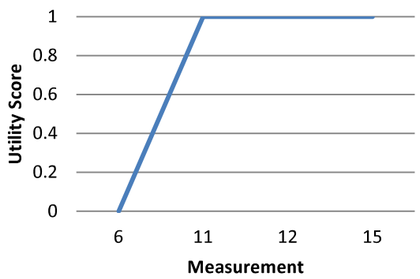
Mitigation: N/A

Alternatives:

Alternative	Type	Utility Score
Alternative A New Steel Girders	Steel	0
Alternative B FRP Strips	Wood	1
Alternative C1 Wood Repairs (12 tonnes)	Wood	1
Alternative C2 Wood Repairs (10 tonnes)	Wood	1
Alternative C3 Wood Repairs (8 tonnes)	Wood	1
Alternative C4 Wood Repairs (6 tonnes)	Wood	1

Structural

Vehicle Loading



Definition: The existing loadings of the bridge with the Bailey Truss is approximately 11 tonnes. Alternatives that provide the highest capacity offer the greatest protection from overload and therefore less likelihood of damage from overweight loads. Alternatives that meet or exceed an 11 tonne capacity is preferred.

Mitigation: The primary mitigation is to restrict oversized vehicles from entering the bridge and triggering greater strengthening that requires more structural intrusion/intervention of the historic truss. The bridge will be posted for 3 tonnes gross vehicle weight. The mitigation to reduce the potential for heavy loads greater than the original associated load of the original design includes:

- Overhead restrictors of large vehicles (3.3 m height restriction);
- Weight detection and restriction for large axle weights (off bridge axle trap, barrier arm or lights for real time detection). Eliminates the need to design intrusions for gross vehicle loads above 6 tonnes);
- Signage to limit the occupancy of pedestrians on the bridge (to be equal to the capacity of the alternative);
- Restrictions on events (dinners, carol singing) to pedestrian loading to be equal to the capacity of the alternative;
- Highway bridge is adjacent; and

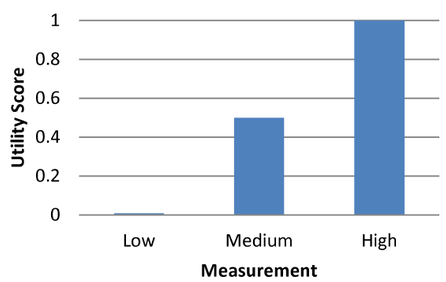
Need to accommodate vehicle turn around area.

Alternatives:

Alternative	Capacity (Tonnes)	Utility Score
Alternative A New Steel Girders	15	1
Alternative B FRP Strips	15	1
Alternative C1 Wood Repairs (12 tonnes)	12	1
Alternative C2 Wood Repairs (10 tonnes)	10	0.8
Alternative C3 Wood Repairs (8 tonnes)	8	0.4
Alternative C4 Wood Repairs (6 tonnes)	6	0

Social Environment

Ability to Accommodate Large Gatherings/Special Events



Definition: Increased structural loading capacity would allow the Region/Township to approve large social gatherings/special events to be held on the bridge.

Alternatives that increase the loading capacity to 15 tonnes would accommodate large gatherings/special events (up to 500 persons) and are preferred.

Alternatives that have reduced structural load carrying capacity will restrict event sizes ranging from 50 to 300 persons.

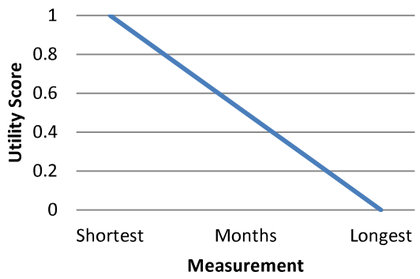
Mitigation: Large gatherings/special events would not be approved for alternatives that do not meet the structural load capacity required (maintains status quo).

Signage for maximum occupancy can be used to restrict large group events.

Alternatives:

Alternative	H/M/L	Utility Score
Alternative A New Steel Girders	H	1
Alternative B FRP Strips	H	1
Alternative C1 Wood Repairs (12 tonnes)	H	1
Alternative C2 Wood Repairs (10 tonnes)	H	1
Alternative C3 Wood Repairs (8 tonnes)	M	0.5
Alternative C4 Wood Repairs (6 tonnes)	L	0

Social Environment
Construction Duration



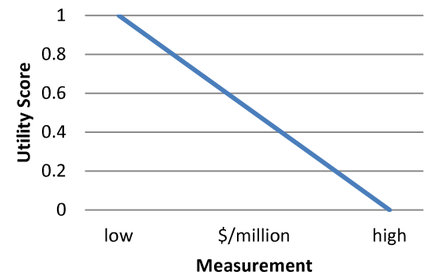
Definition: The current recommended construction methodologies would require the closure of the bridge during construction, for all users. This would include pedestrians, cyclists, horse and buggy, and vehicles. Alternatives with a shorter construction duration or the possibility of partial opening are preferred for all users.

Mitigation: Consideration of a separate active transportation bridge during construction and/or ability to allow pedestrians, cyclists and horse and buggy to cross the bridge outside working hours.

Alternatives:

Alternative	Duration (months)	Utility Score
Alternative A New Steel Girders	8	0
Alternative B FRP Strips	8	0
Alternative C1 Wood Repairs (12 tonnes)	8	0
Alternative C2 Wood Repairs (10 tonnes)	7	0.5
Alternative C3 Wood Repairs (8 tonnes)	7	0.5
Alternative C4 Wood Repairs (6 tonnes)	6	1

Cost
Capital Cost



Definition: Under this sub-factor alternatives are compared based on the expected capital cost of construction. The future life cycle costs are measured under the Durability sub-factor.

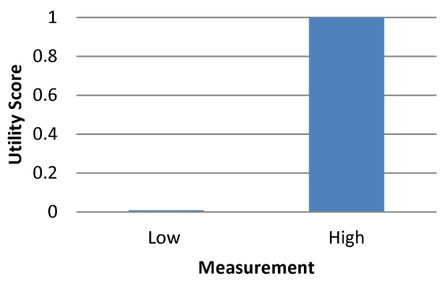
Note that costing is relative, no definitive cost estimates have been completed.

Mitigation: N/A

Alternatives:

Alternative	$/million	Utility Score
Alternative A New Steel Girders	6	0.6
Alternative B FRP Strips	7.5	0
Alternative C1 Wood Repairs (12 tonnes)	6.5	0.4
Alternative C2 Wood Repairs (10 tonnes)	6	0.6
Alternative C3 Wood Repairs (8 tonnes)	5.5	0.8
Alternative C4 Wood Repairs (6 tonnes)	5	1

Cost
Durability



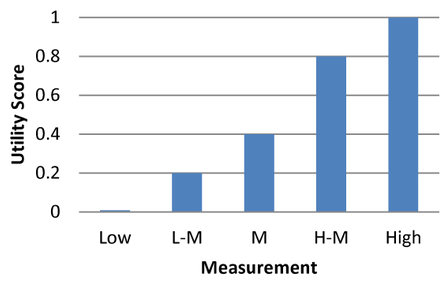
Definition: Under this sub-factor the durability of the alternatives is considered. This is also a measure of the future life cycle costs. The structural design is based on achieving a 50-year life and the individual components using natural material may be replaced based on age and deterioration. Alternative A (that includes the use of steel superstructure) is expected to have the greatest durability and lowest life cycle cost (extended time before a next major rehabilitation).

Mitigation: N/A

Alternatives:

Alternative	High/Low	Utility Score
Alternative A New Steel Girders	High	1
Alternative B FRP Strips	Low	0
Alternative C1 Wood Repairs (12 tonnes)	Low	0
Alternative C2 Wood Repairs (10 tonnes)	Low	0
Alternative C3 Wood Repairs (8 tonnes)	Low	0
Alternative C4 Wood Repairs (6 tonnes)	Low	0

Cost
Construction Risk



Definition: This item measures the relative ease of construction. This is likely to result in greater cost certainty. Alternatives that are easier to construct are preferred.

Mitigation: N/A

Alternatives:

Alternative	Ease of Construction	Utility Score
Alternative A New Steel Girders	High	1
Alternative B FRP Strips	Low	0
Alternative C1 Wood Repairs (12 tonnes)	Low-Medium	0.4
Alternative C2 Wood Repairs (10 tonnes)	Medium	0.6
Alternative C3 Wood Repairs (8 tonnes)	High-Medium	0.8
Alternative C4 Wood Repairs (6 tonnes)	High-Medium	0.8

Appendix D

Technically Preferred Alternative

Structural Alternatives for Evaluation

Technically Preferred Alternative C2

Alternative	A	C1	C2	C3	C4
Description	Strengthen bridge by addition of two new steel box girders to replace the Bailey trusses	Strengthen bridge by repairs to specific wood truss members. Distinguishing factor for all Alternative C sub-alternatives is the design vehicular live load and corresponding strengthening needs.			
Design Vehicular Live Load	15 tonnes	12 tonnes	10 tonnes	8 tonnes	6 tonnes
Posted Vehicular Load Limit	3 tonnes				
Design Pedestrian Live Load	To be determined; will be back-calculated based on strength resulting from strengthening to carry design vehicular live load				
Primary Structural System	New steel girders	Existing wood trusses			
Bailey Bridge	Replaced by steel girders	Permanently removed			
Roof		Replace in kind (i.e. cedar shingles underlain by wood planks and rafters)			
Exterior Cladding		Replace with new sawn wood planks with battens			
Interior Cladding	Replace	Permanently remove			
Curbs/Barriers	None	New sawn wood curbs with scuppers and wood guardrail			
Wearing Surface	New 25mm asphalt + waterproofing	Replace in kind (i.e. tar and chip surface)			
Deck	New orthotropic steel deck	Replace in kind (i.e. nail-laminated wood deck)			
Stringers	New steel stringers	Replace in kind (i.e. sawn wood stringers)			
Floor Beams	New steel floor beams	New 16”x16” sawn wood floor beams			
Needle Beams	Replace in kind (i.e. sawn timbers)	New 16”x16” sawn wood floor beams			
Top Chord		No action*			
Lower Top Chord	No action*	Make composite with top chord by adding wood plate between top chord and lower top chord and fastening together			No action*
Bottom Chord	Localized replacement at decayed sections	Replace with new sawn wood bottom chord			

BT ENGINEERING
BTE

End Diagonals at Abutments	No action*	Repair by fastening on new 4-1/2" (102mm) thick wood plank to increase member cross-section	Repair by fastening on new 4" (89mm) thick wood plank to increase member cross-section	Repair by fastening on new 3" (64mm) thick wood plank to increase member cross-section	
End Diagonals at Piers	Replace in kind (i.e. sawn wood)	Replace in kind (i.e. sawn wood) and strengthen fastening on new wood plank to increase member cross-section			
Interior Diagonals	No action*	Repair by fastening on new 2" (38mm) thick wood plank to increase member cross-section	No action*	No action*	No action*
Lower Diagonals	No action*				
Hanger Rods	Replace with new steel rods and hollow pipes	Replace in kind (i.e. steel threaded rods)			
Sway Bracing		Replace in kind (i.e. steel threaded rods)			
Top Lateral (Overhead) Bracing	May be required	Add new steel threaded rods with turnbuckles or solid sawn timbers (choice to be based on detailed connection design) to form lateral truss in plane of top chords			
Bottom Lateral Bracing		Replace in kind (i.e. steel threaded rods with turnbuckles)			
Bolster Beams	Replace in kind (i.e. sawn timber)	Replace with elastomeric bearings on concrete pedestals (more durable than replacing in kind, but less sympathetic to heritage)			
Repair Strategy for Checks and Splits in Existing Wood Members		Inject with epoxy resin and reinforce with screws			
Approach to Sag Correction	No action	Reduce sag by unloading structure and refitting truss joints			
Approach to Rack (i.e. cross-section out-of-square) Correction	No action	Eliminate racking by means of replumbing trusses. Additional means of rack prevention will be investigated including replacement of tie beams at top chord level and/or installation of ship's knees (some ship's knees already exist). New top lateral (overhead) bracing will help as well.			
Fire protection	Apply fire-retardant to all existing wood surfaces; apply pressure-impregnated fire retardant to all new cladding and roof elements				
Wood Preservative	Incise and pressure-treat all new cladding and roof elements with permissible wood preservative (likely water-borne preservative)				

ENTUITIVE

West Montrose Covered Bridge – Structural Alternatives for Evaluation
November 2023

Paint	To match existing colour	
% of Vehicular Live Load Carried by Existing Wood Trusses	0%	100%
% of Existing Wood Trusses Remaining	+/- 60-70%**	+/- 60%

*No action means no remediation beyond injecting and reinforcing checks and splits
**Alternative A does not rely on the existing wood trusses to carry vehicular live load despite retaining potentially more of the existing wood trusses

Appendix M

Council Resolutions

Regional Council Minutes

February 21, 2024, 5:00 p.m.
Council Chambers

Members Present: K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, P. Wolf

Should you require an alternative format or a copy of the official minutes please contact the Regional Clerk at Tel.: 519-575-4400, TTY: 519-575-4605, or regionalclerk@regionofwaterloo.ca

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1. Call to Order

Regional Chair K. Redman called the meeting to order at 5:00 p.m.

2. Land Acknowledgement

Regional Chair K. Redman provided a land acknowledgement.

3. Motion to go into Closed Session

Moved by S. Foxton
Seconded by P. Wolf

That a closed meeting of Council be held on February 21, 2024 at 5:00 p.m., in accordance with Section 239 of the "Municipal Act, 2001", for the purposes of considering the following subject matters:

1. Receiving advice that is subject to solicitor-client privilege related to a local board.

In Favor (14): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, S. Shantz, K. Williams, and P. Wolf

Carried (14 to 0)

4. Motion to Reconvene into Open Session

N. Salonen joined the meeting at 7:00 p.m.

J. Liggett left the meeting at 7:02 pm.

Moved by M. Harris
Seconded by K. Williams

That Council reconvene into Open Session.

In Favor (14): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, D. McCabe, J. Nowak, N. Salonen, S. Shantz, K. Williams, and P. Wolf

Carried (14 to 0)

5. Declarations of Pecuniary Interest under the "Municipal Conflict of Interest Act"

C. James declared an indirect pecuniary interest with respect to the second part of item 3.1 on the Closed Council agenda and the second recommendation on the closed council summary due to her company's work with the Waterloo Region Community Foundation.

6. Presentations

None.

7. Petitions

None.

8. Delegations

8.1 Jeff Wilmer, A Better Tent City

J. Wilmer appeared before Council on behalf of A Better Tent City noting that they have no concerns with the intent of the request for data and reporting in M. Harris' motion. He explained that they have been in contact with Regional staff to clarify what information would be requested, and don't have any issues with sharing that information. He stressed that they work with a high needs population and are hoping to use the additional funding to improve the services that they provide.

In response to a question from Council, Peter Sweeney, Commissioner, Community Services, recommended that staff would follow the existing

accountability framework for similar organizations, which has been shared with A Better Tent City. Council requested that staff share the criteria as information to Council, and requested a future discussion on the funding criteria.

J. Liggett joined the meeting at 7:09 pm.

8.2 Temesgen Weldemihret, Erican Foundation

T. Weldemihret did not appear when called.

9. Minutes of Previous Meetings

Moved by P. Wolf
Seconded by C. James

That the following minutes be approved.

In Favor (15): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, K. Williams, and P. Wolf

Carried (15 to 0)

9.1 Closed Council - January 24, 2024

9.2 Council - January 24, 2024

9.3 Library Committee - February 2, 2024

9.4 Administration and Finance Committee - February 6, 2024

9.5 Community and Health Services Committee - February 6, 2024

9.6 Closed Committee - February 6, 2024

9.7 Planning and Works Committee - February 6, 2024

9.8 Special Council - February 6, 2024

9.9 Licensing and Hearings Committee - February 16, 2024

10. Communications

10.1 Council Information Package - February 14, 2024 (Distributed to Councillors Electronically)

Received for information.

11. Motion to Go Into Committee of the Whole to Consider Reports

Moved by C. Huinink
Seconded by D. McCabe

That Council go into Committee of the Whole to consider reports.

In Favor (15): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, K. Williams, and P. Wolf

Carried (15 to 0)

12. Reports

12.1 Finance Reports

Moved by M. Harris
Seconded by C. James

That the Finance Reports items be received for information and approved.

In Favor (15): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, K. Williams, and P. Wolf

Carried (15 to 0)

12.1.1 COR-TRY-24-006, T2023-151 - River Road/Bleams Road (Regional Road 56) Extension

Moved by M. Harris
Seconded by C. James

That the Regional Municipality of Waterloo accept the tender of J-AAR Excavating Limited for T2023-151 - River Road/Bleams Road (Regional Road 56) Extension in the amount of $11,771,530.55 plus all applicable taxes as set out in report COR-TRY-24-006 dated February 21, 2024.

Carried

12.2 Committee Reports

12.2.1 Administration & Finance Committee Summary - February 6, 2024

Moved by P. Wolf
Seconded by J. Nowak

That the following recommendations from the Administration and Finance Committee be approved:

1. That the Regional Municipality of Waterloo approve the Terms of Reference for the annual Community Capacity Building Fund as set out in report COR CFN 24 002 dated February 6, 2024.

2. That the Regional Municipality of Waterloo take the following action with respect to the 2024 allocations under the Key Cultural Institutions grant program as outlined in COR-CFN-24-003 dated February 6, 2024:

1. Approve the 2024 allocation of $840,603 under the Key Cultural Institutions grant program as set out below:

a. Kitchener Waterloo Art Gallery - $100,000;
b. Canadian Clay and Glass Gallery - $93,587;
c. Drayton Entertainment - $261,291;
d. THEMUSEUM - $385,725;

2. Fund the additional costs (in excess of the 2024 Budget provision) of $493,450 from the Tax Stabilization Reserve in 2024;
3. Direct staff to include an incremental $493,450 in the Preliminary 2025 Base Budget funded from the property tax levy; and
4.Direct staff to review the KCI program and funding model with the area municipal working group in 2024, and provide an update to Regional Council in Q2 2024 so that there is clarity in advance of 2025 funding requests.

In Favor (15): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, K. Williams, and P. Wolf

Carried (15 to 0)

12.2.2 Community and Health Services Committee Summary - February 6, 2024

Moved by M. Harris
Seconded by C. Huinink

That the following recommendation from the Community and Health Services Committee be approved:

1. That the Regional Municipality of Waterloo take the following action with respect to implementing the Canada-wide Early Learning and Child Care (CWELCC) directed growth plan, which prioritizes non-profit growth as outlined in report CSD-CHS-24-001 dated February 6, 2024:

a. Direct staff to explore, where feasible and appropriate, the development of community-based non-profit child care spaces in Regionally owned land/buildings and surplus lands, Waterloo Region Housing redevelopments, and other emerging opportunities.

b. Direct Children's Services, Housing Services, and Economic Development staff to consult with area municipalities, school boards, universities and colleges, hospitals, other community partners and businesses to explore creating affordable spaces for community-based non-profit child care in under-utilized buildings and lands.

In Favor (15): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, K. Williams, and P. Wolf

Carried (15 to 0)

12.2.3 Closed Committee Summary - February 6, 2024

Moved by C. Huinink
Seconded by K. Williams

That the following recommendation from Closed Committee be approved:

1. That the Regional Municipality of Waterloo approve the reappointments of the following Grand River Accessibility Advisory Committee (GRAAC) members for a second, four-year term, ending on December 31, 2028.

a. Carrie Speers

b. Paula Saunders

c. Heather Clark-Harris

In Favor (15): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, K. Williams, and P. Wolf

Carried (15 to 0)

12.2.4 Planning and Works Committee Summary - February 6, 2024

Moved by N. Salonen
Seconded by S. Foxton

That the following recommendation from the Planning and Works Committee be approved:

1. That the Regional Municipality of Waterloo:

a. Approve the recommended rehabilitation design concept for the West Montrose Covered Bridge in the Township of Woolwich, as described in Report EES-DCS-24-002, dated February 6, 2024.
b. Direct staff to file the Notice of Completion for this Class Environmental Assessment Study and to place the Environmental Study Report on the public record for a period of 30 days.
c. Direct staff to work with the Township of Woolwich for the necessary amendments to the Heritage Designation By-law 60-2007, for Township of Woolwich Council approval.

In Favor (15): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, K. Williams, and P. Wolf

Carried (15 to 0)

12.2.5 Licensing and Hearings Committee Summary - February 16, 2024

In response to a question from Council, Craig Dyer, Commissioner, Corporate Services/Chief Financial Officer, stated that the funding come for the increased vehicle conversion project will come from

the transportation accessibility reserve, which staff has calculated will be stable for 10 years.

B. Vrbanovic joined the meeting at 7:23 pm.

Moved by N. Salonen
Seconded by S. Foxton

That the following recommendation from the Licensing and Hearings Committee be approved:

1. That the Regional Municipality of Waterloo take the following action with respect to taxi fares and the disbursement of accessible taxi funds as outlined in report PDL-CAS-24-001 dated February 16, 2024:

    1. Amend the taxi fares in Bylaw 16-044, a Bylaw to Licence, Regulate and Govern Brokers, Owners and Drivers of Taxi Cabs, as follows: Increase the meter drop rate from $3.50 to $4.50; and

    2. Approve a new 5-year program to disburse accessibility funds collected by the Region as follows:

        a. Increase to Taxi Scrip program funds from $40,000/year to $55,000/year;

        b. Increase funds for the Vehicle Conversion Project from $10,000 per vehicle to $40,000 over 5 years to support the purchase of new vehicles; and

        c. Increase Fare Subsidy program support from $2.00/trip to $5.00/trip.

In Favor (16): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, and P. Wolf

Carried (16 to 0)

12.2.6 Closed Council Summary - February 21, 2024

Moved by N. Salonen
Seconded by S. Foxton

That the following recommendation from Closed Council be approved:

1. That the Regional Municipality of Waterloo, as a result of incidents of bullying and harassment of Regional staff and governance concerns related to the Region of Waterloo Arts Fund's administration, temporarily pause funding and administrative support to the Region of Waterloo Arts Fund pending the results of a third party expert review to be commissioned at the earliest possible date.

In Favor (16): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, and P. Wolf

Carried (16 to 0)

Moved by D. McCabe
Seconded by M. Harris

2. That the Regional Municipality of Waterloo, in order to continue support for artists and arts organizations this year, enter into a temporary agreement with the Waterloo Region Community Foundation to collect, review and administer grant applications for 2024 as part of the Foundation's annual Arts Grant Fund, with the Region providing funding to the recommended organizations and artists.

In Favor (14): K. Redman, D. Craig, J. Erb, S. Foxton, M. Harris, C. Huinink, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, and P. Wolf

Opposed (1): R. Deutschmann

Conflict (1): C. James

Carried (14 to 1)

12.3 Board of Health

12.3.1 Respiratory Season Update

Dr. Hsiu-Li Wang, Commissioner, Public Health & Paramedic Services/Medical Officer of Health, informed Council that current waste water levels indicate that Covid-19 is decreasing in the community and further noted that both Influenza and RSV rates are currently low. She highlighted that globally there is a significant increase in the rate of Measles but there have been no confirmed cases or contacts in Waterloo Region since 2019. Dr. H. Wang stressed that Measles can cause serious complications and encouraged the public to ensure they are fully vaccinated if travelling.

Dr. H. Wang stated that 18,000 suspension orders were sent out to parents for immunization of pupils. She noted that 10,000 records have been updated since January 1st and encouraged parents to not wait until the deadline. In response to a question from Council, she explained that the letters to parents contain an information sheet in many different languages in an effort to accommodate the many languages spoken within the Region.

13. Other Matters Under Committee Of The Whole

13.1 TSD-TRS-24-004, Every Child Matters Bus Mural Extension

Moved by J. Nowak
Seconded by N. Salonen

That the Regional Municipality of Waterloo extend the 2023-2024 Every Child Matters bus mural to run through to September 29, 2024, as described in report TSD-TRS-24-004, dated February 21, 2024.

In Favor (16): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, and P. Wolf

Carried (16 to 0)

14. Motion for Committee of the Whole to Rise and Council Resume

Moved by M. Harris
Seconded by S. Shantz

That Committee of the Whole rise and Council resume.

In Favor (16): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, and P. Wolf

Carried (16 to 0)

15. Motion To Adopt Proceedings of Committee of the Whole

Moved by P. Wolf
Seconded by S. Foxton

That Council adopt the proceedings of Committee of the Whole.

In Favor (16): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, and P. Wolf

Carried (16 to 0)

16. Motions

17. Notice of Motion

17.1 Councillor M. Harris Notice of Motion

Moved by M. Harris
Seconded by D. McCabe

Deferred from February 6, 2024 Community and Health Services Committee Meeting:

Whereas, the Region of Waterloo is implementing its Interim Housing Plan while developing a Plan to End Chronic Homelessness, an unprecedented commitment using an all of community approach to ending chronic homelessness in Waterloo Region.

Whereas, the 2024 Regional budget included an addition of $10.2 million to address, prevent and end chronic homelessness while the Plan to End Chronic Homelessness will be finalized and delivered in April of 2025,

Whereas, an additional $236,390 grant was approved by Council for A Better Tent City, a volunteer-led organization that did not meet the criteria set out in the Region's Fee-for-Service call for proposals to provide Community Outreach and Support Services,

Whereas, agreement outcomes and accountabilities currently exist for similar outreach services funded by the Region of Waterloo,

Therefore be it resolved that Regional staff be directed to collect outcomes, data and metrics from A Better Tent City that align with existing homelessness outreach agreements and providers and that such are agreed to with A Better Tent City.

In Favor (16): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, and P. Wolf

Carried (16 to 0)

18. Unfinished Business

None.

19. Other Business

None.

20. Questions

None.

21. Enactment of By-laws – First, Second & Third Readings

Moved by C. Huinink
Seconded by D. McCabe

That the following by-laws be approved.

In Favor (16): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, and P. Wolf

Carried (16 to 0)

21.1 By-law 24-003

Moved by C. Huinink
Seconded by D. McCabe

That a By-law to Amend By-law 16-023, as amended, being a By-law to Regulate Traffic and Parking on Highways Under the Jurisdiction of the Regional Municipality of Waterloo (No Parking, Rates of Speed,

Community Safety Zones, Reserved Lanes and School Zones) be read a first, second and third time, finally passed and numbered 24-003, be signed by the Regional Chair and Regional Clerk and sealed with the Regional Seal.

Carried

21.2 By-law 24-004

Moved by C. Huinink
Seconded by D. McCabe

That a By-law to appoint an Interim Deputy Treasurer be read a first, second and third time, finally passed and numbered 24-004, be signed by the Regional Chair and Regional Clerk and sealed with the Regional Seal.

Carried

21.3 By-law 24-005

Moved by C. Huinink
Seconded by D. McCabe

That a By-law to Confirm the Proceedings of the Council of the Regional Municipality of Waterloo at this Meeting Held on February 21, 2024 be read a first, second and third time, finally passed and numbered 24-005, be signed by the Regional Chair and Regional Clerk and sealed with the Regional Seal.

Carried

22. Adjourn

Moved by C. James
Seconded by C. Huinink

That the meeting adjourn at 7:41 p.m.

In Favor (16): K. Redman, D. Craig, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, and P. Wolf

Carried (16 to 0)

Regional Clerk

Regional Chair

Planning and Works Committee Minutes

February 6, 2024, 12:45 p.m.
Council Chambers

Members Present: K. Redman, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, P. Wolf

Members Absent: D. Craig

Should you require an alternative format or a copy of the official minutes please contact the Regional Clerk at Tel.: 519-575-4400, TTY: 519-575-4605, or regionalclerk@regionofwaterloo.ca

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1. Call to Order

Chair C. James called the meeting to order at 1:42 p.m.

2. Land Acknowledgement

Chair C. James provided a land acknowledgement.

3. Motion to Reconvene into Open Session

Moved by S. Foxton
Seconded by C. Huinink

That the Planning and Works Committee reconvene into open session.

In Favor (13): K. Redman, J. Erb, S. Foxton, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, and P. Wolf

Carried (13 to 0)

4. Declarations of Pecuniary Interest under the "Municipal Conflict of Interest Act"

None declared.

5. Presentations

There were no presentations.

6. Delegations

6.1 Isaac Ransom, Head of Corporate Affairs, Neuron Mobility

Isaac Ransom, Head of Corporate Affairs, Neuron Mobility shared an update on the 2023 riding season for the micromobility program, noting that the first year of the pilot was successful by all accounts, including various safety events being held, an average rating of 4/5 by riders, and an economic impact of roughly $8.2 million.

A copy of their presentation is attached to the minutes.

Responding to questions from the Committee, I. Ransom noted that they would be happy to explore extending the service area and months of operation, as the batteries can operate in cold conditions with stability, and it is possible to disable the fleet quickly if needed, such as during a snow event. I. Ransom also shared that they are looking to continue to build interconnectivity to help support longer trips, and that Neuron Mobility would be willing to look at expansion in certain areas based on direction from Council, area municipalities, and staff. I. Ransom also shared that some soft parking infrastructure has been introduced, such as the parking mats, to help encourage proper and consistent parking.

In response to a question from the Committee, I. Ransom stated that the same impaired driving laws apply to operating Escooters and Ebikes as motor vehicles. I. Ransom shared that a variety of initiatives have been explored to help limit riders operating an Escooter or Ebike while impaired, such as a reaction game prior to activation, stickers and app notifications, safety events, and engaging with law enforcement.

Responding to questions from the Committee, I. Ransom noted that Neuron Mobility is continuing to strive for a high compliance on helmet wearing and that insurance is provided to the riders, but if they void the terms, such as by not wearing a helmet, their eligibility for insurance would be assessed at the time of the incident.

R. Deutschmann joined the meeting at 1:55 pm.

M. Harris joined the meeting at 1:56 pm.

7. Consent Agenda

Item 7.1.2 TSD-TRS-24-003, Grand River Transit Bus Stop Design Guidelines was removed from the consent agenda.

M. Harris left the meeting at 2:18 pm.

Moved by S. Foxton
Seconded by N. Salonen

That the Consent Agenda items be received for information and approved.

In Favor (14): K. Redman, R. Deutschmann, J. Erb, S. Foxton, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, and P. Wolf

Carried (14 to 0)

7.1 Strategic Priority - Climate Aligned Growth

7.1.1 TSD-TRS-24-001, Update on Shared Micromobility Program 2023 Riding Season

This report was received for information.

7.1.2 TSD-TRS-24-003, Grand River Transit Bus Stop Design Guidelines

Responding to questions from the Committee, Doug Spooner, Director Transit Services, noted that staff will look to correct wording in the guidelines, as residents that use MobilityPLUS may also be able to use conventional transit. D. Spooner also shared that waste receptacles at transit stops can be discussed on a case by case basis, as a lot of the stops are operated by other GRT partners.

In response to a question from the Committee, D. Spooner noted that there is a capital budget for transit stop improvements, which includes implementing shelters and accessible pads.

This report was received for information.

8. Regular Agenda

8.1 Strategic Priority - Climate Aligned Growth

8.1.1 EES-DCS-24-002, Project Approval for the West Montrose Covered Bridge Rehabilitation, Township of Woolwich

Jennifer Rose, Commissioner, Engineering and Environmental Services introduced the report, sharing that this project is a really good example of how staff interacted with and engaged the

community, and that staff will continue to work with the community and the Township of Woolwich.

In response to a question from the Committee, J. Rose noted that the bridge is designated under the Ontario Heritage Act and that staff have been working closely with heritage groups to ensure that the heritage status and any funding that comes with that status is maintained. J. Rose also confirmed that remaining community concerns can be reviewed through the detailed design stage.

M. Harris joined the meeting at 2:28 pm.

Moved by S. Shantz
Seconded by S. Foxton

That the Regional Municipality of Waterloo:

a. Approve the recommended rehabilitation design concept for the West Montrose Covered Bridge in the Township of Woolwich, as described in Report EES-DCS-24-002, dated February 6, 2024.

b. Direct staff to file the Notice of Completion for this Class Environmental Assessment Study and to place the Environmental Study Report on the public record for a period of 30 days.

c. Direct staff to work with the Township of Woolwich for the necessary amendments to the Heritage Designation By-law 60-2007, for Township of Woolwich Council approval.

In Favor (15): K. Redman, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, and P. Wolf

Carried (15 to 0)

9. Information/Correspondence

9.1 Council/Committee Tracking List

Received for information.

9.2 Tony Dowling, West Montrose

Received for information.

10. Other Business

None.

11. Next Meeting- March 5, 2024

12. Adjourn

Moved by J. Liggett
Seconded by C. Huinink

That the meeting adjourn at 2:39 p.m.

In Favor (15): K. Redman, R. Deutschmann, J. Erb, S. Foxton, M. Harris, C. Huinink, C. James, J. Liggett, D. McCabe, J. Nowak, N. Salonen, S. Shantz, B. Vrbanovic, K. Williams, and P. Wolf

Carried (15 to 0)

Committee Clerk

Committee Chair

Regional Municipality of Waterloo
Planning and Works Committee
Addendum Agenda

Date: Tuesday, February 6, 2024
Regular Session: 12:45 p.m.
Location: Council Chambers

Should you require an alternative format please contact the Regional Clerk at Tel.: 519-575-4400, TTY: 519-575-4605, or regionalclerk@regionofwaterloo.ca

Pages

Start time is approximate. The Planning and Works Committee will start immediately following the Closed Committee.

1. Call to Order

2. Land Acknowledgement

3. Motion to Reconvene into Open Session

Recommended Motion:
That the Planning and Works Committee reconvene into open session.

4. Declarations of Pecuniary Interest under the "Municipal Conflict of Interest Act"

5. Presentations

6. Delegations

***6.1 Isaac Ransom, Head of Corporate Affairs, Neuron Mobility** *3*
re: support the report TSD-TRS-24-001, Update on Shared Micromobility Program 2023 Riding Season

7. Consent Agenda
Items on the Consent Agenda can be approved in one motion of Committee to save time. Prior to the motion being voted on, any member of Committee may request that one or more of the items be removed from the Consent Agenda and voted on separately.

Recommended Motion:
That the Consent Agenda items be received for information and approved.

7.1 Strategic Priority - Climate Aligned Growth

7.1.1 TSD-TRS-24-001, Update on Shared Micromobility Program 2023 Riding Season 9
For information.

7.1.2 TSD-TRS-24-003, Grand River Transit Bus Stop Design Guidelines 18

For information.

8. Regular Agenda

8.1 Strategic Priority - Climate Aligned Growth

8.1.1 EES-DCS-24-002, Project Approval for the West Montrose Covered Bridge Rehabilitation, Township of Woolwich 137

Recommended Motion:

That the Regional Municipality of Waterloo:

a. Approve the recommended rehabilitation design concept for the West Montrose Covered Bridge in the Township of Woolwich, as described in Report EES-DCS-24-002, dated February 6, 2024.

b. Direct staff to file the Notice of Completion for this Class Environmental Assessment Study and to place the Environmental Study Report on the public record for a period of 30 days.

c. Direct staff to work with the Township of Woolwich for the necessary amendments to the Heritage Designation By-law 60-2007, for Township of Woolwich Council approval.

9. Information/Correspondence

9.1 Council/Committee Tracking List 153

***9.2 Tony Dowling, West Montrose** *154*
re: West Montrose Covered Bridge Rehabilitation

10. Other Business

11. Next Meeting- March 5, 2024

12. Adjourn

Recommended Motion:

That the meeting adjourn at x:xx x.m.

Region of Waterloo

Engineering and Environmental Services

Design and Construction

To:	Planning and Works Committee
Meeting Date:	February 6, 2024
Report Title:	Project Approval for the West Montrose Covered Bridge Rehabilitation, Township of Woolwich

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1. Recommendation

That the Regional Municipality of Waterloo:

a) Approve the recommended rehabilitation design concept for the West Montrose Covered Bridge in the Township of Woolwich, as described in Report EES-DCS-24-002, dated February 6, 2024.

b) Direct staff to file the Notice of Completion for this Class Environmental Assessment Study and to place the Environmental Study Report on the public record for a period of 30 days.

c) Direct staff to work with the Township of Woolwich for the necessary amendments to the Heritage Designation By-law 60-2007, for Township of Woolwich Council approval.

2. Purpose / Issue:

Seeking Regional Council approval of the recommended rehabilitation design concept for the West Montrose Covered Bridge and to file a notice of study completion.

3. Strategic Plan:

This project supports the Region’s Strategic Plan priority area for Climate Aligned Growth and Equitable Opportunities and Services.

4. Report Highlights:

- The preferred rehabilitation alternative includes removal of the existing steel Bailey trusses installed in 1959, replacement of deteriorated wooden truss members and bridge elements, and reinforcing select members to accommodate a 10-tonne design vehicular live load. Photos depicting the preferred rehabilitation alternative can be found in Appendix A.

- The three-tonne load limit will be maintained. To prevent oversized vehicles from accessing and damaging the bridge, an overhead height restriction bar on the north approach and narrowing the road by moving the guiderails closer to each other on the south approach of the bridge is proposed. A concept of this can be found in Appendix B.

- The bridge is designated under Township of Woolwich Heritage Designation By-law 60-2007. Following Regional Council approval of the rehabilitation design concept, an amendment to the By-law will be required for the preferred alternative, to be approved by Township of Woolwich Council.

- Construction is planned to start in Spring 2025 and be complete by Spring 2026.

- This project is funded by the Investing in Canada Infrastructure Program (ICIP) including a 40% contribution from the federal government and a 33.33% contribution from the provincial government. Council approval is necessary to proceed with detailed design and construction in order to meet the timelines outlined in the Transfer Payment Agreement for the ICIP funding.

5. Background:

The West Montrose Covered Bridge must undergo a rehabilitation to ensure safety of the structure and its users. The bridge was built in 1881 and was originally constructed entirely of wood. It is Ontario's last remaining covered bridge and a tourist destination in the Region where visitors come to see, walk across, and photograph this picturesque and unique bridge.

In 1998, the Ministry of Transportation transferred ownership of the bridge to the Region. In 1999, the Region completed major rehabilitation work on the bridge. A Preservation Plan was prepared in 2014 and ongoing structural monitoring and bridge assessments have been undertaken.

A detailed inspection and evaluation of the existing wooden truss was done in 2023 to identify the truss elements that require reinforcement and/or replacement based on condition. Six rehabilitation alternatives were reviewed against a set of evaluation criteria including heritage, structural, social environment and cost criteria to recommend the preferred rehabilitation alternative.

6. Communication and Engagement with Area Municipalities and the Public

Area Municipalities: Township of Woolwich staff were part of the project team that developed the recommended rehabilitation alternative. It is expected that Woolwich Council will approve the necessary amendments to Township of Woolwich By-law 60-2007, as staff have been part of the project team, and the Township's Heritage Committee is supportive of the recommended rehabilitation design concept.

Public: Public consultation included three occasions where project information was posted to the Region's EngageWR website and residents were asked to provide feedback. Letters were delivered to applicable agencies and property owners within the Village of West Montrose at various stages during the study to provide project information and engagement opportunities. Engagement information was also included on signs at the bridge and ads in local newspapers. Letters/emails providing notification of this Committee Report were sent to local residents and stakeholders.

An in-person meeting was held with the BridgeKeepers/West Montrose Residents' Association on October 19, 2023. Members from the National Society for the Preservation of Covered Bridges also attended this meeting and have provided feedback for consideration during the development of the preferred alternative. An in-person public open house was held on November 22, 2023 at the West Montrose United Church and approximately 40 people attended.

In-person meetings and phone conversations were coordinated with area residents and the local Mennonite community. 141 survey responses were received with over 952 visits to the EngageWR website. In general, the public supported the recommended rehabilitation design concept. Responses to public comments are provided in a summary of Frequently Asked Questions on the project EngageWR website. The main comments raised by the public include support for Option 3 for the overhead height restriction bar, and a preference that the height restriction bars be moved as far away from the bridge as possible so the view of the bridge is not impacted. The Project Team has since updated the alternative to narrow the road at the south approach of the bridge to eliminate the need for the height restriction bar on this approach. This updated alternative is shown in Appendix B. After implementation, if narrowing the road on the south approach proves to not be effective or requires ongoing maintenance due to damaged guiderails, an overhead height restriction bar could be installed on the south approach of the bridge at a later time.

A presentation was made to the Township of Woolwich Heritage Committee. The Committee supports the preferred alternative and the necessary amendments to the Township's Heritage Designation By-Law. The Committee is also advocating for a motor vehicle restriction on the bridge. 47% of respondents to the public engagement survey prefer that motorized vehicles continue to be allowed on the bridge, 29% of people are in favour of a motor vehicle restriction, and 24% of respondents did not have a preference. The Project Team is not recommending a restriction of motorized vehicles on the bridge at this time.

7. Financial Implications:

The Region's approved 2024-2033 Transportation Capital Program includes a budget of

$2,565,000 in 2024 and $3,090,000 in 2025-2026 for the West Montrose Covered Bridge Rehabilitation (project #07626) to be funded from the Investing in Canada Infrastructure Program (ICIP) (71%, $4,022,200) and the Transportation Capital Reserve (29%, $1,632,800).

8. Conclusion / Next Steps:

Subject to Regional Council approval of the recommended design concept, staff will file a Notice of Study Completion on the public record for a 30-day review period. After the review period, staff will start detailed design, and coordinate the required permits, with construction planned from Spring 2025 to Spring 2026.

9. Attachments:

Appendix A: Recommended Rehabilitation Alternative Renderings

Appendix B: South Approach – Oversized Vehicle Restriction Concept

Prepared By: Michelle Pinto, Engineer, Design and Construction

Skylar Van Kruistum, Head, Design and Construction

Reviewed By: Frank Kosa, Director, Design and Construction

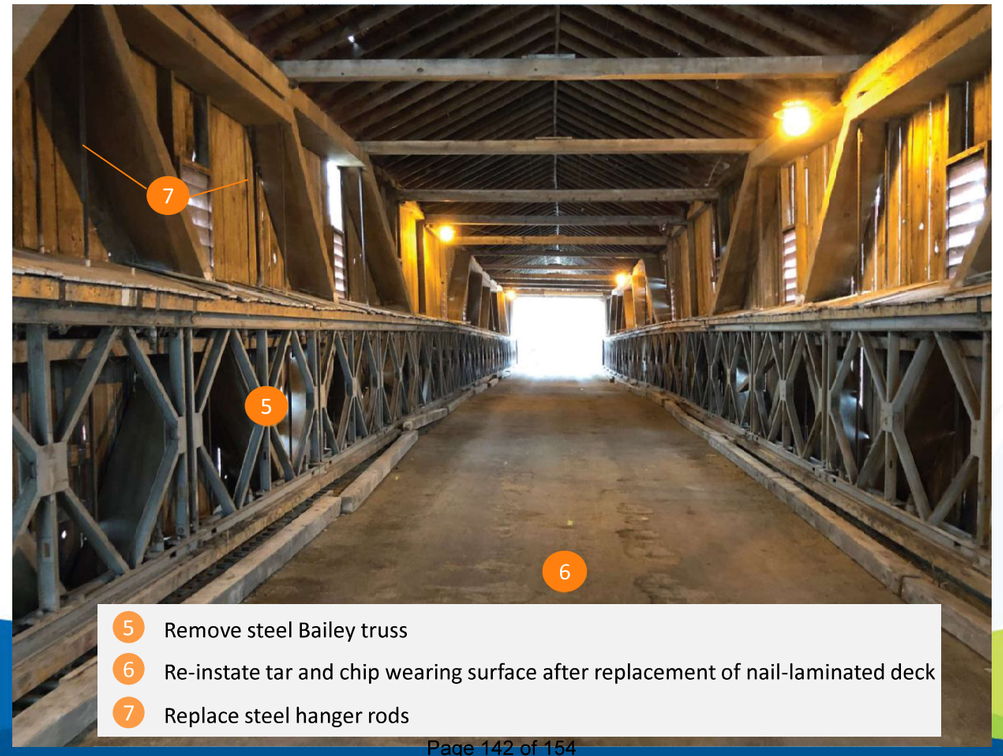
Approved By: Jennifer Rose, Commissioner, Engineering and Environmental Services

Rod Regier, Acting Commissioner, Transportation Services

Appendix A – Recommended Rehabilitation Alternative Renderings



Recommended Rehabilitation Alternative



5 Remove steel Bailey truss

6 Re-instate tar and chip wearing surface after replacement of nail-laminated deck

7 Replace steel hanger rods



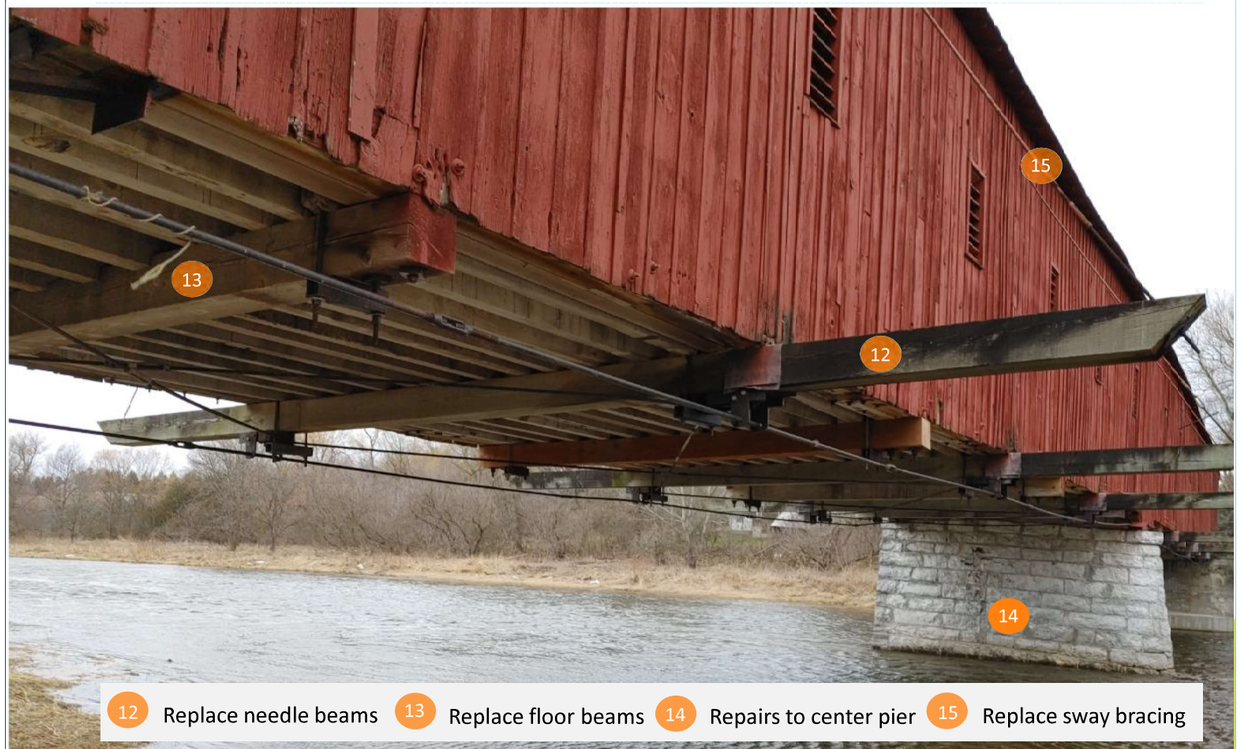
8 Replace rafters as necessary

9 Replace tie beams as necessary

10 Replace wood curbs

11 Replace light bulbs as necessary

Recommended Rehabilitation Alternative



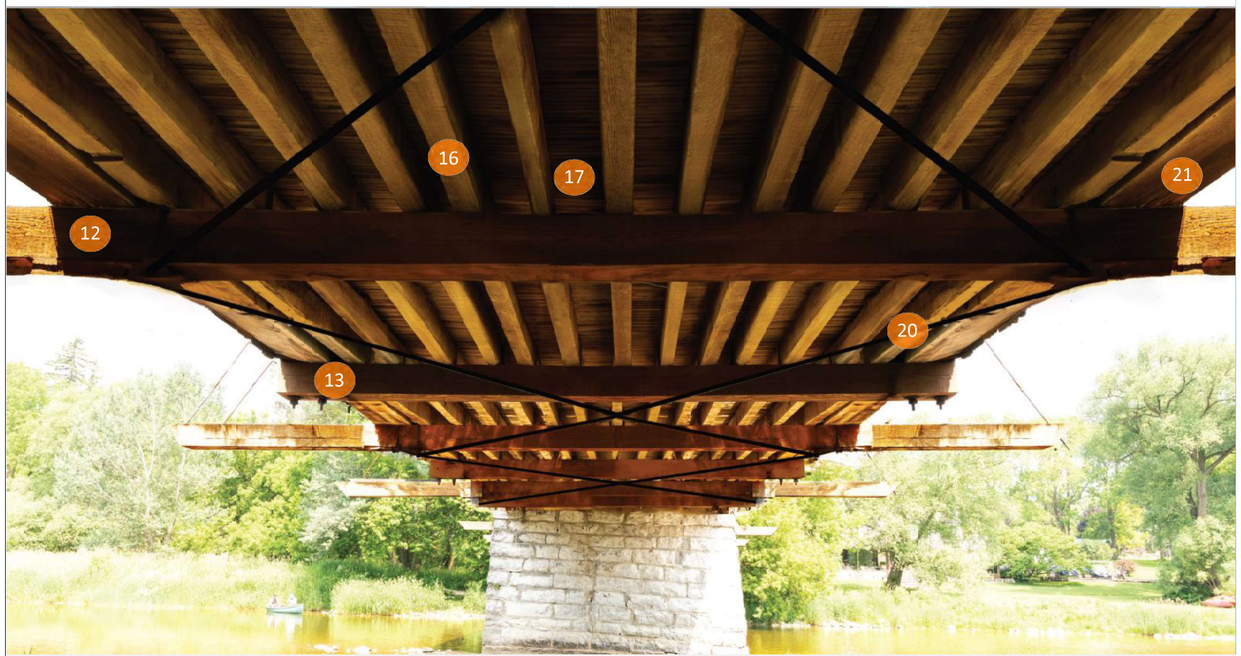
12 Replace needle beams
13 Replace floor beams
14 Repairs to center pier
15 Replace sway bracing

Recommended Rehabilitation Alternative



16 Replace stringers
17 Replace nail-laminated deck
18 Remove Bailey truss hanger system
19 Remove non-functioning tension rods (1959)
20 Replace bottom lateral bracing
21 Replace bottom chords

Recommended Rehabilitation Alternative



12 New Douglas Fir 16"x16" needle beams

13 New Douglas Fir 16"x16" floor beams

16 New sawn wood stringers

17 New nail-laminated wood deck

20 New steel rod cross-bracing

21 New Douglas Fir bottom chords

Recommended Rehabilitation Alternative

22 Concrete repairs to bridge abutments

23 Bridge deck elevation and approach grades will remain the same

24 Height restriction bar to prevent oversized vehicles from using the bridge

25 Fire retardant materials applied to various bridge elements

3 tonne posted load limit to be maintained



✓ Small Cars, SUVs, Horse & Buggies	1 - 3 tonnes
✓ ✗ Pick-up Trucks	1.7 – 3.5 tonnes
✗ EMS Vehicles	4 - 8 tonnes
✗ School Bus/Small Truck	6 - 12 tonnes
✗ Large truck	13+ tonnes

Height Restriction Bar - North Approach



*Details to be finalized with the input of an architect

Recommended Rehabilitation Alternative

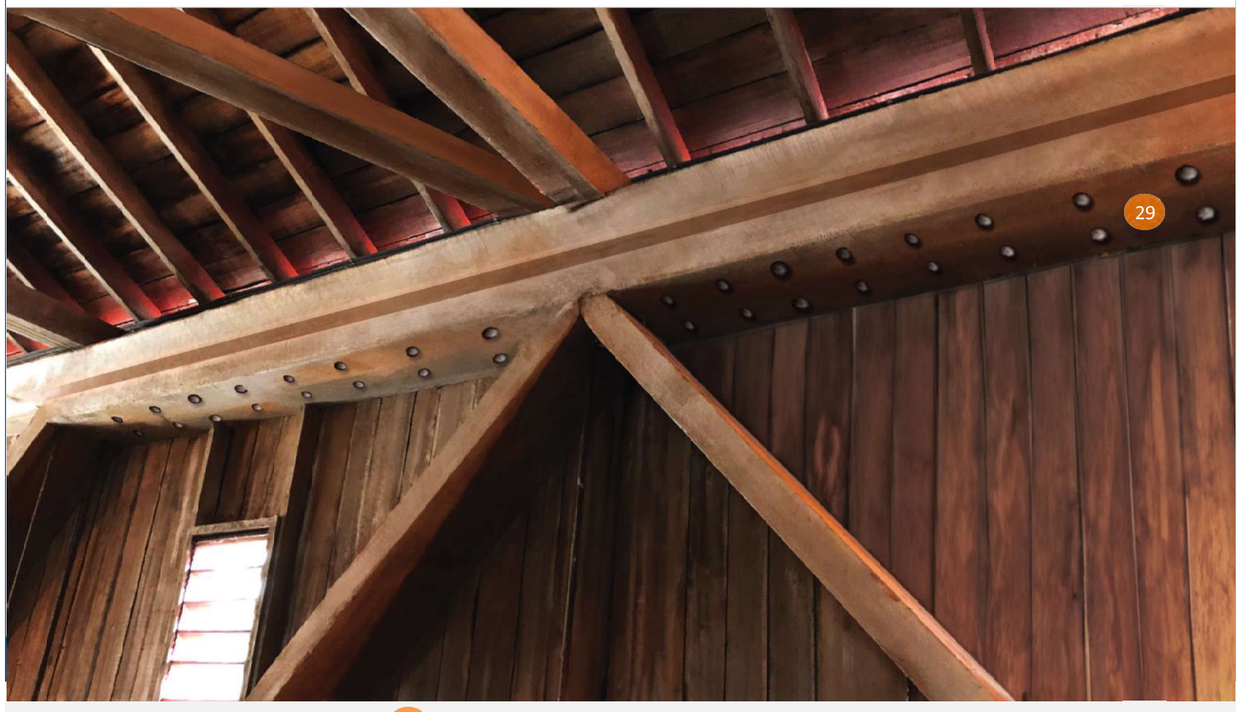


26 Replace end diagonals at pier and strengthen end diagonals at abutments

27 New overhead wood lateral bracing

28 New timber guiderail

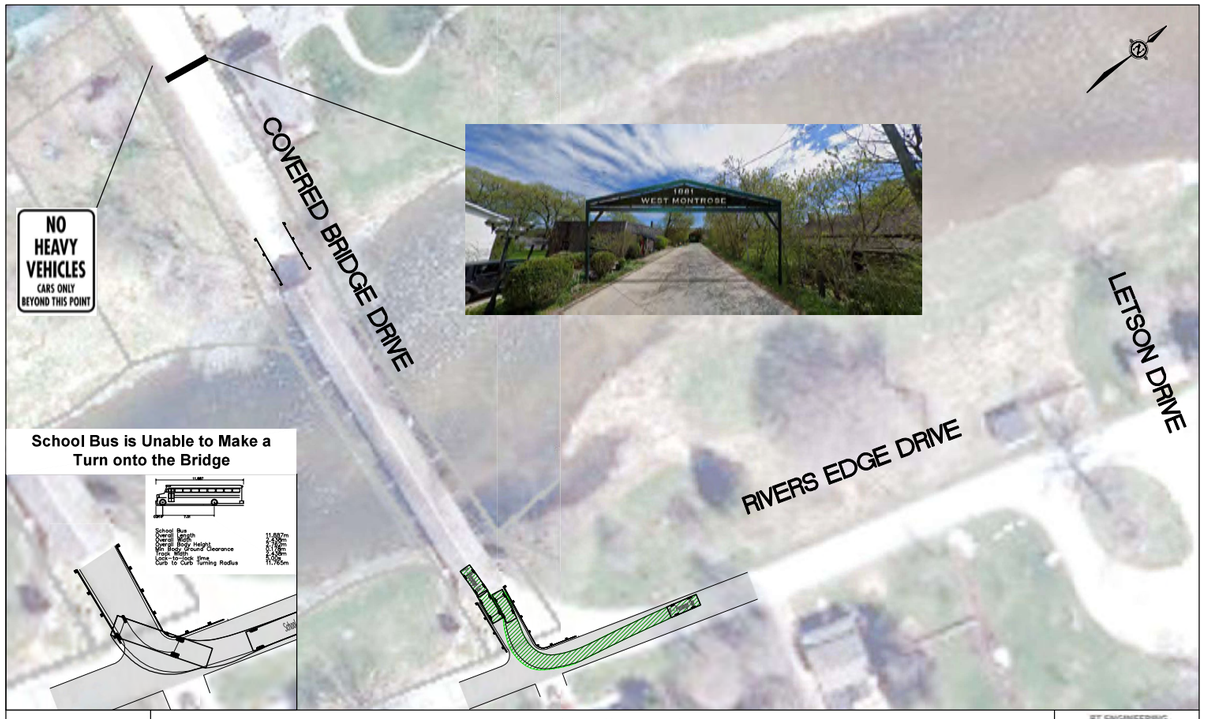
Recommended Rehabilitation Alternative



29 Reinforce top chord with lower top chord



30 Reinstate interior cladding in short sections at each end of the bridge



BTE 22-058 2024-01-12	**West Montrose Covered Bridge** Appendix B - South Approach – Oversized Vehicle Restriction Concept	BTE

1. You're proposing to substantially narrow the southern approach to the bridge, to prevent longer vehicles from making the turn. Currently, buggy drivers use the long sweep to reduce the grade for horses coming downhill. The wide sweep is also used as a pull-over for buggies and cars to allow southbound traffic to get around them. They can pull over en route or back into the wide area. How do you propose vehicles will back away from the bridge with the narrower access and T intersection if they encounter southbound traffic coming through the bridge? I understand staff have spoken to one of the Old Order Mennonites to see if they have any concerns with this approach. It would be prudent to visit the location on a Sunday afternoon when the Mennonites are returning from after-church socializing to observe the interactions of buggies and vehicles. It would also be beneficial to simulate the narrowing of the approach with barriers to observe how this impacts the interactions.
2. You are proposing to erect a height restrictor about 40 metres from the bridge on the north approach. This will restrict fire truck access by that 40 metres. Have you consulted with the Township's fire department to ensure they are comfortable with this restriction?
3. Have you considered a laser or infrared beam, say 9' off the ground that triggers a large LED warning, rather than these two other solutions?
4. The earlier report proposed to replace both lower chords "to maintain parallel service life", despite the analysis results saying one should still be serviceable for many years. Bill Caswell, the President of the National Society for the Preservation of Covered Bridges, says, "I don't want people to get too comfortable offering that as a solution without making a concerted effort to seek alternate solutions". Staff has since advised that both chords are experiencing decay that makes replacement necessary. Is this further decay the result of delays in moving forward with the restoration? If so, how do we minimize decay of other members over the two years until the restoration will be complete? I note the roof and exterior cladding are rife with holes and missing boards, allowing rain and melting snow to reach the timber.
5. Closure of the covered bridge for extended periods of time will require horse and buggy traffic to detour onto Line 86, where there is an 80 km. / hour speed limit over a bridge with virtually no shoulders. Has staff consulted with the Old Order community to seek any concerns they may have with this detour, especially in inclement weather where there might be restricted visibility and slippery road surfaces? I'm not comfortable with waiting to "see how it goes" before reducing speed limits and adding cautionary signage.

Regards,

Tony Dowling
West Montrose

Michelle Pinto

From: Frank Kosa
Sent: February 9, 2024 4:48 PM
To: 'Tony Dowling'
Cc: Regional Council All; Corporate Leadership Team; Skylar Van Kruistum; Michelle Pinto
Subject: Responses to Questions in the Revised February 6, 2024 Planning & Works Committee Agenda Package - Tony Dowling
Attachments: 154_Merged Agenda Package - PW_Feb06_2024.pdf

Good afternoon Tony,

Below are responses to the questions you prepared that were included in the February 6, 2024 Planning & Works Committee Agenda package regarding the West Montrose Covered Bridge.

Should you have any follow up questions, please feel free to reach out to Michelle, Skylar or myself.

Question 1 - You're proposing to substantially narrow the southern approach to the bridge, to prevent longer vehicles from making the turn. Currently, buggy drivers use the long sweep to reduce the grade for horses coming downhill. The wide sweep is also used as a pull-over for buggies and cars to allow southbound traffic to get around them. They can pull over en route or back into the wide area. How do you propose vehicles will back away from the bridge with the narrower access and T intersection if they encounter southbound traffic coming through the bridge? I understand staff have spoken to one of the Old Order Mennonites to see if they have any concerns with this approach. It would be prudent to visit the location on a Sunday afternoon when the Mennonites are returning from after-church socializing to observe the interactions of buggies and vehicles. It would also be beneficial to simulate the narrowing of the approach with barriers to observe how this impacts the interactions.

Response
Vehicles will still be able to back up and wait for a southbound vehicle to pass on River's Edge Drive, similar to the way the intersection functions now. Region Staff have been to the site on Sunday afternoon to observe the horse and buggy procession. We will still have an opportunity to review and refine the geometry of the narrowed approach during detailed design. We will check in with our Mennonite Community contact again once we've developed the design further. A test simulation prior to construction may be beneficial.

We understand that the change to the geometry will make it more difficult for drivers to pass by each other, but it will also provide a more clear indication that the bridge is meant to be a local traffic roadway and not a major thoroughfare. Furthermore, the change to geometry will help reduce vehicle speeds at the intersection (since they can no longer make the sweeping right turn), making it more likely that vehicles will see each other well before they cross paths. The slower speeds will also help alleviate some of the concerns that the community had previously expressed about traffic safety at this intersection.

Question 2 - You are proposing to erect a height restrictor about 40 metres from the bridge on the north approach. This will restrict fire truck access by that 40 metres. Have you consulted with the Township's fire department to ensure they are comfortable with this restriction?

Response
The Fire Department has been consulted about the height restrictor on the north approach and has suggested the use of a "breakaway feature" on the height restrictor, so they can access the area between the height restrictor and the bridge if needed. The Project Team will explore this further during detailed design, in consultation with the Fire Department.

Question 3 - Have you considered a laser or infrared beam, say 9' off the ground that triggers a large LED warning, rather than these two other solutions?

Response
This approach is not preferred because it is considered another advanced form of signage, providing less assurance that the historic structure will be protected in comparison to a height restriction bar, and would not physically stop an oversized vehicle from proceeding through the bridge.

Question 4 - The earlier report proposed to replace both lower chords "to maintain parallel service life", despite the analysis results saying one should still be serviceable for many years. Bill Caswell, the President of the National Society for the Preservation of Covered Bridges, says, "I don't want people to get too comfortable offering that as a solution without making a concerted effort to seek alternate solutions". Staff has since advised that both chords are experiencing decay that makes replacement necessary. Is this further decay the result of delays in moving forward with the restoration? If so, how do we minimize decay of other members over the two years until the restoration will be complete? I note the roof and exterior cladding are rife with holes and missing boards, allowing rain and melting snow to reach the timber.

Response
The recommendation is for both bottom chords to be replaced. Early onset decay was noted at several locations and the existing Eastern Hemlock material comprising the bottom chords is not strong enough to resist the applied demand resulting from the 10-tonne design live load.

Question 5 - Closure of the covered bridge for extended periods of time will require horse and buggy traffic to detour onto Line 86, where there is an 80 km. / hour speed limit over a bridge with virtually no shoulders. Has staff consulted with the Old Order community to seek any concerns they may have with this detour, especially in inclement weather where there might be restricted visibility and slippery road surfaces? I'm not comfortable with waiting to "see how it goes" before reducing speed limits and adding cautionary signage.

Response
The Mennonite community understands that the bridge will not be accessible during construction and that Line 86 will be the detour route. Mennonite community members have provided comments on the Line 86 detour route, including suggestions for changes to the traffic signals on Line 86 at Katherine Street North.

Given the nature of the rural environment on Line 86, a change to the posted speed limit is not expected to have a significant impact on driver speeds. During detailed design, the Project Team will explore other options to improve safety for horse and buggies using the detour route on Line 86 during construction.

Regards,

Frank Kosa, P.Eng.
Director, Design and Construction
Region of Waterloo
Tel: 519-575-4757 x3185

Township of Woolwich
Heritage Committee Minutes

November 8, 2023
5:02 p.m. – 6:27 p.m.
Video Conference
Hosted in Virtually
24 Church Street West, Elmira

Meeting Chair:	Councillor Bonnie Bryant, Chair
Attended:	Colleen Willard-Holt, Co-Chair Katy Boose Kim Hodgson Marg Drexler Michelle Pinto, Engineer, Transportation Rehabilitation for Region of Waterloo (Project Team) Steve Taylor, EA Project Manager (Project Team) Andrew Lehan, Senior Bridge Engineer (Project Team) Richard Unterman, Heritage Consultant (Project Team)
Staff Present:	Natalia Smiarowski, Records and Information Management Assistant Sherwin Meloney, Planner
Regrets:	Karen Cummings

Land Acknowledgement

Councillor Bonnie Bryant read a land acknowledgement.

Call to Order at 5:02 P.M.

Disclosure of Pecuniary Interest

None.

Adoption of Minutes

Moved by Colleen Willard-Holt
Seconded by Katy Boose

Adoption of the Minutes for September 11, 2023.

…Carried.

Work Plan Update

Work Plan Update

The Work Plan brainstorming session was deferred to the next meeting.

The plan will be presented by Co-Chair Colleen Willard-Holt at the November 14th Committee of the Whole Meeting.

New Business

Region of Waterloo Presentation

Michelle Pinto, Steve Taylor, Andrew Lehan and Richard Unterman of the Region of Waterloo West Montrose Bridge Rehabilitation Team, which will henceforth be called the Project Team, provided a presentation to the members. A copy of the presentation is attached to this meeting's agenda and can be found on the Township's website.

- Project Need and Opportunities
- Existing Challenges
- Background Studies
- Public Consultation and Feedback
- Proposed Rehabilitation
- Rehabilitation Alternatives
- C2 Being the preferred alternative of wooden repairs up to a weight of 10 tonnes.
- Alternatives Evaluation
- Recommended Rehabilitation Alternative
- Proposed Improvement
- Heritage Impact Assessment
    - The structure has been renewed many different times with including the earliest photos, show replacement of the wood, showing that the bridge has been an ever-changing structure
    - Some of these changes include:
        - the original wooden pier has been replaced with stone
        - Floor beams, chord beams, coverings on windows
        - The red colour was added in the 1960's
    - Project Team an Impact Document and Environmental Assessment Document will show all changes that need to be made to the heritage designation, a few of the changes will be:
        - Remove the Bailey steel truss
        - The white splash paneling
    - From a Heritage Perspective the C2 Alternative all wood structure is more like an earlier version of the bridge, and it would be able to reversed which is an essential requirement of for heritage preservation

The Project team noted that the next Public Consultation will be on November 22, 2023 at West Montrose Church from 6:30pm to 9pm. Comments will continue to be received from November 20 to December 15th.

The Committee highlighted the need for vehicular traffic on the bridge, as their intention is to bring the bridge to its 1881 original form which did not have large loads. The Project Team informed the Committee that pedestrian bridges are required to support 8 tonnes for maintenance vehicles. The Committee discussed possibilities of heavier vehicles using the bridge, current vehicle allowance, and whether there is a possibility of EMS vehicles using the bridge.

The Project Team noted that the focus of the bridge rehabilitation is to preserve the bridge, and not to accommodate all traffic.

The Committee discussed concerns that the bridge should not be used by any vehicular traffic and asked if the bridge could be closed to motorized traffic while keeping it open for horse and buggy traffic. The Project Team commented that the Mennonite community preferred the low traffic and speed of the West Montrose bridge compared to the 2 alternative bridges.

The Committee discussed the possibility of removable bollards.

The Committee discussed amending the motion to advocate for non-motorized use of the bridge.

Motion

That the Woolwich Heritage Committee, regarding the West Montrose Covered Bridge Rehabilitation presentation, recommends that the Township of Woolwich Council direct the Project Team to:

1. Implement the Alternative C2 option for wood repairs (10 tonnes) within the rehabilitation project;
2. Work with staff to draft the necessary amendments to the Heritage Designation By-Law 60-2007 for Council approval; and
3. Proceed with next steps to obtain Regional Council approval.

And further that the Township strongly advocates that consideration be given to restricting the bridge to pedestrian, cyclist and horse and buggy usage only and that vehicular traffic not be permitted on the bridge.

Moved by Colleen Willard-Holt.
Seconded by Katy Boose.

…Carried.

Items for the Next Agenda

Work Plan

Next meeting will be used as planning meeting for 2024 objectives.

ACTION: Colleen will present the 2024 work plan to Committee of the Whole on November 14th.

Thank You Card for Hans Pottkamper

A Thank You Card will be bought and signed for Hans Pottkamper.

ACTION: Marg Drexler to bring card.

Meeting Schedule for 2024

Create the new meeting schedule for 2024.

Appointment of 2024 Meeting Chair and Co-Chair

Appoint Chair and Co-Chair for 2024.

Adjournment

Moved by Colleen Willard-Holt.
Seconded by Kim Hodgson.
That the meeting be adjourned.

…Carried.

THE TOWNSHIP OF
WOOLWICH
BOX 158, 24 CHURCH ST. W.
ELMIRA, ONTARIO N3B 2Z6
TEL. 519-669-6010 / 1-877-969-0094 ext. 6010
COUNCIL/CAO/CLERKS FAX 519-669-1820
EMAIL: jsmith@woolwich.ca

Date: November 10, 2023

Mayor Sandy Shantz and Members of Woolwich Township Council
The Corporation of the Township of Woolwich
24 Church Street West, Elmira ON

Re: Resolution: West Montrose Bridge Rehabilitation

Dear Mayor Shantz and Members of Council,

This letter is to inform you that the Woolwich Heritage Committee passed the following resolution at their meeting on November 8, 2023, requesting direction from Council:

That the Woolwich Heritage Committee, regarding the West Montrose Covered Bridge Rehabilitation presentation, recommends that the Township of Woolwich Council direct the Project Team to:

1. **Implement the Alternative C2 option for wood repairs (10 tonnes) within the rehabilitation project;**

2. **Work with staff to draft the necessary amendments to the Heritage Designation By-law 60-2007 for Council approval; and**

3. **Proceed with next steps to obtain Regional Council approval.**

And further that the Township strongly advocates that consideration be given to restricting the bridge to pedestrian, cyclist and horse and buggy usage only and that vehicular traffic not be permitted on the bridge.

Should you require any further clarification, please contact me by email jsmith@woolwich.ca or by phone at 519-669-6010.

Yours truly,

Jeff Smith, B.A, M.A
Director of Corporate Services / Clerk
Township of Woolwich

Township of Woolwich
Council Minutes

Tuesday, November 21, 2023
7:00 PM
Council Chambers – Hybrid with YouTube Livestream
24 Church Street West, Elmira

Present from Council:	Mayor Shantz (Chairperson) Councillor Burgess Councillor Bryant Councillor Cadeau Councillor Schwindt Councillor Grant
Present from Staff:	David Brenneman, Chief Administrative Officer Jeff Smith, Director of Corporate Services/Clerk Deanne Friess, Director of Development Services Richard Petherick, Director of Financial Services/Treasurer Jared Puppe, Director of Infrastructure Services Ann McArthur, Director of Recreation and Community Services Thomas van der Hoff, Deputy Director of Recreation and Community Services Lori Fox, Manager of Development Engineering Sherwin Meloney, Planner* Jeremy Vink, Manager of Planning Nick Racanelli, Chief Building Official* Alex Smyth, Deputy Clerk Craig Eveson, Deputy Fire Chief* Tanya Bettridge, Council and Committee Support Specialist Meet Patel, IT HelpDesk/Support Representative

**indicates remote participation*

Public Resolution to Move into Closed Session (6:15 P.M.)

Moved by Councillor Bryant
Seconded by Councillor Grant
That the Council of the Township of Woolwich convenes in closed session on Tuesday, November 21, 2023 at 6:15 p.m. in accordance with section 239 (2) of the Municipal Act, 2001, for the purposes of considering the following:

1. Advice that is subject to solicitor-client privilege, including communications necessary for that purpose; a proposed or pending acquisition or disposition of land by the municipality or local board (Property Matter); and
2. Litigation or potential litigation, including matters before administrative tribunals, affecting the municipality or local board (Legal Matter).

…Carried.

Public Resolution to Reconvene in Open Session (7:00 P.M.)

Motion by Councillor Grant
Seconded by Councillor Cadeau
That Council reconvenes in open session.

…Carried

Land Acknowledgement

Mayor Shantz read a land acknowledgement.

Moment of Silence

Council observed a moment of silence.

Disclosures of Pecuniary Interest

None.

Items From Closed Session

None.

Adoption of Minutes

Clerk Jeff Smith, noted a possible omission from the October 24, 2023 minutes.

Moved by Councillor Bryant
Seconded by Councillor Grant
That the following minutes be adopted:

- Council Minutes – October 24, 2023 – as amended
- Special Council – Planning Minutes – November 7, 2023
- Committee of the Whole Minutes – November 14, 2023

…Carried

Public Meeting

None.

Presentations

None.

Delegations

R11-2023: 22 Mockingbird Update (former Regional Daycare facility) – Proposed Lease Creative Beginnings Non-profit Daycare

Delegate Christa O'Connor of Creative Beginnings Childcare Centre highlighted the gap in childcare spaces across the Region, the history of Creative Beginnings as a not-for-profit childcare centre, and the focus of its programming. Ms. O'Connor discussed the shortage of childcare spaces and the long waitlist for 0-4 year olds and how Creative Beginnings would contribute to providing both childcare and employment opportunities to the Woolwich community.

Council discussed timelines for the building to be ready, prioritizing Woolwich residents and how the centre would serve underrepresented groups and low-income families.

Motion by Councillor Grant
Seconded by Councillor Cadeau
That the Council of the Township of Woolwich, in consideration of Report R11-2023 respecting 22 Mockingbird Drive in Elmira authorize staff to negotiate terms to enter into a long-term Agreement to Lease with Creative Beginnings Childcare Centre as per the Township's Delegation of Authority By-law.

…Carried

DS44-2023: Zone Change Application 10/2023 (Michelle Shannon)

Delegate Bob Black of RBA Planning Consultants provided comments on behalf of the applicant in support of the Zone Change Application.

Moved by Councillor Bryant
Seconded by Councillor Schwindt
That the Council of the Township of Woolwich, considering Report DS44-2023 respecting Zone Change Application 10/2023 (Michelle Shannon) amend the Agricultural (A) zone with site specific provisions to recognize a reduced Agricultural parcel size of 34 hectares for the property of 1189 Weeby Place in accordance with the by-law in Attachment 3 to this report.

…Carried

Memo: Responding to the Province's Announcement – Re: Winding Back Changes to Approved Official Plans

Jeremy Vink, Manager of Planning outlined the memo and shared maps showing the boundary differences being considered. In response to a question from Council, Mr. Vink noted that approximately $500,000 has been spent to date on planning for new areas including consultants and staff time. In response to a question from Council, Mr. Vink noted that he does not think additional staff would be needed to implement either option outlined in the memo. Mr. Vink expressed concern that more staff may be needed if the Township is not authorized to use appropriate staging to manage growth.

Delegate Tom McLaughlin of Thomasfield Homes Limited presented to Council their support for the Ministry-modified ROPA 6 and requested that Council's response to the Ministry be in support of the modifications and that the Township continue the Secondary Plan as is based on the Ministry's decision. Mr. McLaughlin cited the Region's current and future housing needs, the generational housing crisis, demand for detached homes, and commercial/mixed-use needs as the basis for their requests.

Delegate Pierre Chauvin of the Waterloo Region Home Builders Association presented the Association's key messages for sustainable growth:

- Economic and population growth in the region demands growth in housing
- Support for increased urban density as key in meeting housing targets
- Need for a variety of housing to satisfy consumer demand
- Opportunity for cooperative, multi-lateral planning involving public and private sector stakeholders to address growth needs

Delegate Dr. Barbara Schumacher of the 50by30 Waterloo Region (50by30WR) highlighted the government's process to date, urged Woolwich Council to support its original plan as adopted by Regional Council and asked Council to revisit the Province's identified expansion areas in a future Official Plan review instead. Dr. Schumacher expressed concern that the development plans currently do not address environmental targets nor plan for them.

Delegate Arthur Eby of Ebycrest Farms gave an overview of the history of his farm, the current situation of being surrounded by development, and as a result, the property can only be of value for development. Mr. Eby asked Council to include his property within the future development area.

Delegate Kevin Thomason of the Grand River Environmental Network requested that Council endorse the ROPA 6 as originally adopted by Regional Council, which he felt would respect the public consultation processes, indigenous engagement, and time and efforts of all those involved.

A member of Council inquired about the Freedom of Information (FOI) request that Mr. Thomason had undertaken with regard to the Province and Mr. Thomason provided a brief summary of the FOI request and its implications for both the Region and Woolwich.

Delegate Kevin Eby stated his appreciation for both staff and Council and the difficult position they have been put in by the Province. Mr. Eby expressed concern that the Township was being asked to override what was a collaborative, engaging ROPA 6 process including the integral involvement of First Nations. Mr. Eby explained that based on data he has reviewed, the Region needs thousands of affordable, 1-bedroom apartments to resolve the affordable housing crisis, not via more land with single detached dwellings. In response to Council's inquiry, Mr. Eby provided a history of the Countryside line and its purpose.

Delegate Mike Gilles of 1604964 Ontario provided a presentation to Council, highlighting his property in terms of its inclusion in both the original and modified settlement boundaries in ROPA 6. Mr. Gilles asked Council to move forward in endorsing the Province's adjusted boundaries.

Council discussed what the process would be should the original ROPA 6 be kept and the property owner wished to install the turnaround for the development, which is currently beyond the settlement area. Staff confirmed the process required for this project.

Delegate Stuart Martin asked Council to endorse the modifications the Province made regarding their 24 acre property on Hawkesville Road, citing the need for land to build homes, churches, and places of employment.

Delegate Vaughn Bender of Schlegel Urban Developments also spoke to the 24 acre property on Hawkesville Road as well as the Township's pending response to the Province's announcement. Mr. Bender requested that Council proceed with the inclusion of their property as per the boundary adjustments made by the Province in April, 2023.

Moved by Councillor Cadeau
Seconded by Councillor Grant
That the Council of the Township of Woolwich allow unregistered delegations in the November 21, 2023 Council meeting to speak for 5 minutes as per section 64 of the Procedural By-law.

…Carried

Unregistered Delegate Jonathan Koutaloukis of Madwest Breslau Ltd. asked Council to support the ROPA 6 as Regional Council approved it in order to promote controlled growth.

Unregistered Delegate John Mesina of Bloomingdale Road expressed concern that a property that they have been trying to develop for many years has been rejected, despite it being fully serviced lot, and urged Council to consider similar, small parcels of land for development instead of the large areas the Province identified for growth.

Unregistered Delegate Delmer B. Martin expressed concern for the integrity of the past process and the importance of focusing on truth and common sense in the current process.

Council inquired about any communications with the Province since receiving the letter from the Minister. Staff confirmed that there has not been any dialogue with the Province. Council expressed frustration with the short, 45-day response window, the integrity of the Provincial process, the desire to respect the collaborative process undertaken to achieve ROPA 6, and the lack of confidence in the Province accepting the conditions like staging that staff proposed. Council members appreciated that Mayor Shantz has brought this to Council for an engaged discussion which also allows for public comment. Mayor Shantz thanked everyone for their feedback and advised that she will be working on drafting a letter to the Province.

<u>Proposed Unfiltered and Untreated Human Waste on Prime Agricultural Land By Regional Recharge Areas</u>

Delegates Dawn Peace, Jazmin Wynter, Richelle Lanting, and Maynard Lanting presented their concerns to Council regarding a commercial business' application to the Province, and its intent to purchase prime agricultural land, for the purpose of spreading untreated, unfiltered human waste as part of its commercial operation. The delegates' presentation highlighted their perspective on the source water, air, and soil quality implications, and contradiction of planning policies and plans. Staff provided their interpretation of planning policies and noted contradictions in mapping.

Council members shared concerns about allowing untreated waste operations in the way the delegates described, discussed with staff the lack of internal expertise in that subject area, and the need to get more information. Council also acknowledged normal waste spreading practices in agricultural operations.

Council directed staff to:

- Send a letter to request an extension in the commenting period to allow the Township to gather more information, identify the Township's preliminary concerns regarding human waste spreading, and send a copy of the letter to MPP Mike Harris; and
- Request that Ministry staff meet with Township staff and concerned residents to exchange information, facts and up to date maps.

Unfinished Business

None.

Consent Items

Moved by Councillor Grant
Seconded by Councillor Bryant
That the following consent items be approved and received for information:

Items for Approval

Recommendations from Committee of the Whole (November 14, 2023)
That the Summary of Recommendations of the Committee of the Whole dated Tuesday, November 14, 2023 be adopted.

1. Final Report from the 2SLGBTQ+ Ad-hoc Working Group
That the Council of the Township of Woolwich, considering Report C32-2023 respecting Final Report from the 2SLGBTQ+ Ad-hoc Working Group take the following actions to support and celebrate 2SLGBTQ+ people, friends, family and allies who live, work and play in the Township:

1. Include Equity, Diversity, Inclusion and Belonging (EDIB) in the Township's strategic plan;
2. Advance inclusivity including:
    a. Organize an annual pride flag raising ceremony;
    b. Join the UNESCO Coalition of Inclusive Municipalities;
    c. Provide EDIB grants during annual budget deliberations;
    d. Consider a shared EDIB staff role; and
    e. Provide EDIB staff training;
3. Direct staff to explore EDIB programming and partnerships;
4. Promote inclusive symbols including:
    a. Pride window stickers;
    b. Consider installing community murals;
    c. Consider installing professional mural; and
    d. Consider installing rainbow crosswalks or sidewalks;
5. Direct staff to proceed with the design and purchase of rainbow benches within the 2023 budget and plan for a spring, 2024 installation; and
6. Direct staff to establish avenues for continuing community engagement and feedback on the implementation of this report as needed.

2. Woolwich Township Heritage Committee 2024 Work Plan and Budget
That the Council of the Township of Woolwich receives the Woolwich Heritage Committee 2024 Work Plan.

And further that the $4000 identified in the Work Plan be included in the proposed Development Services Operating Budget in 2024.

3. 1st Elmira Scout Group, Request for Gore Park Fee Reduction
That the Council of the Township of Woolwich, considering the 1st Elmira Scout Group's request for a reduction in rental fees for Gore Park, approve the full fee waiver for the term of Council.

4. By-law to Establish, Maintain and Regulate a Fire Department for the Township of Woolwich
That the Council of the Township of Woolwich, considering Report A11-2023 respecting a By-law to regulate the operation of the Fire Department, authorize the Mayor and Clerk to sign the By-law.

5. Draft 2024 Council Meeting Schedule
That the Council of the Township of Woolwich, considering Report C28-2023 respecting Draft 2024 Council Meeting Schedule:

1. Approve the draft 2024 Council Meeting Schedule as attached to this report; and
2. Direct staff to continue to use the same method of drafting council meeting schedules as the 2024 draft for the term of Council.

6. Township Historic Bridge Update
That the Council of the Township of Woolwich, considering Report IS21-2023 respecting Township Historic Bridge Updates, receives the report for information purposes.

Items for Information and Public Notices

- Notice of Intent to Consider an Amending By-law to Impose Fees or Charges for Building, Planning, Fire, and General Services

…Carried

Staff Reports and Memos

Quarterly Report – 3rd Quarter – July 1 to September 30

Richard Petherick, Director of Financial Services provided an overview of the report and requested Council consider directing unspent funding from the surface treatment program to be used in 2024. Council requested clarity on statistics in the report for by-law enforcement and recreation centre programming.

Moved by Councillor Bryant
Seconded by Councillor Grant
That the Council of the Township of Woolwich authorize staff to direct $130,500 from the Surface Treatment 2023 Budget contained in the Infrastructure Services Hard Top Budget to the Operating Contingency Reserve to be used for surface treatment works in 2024.

…Carried

DS45-2023: Building Official Position

Moved by Councillor Cadeau
Seconded by Councillor Grant
That the Council of the Township of Woolwich, considering Report DS45-2023 respecting Building Official Position, receive this report for information.

…Carried

Other Business

Resolution to Participate in Regional All Council Closed Session on December 8, 2023
Motion by Councillor

Moved by Councillor Grant
Seconded by Councillor Schwindt
That a closed meeting of Council be held on Friday, December 8, 2023 at 1:00 p.m. in the Regional Council Chambers and electronically, in accordance with Section 239 of the Municipal Act, 2001, for the purposes of considering the following subject matters:

1. Education related to Indigenous History and Reconciliation

…Carried

Resolution to Participate in an All-Council Meeting at the Region of Waterloo on December 15, 2023

Moved by Councillor Cadeau

Seconded by Councillor Bryant
That the Council of the Township of Woolwich participate in an in-person All-Council meeting hosted by the Region of Waterloo in Regional Council Chambers on Friday, December 15, 2023 at 2:00 p.m.

…Carried

Woolwich Heritage Committee Resolution - West Montrose Bridge Rehabilitation

Moved by Councillor Bryant
Seconded by Councillor Grant
That the Council of the Township of Woolwich considering a recommendation from the Woolwich Heritage Committee direct the Project Team to:

1. Implement the Alternative C2 option for wood repairs (10 tonnes) within the rehabilitation project;
2. Work with staff to draft the necessary amendments to the Heritage Designation By-law 60-2007 for Council approval; and
3. Proceed with next steps to obtain Regional Council approval.

And further that the Township strongly advocates that consideration be given to restricting the bridge to pedestrian, cyclist and horse and buggy usage only and that vehicular traffic not be permitted on the bridge.

Council expressed concern with the recommendation from the Heritage Committee regarding the possibility of allowing horse and buggies but restricting vehicular traffic. Mr. Smith noted that the project manager will be working on more public consultation before bringing this back to Council for more information.

…Carried

Mayor's Report on Regional Matters

None.

Council Reports/Updates

None.

Outstanding Activity List as of Thursday, November 16, 2023

None.

Notice of Motion

None.

By-laws

For First, Second and Third Readings

Moved by Councillor Schwindt
Seconded by Councillor Cadeau
That the following by-laws in the hands of the Clerk be read a first, second, third time and finally passed, that they be numbered as By-law numbers 71-2023 to 76-2023, and that they be signed by the Mayor and Clerk and sealed with the corporate seal.

- A By-law to Establish, Maintain and Regulate a Fire Department for the Township of Woolwich
- A By-law to Further Amend Zoning By-law 55-86, of the Township of Woolwich (1189 Weeby Place)
- A By-law to Provide for the Appointment of a Municipal Law Enforcement Officer, Animal Control Officer and Property Standards Officer for the Township of Woolwich (Coleman Meyer)
- A By-law to Provide for the Appointment of a Municipal Law Enforcement Officer, Animal Control Officer and Property Standards Officer for the Township of Woolwich (Colin Moran)
- A By-law to Provide for the Appointment of a Municipal Law Enforcement Officer for the Township of Woolwich (Xxandra Morgan)
- A By-law to Confirm All Actions and Proceedings of the Council (November 21, 2023)

…Carried

Adjournment (10:27pm)

Moved by Councillor Cadeau
Seconded by Councillor Bryant
That the meeting adjourns to meet again in regular session on Tuesday, December 12, 2023.

...Carried

Signature on file
Sandy Shantz, Mayor

Signature on file
Jeff Smith, Clerk

Township of Woolwich
Special Heritage Committee Minutes

July 26, 2022
Virtual – Zoom Meeting
From 5:00 p.m. to 6:21 p.m.

Meeting Chair:	Councillor Patrick Merlihan (Chair)
Attended:	Bonnie Bryant (Co-Chair) Colleen Willard-Holt Hans Pottkamper
Staff Present:	David Gundrum, Planner Robyn Koutrouliotis, Licensing Officer/Administrative Assistant
Presenters:	Bridget Coady, Cultural Heritage Principal Planner, Region of Waterloo* Doug Dixon, President, Senior Bridge Engineer, Doug Dixon & Associates* Kevin Li, Junior Bridge Designer, Doug Dixon & Associates* Michelle Pinto, Project Manager, Region of Waterloo* Richard Unterman, Principal, Unterman McPhail Associates*
Regrets:	Kim Hodgson Marg Drexler Pat Stortz

CALL TO ORDER at 5:00 P.M.

LAND ACKNOWLEDGEMENT

Chair Patrick Merlihan read a land acknowledgement.

DISCLOSURE OF PECUNIARY INTEREST

None.

NEW BUSINESS

** Bridget Coady, Region of Waterloo; Doug Dixon, Doug Dixon & Associates; Kevin Li, Doug Dixon & Associates; and Michelle Pinto, Region of Waterloo entered the meeting.*

West Montrose Covered Bridge Rehabilitation Project (Region of Waterloo, Doug Dixon & Associates, Unterman McPhail Associates)

Michelle Pinto, Project Manager, Region of Waterloo provided a land acknowledgement.

M. Pinto provided an overview of the proposed rehabilitation alternatives for the West Montrose Covered Bridge and noted ongoing studies, including a natural environment review, an archeological investigation, and a cultural heritage review. M. Pinto outlined the projected timeline for the rehabilitation, including consultation with the Committee, timber analysis, Regional Council approval, presentation to Township Council, and updates to the designation by-law.

Public Consultation

Doug Dixon, President and Senior Bridge Designer, Doug Dixon & Associates, provided a summary of the Virtual Public Information Centre data, including requests for the replacement of the Bailey truss with steel girders, maintaining a timbered deck, installation of a fire suppression system, the addition of roadside features to restrict oversize vehicles, removal of visible sag in the roofline and deck, installation of security cameras, and installation of fire optic ducts. M. Pinto expanded on concerns relating to load capacity, reinforcement requirements, height impacts, analysis of the existing structure, Request for Proposal (RFP), roadway elevation, camber, and conservation planning.

Proposed Alternatives

D. Dixon outlined considerations relating to long-term upkeep of the structure; risk mitigation involving oversize vehicles, vandalism, fire, flood, ice, snow, and other environmental factors; minimizing future maintenance requirements; and heritage considerations. D. Dixon noted the Region is investigating the addition of a fire suppression system as the local water main does not possess sufficient flow capacity. A more in-depth review of alternative water sources and budget considerations will be undertaken separately at a later date.

Kevin Li, Junior Bridge Designer, Doug Dixon & Associates, provided an overview of the preferred rehabilitation methods and the evaluation of structural performance, constructability, cultural heritage, aesthetics, sustainability, and life-cycle cost. K. Li identified Alternative B as the preferred option.

Heritage Impact Assessment

Richard Unterman, Principal, Unterman McPhail Associates, provided an overview of the Heritage Impact Assessment (HIA), identified Alternative A as the preferred option, and noted both alternatives will allow for the Bridge to be maintained for up to 75 years. M. Pinto noted the project goal is conservation through rehabilitation and repair rather than a historical restoration.

At the Committee's request, R. Unterman identified the differences between Alternatives A and B, expanded on the identification of Alternative A as the preferred method in the HIA, and outlined potential benefits of reinstalling the splash panels; D. Dixon summarized considerations relating to reinstalling the panels including vandalism, animal habitation, and structural deterioration.

Bridget Coady, Cultural Heritage Principal Planner, Region of Waterloo, confirmed that any designated heritage attributes removed during the rehabilitation will either be commemorated on-site or through a museum installation.

Committee Feedback

The Committee discussed concerns relating to the long-term structural integrity of steel substructures, temporary speed reduction on detour routes to accommodate horse and buggy traffic, and the inclusion of heritage signage on both sides of the Bridge.

M. Pinto noted the Committee's comments and feedback are required as part of the public consultation process. The preferred alternative is anticipated to go before to Regional Council in December.

The Committee thanked the delegates for their presentation.

** Bridget Coady, Doug Dixon, Kevin Li, Michelle Pinto, and Richard Unterman left the meeting.*

Action: The Committee requested David Gundrum, Planner, circulate the HIA to the Committee.

Action: The Committee requested D. Gundrum include the provision of formal feedback on the September Committee meeting agenda.

Action: The Committee will provide formal feedback to the project team following the September Committee meeting.

Action: The Committee requested D. Gundrum liaise with M. Pinto regarding new information on the project in advance of the September meeting.

Document Number: 83103

OTHER BUSINESS

Heritage Registry

The Committee discussed active heritage designations and agreed to prioritize St. Boniface Church. D. Gundrum noted timing considerations relating to the limited number of Council Meetings remaining before the Municipal Election.

Action: The Committee requested Chair Merlihan liaise with Roger Miller, Historian, for additional information in support of the Maryhill designations.

Action: The Committee requested D. Gundrum liaise with Planning Services staff to determine a Council Meeting date for the designation report.

Economic Development and Tourism

The Committee will revisit this item at a future meeting.

St. Boniface School Plaque

There were no updates.

Action: The Committee requested D. Gundrum provide Chair Merlihan and H. Pottkamper with the vendor's contact information.

Action: The Committee requested H. Pottkamper contact the vendor to coordinate installation.

58 Glasgow Street North (Ebel House) Demolition

D. Gundrum noted a building permit application has not been submitted.

ADJOURNMENT

Moved by Co-Chair Bonnie Bryant

Seconded by Colleen Willard-Holt

That the meeting be adjourned to meet again on September 14, 2022.

…Carried.

Regional Municipality of Waterloo

Heritage Planning Advisory Committee

Minutes

June 9, 2022

5:00 PM

ONLINE – via ZOOM

Present were: Councilor E. Clarke (Chair), B. Benninger (Vice-Chair), B. Bryant, S. David, A. Carswell, W. Stauch, L. Cunningham Martz, E. Thorsen, K. Cressman C. Pratt, P. Arens,

Members absent: E. Heinrichs

Staff in attendance: B. Coady,

1. Approval of the Agenda and Declaration of Pecuniary Interest under the Municipal Conflict Of Interest Act

Moved by B. Benninger

Seconded by C. Pratt

THAT the agenda for the Heritage Planning Advisory Committee Meeting June 9, 2022 be approved.

Carried.

2. Delegations

a. West Montrose Covered Bridge Rehabilitation – Michelle Pinto, Engineer, Design and Construction, Doug Dixon, Doug Dixon and Associates and Richard Unterman, Unterman Mcphail Associates

HPAC received a presentation on the West Montrose Covered Bridge rehabilitation project. The slide deck from the presentation can also be found on the Engage webpage for the project at https://www.engagewr.ca/west-montrose. Two rehabilitation alternatives were presented and explained in relation to heritage considerations. HPAC was reminded that this project is not an historical restoration, but a rehabilitation to conserve the bridge in its current use and in its current location for decades to come. HPAC was able to ask questions of the consulting engineer, heritage consultant and staff.

C. Pratt indicated that the height restriction bar is an important consideration/impact to the bridge and requested to see examples of height restriction bars used at other historic bridges across the country/North America. B. Benninger questioned whether the proposed height increase of the preferred alternative would increase wind resistance. D. Dixon indicated that it would, but that the bridge design would account for increased wind load. A. Carswell questioned which alternative would be more historically sympathetic. R. Unterman answered that the bridge is an evolved structure, that has had major and ongoing interventions to keep it functional over its 140 years. Both alternatives will have impacts to the historic integrity and the Heritage Impact Assessment will provide recommendations that will mitigate impacts and balance the need to conserve the heritage resource while maintaining a safe bridge crossing in its historic context. W. Stauch questioned if the piers will be restored. D. Dixon explained that there will be no structural change to the piers, the load on the piers will be maintained and some repointing will take place, but that consideration is being given to placing some natural stones upstream in the river to reduce water and ice scour on the masonry piers. B. Bryant asked if the Region will be retaining the wood expert that helped to develop the all-wood rehabilitation alternative. M. Pinto assured HPAC that a wood expert and specialty wood engineering team will be retained in accordance with the Region's purchasing by-law. Other questions included if the height restriction bar will be alarmed (unsure at this point), if a conservation plan, implementing the recommendations of the HIA will be provided (it will, once the alternative is chosen by Regional Council), and if the concrete abutments will be repaired (they will be repaired and refaced in an appropriate fashion).

3. Approval of the Minutes

Moved by W. Stauch

Seconded by B. Bryant

THAT the Minutes of the Heritage Planning Advisory Committee Meeting of April 14, 2022 be approved.

Carried.

4. Business Arising

None.

5. Initiatives

a. West Montrose Covered Bridge Rehabilitation Public Information Centre

HPAC discussed providing comments as part of the Public Information Centre #2 for the West Montrose Covered Bridge and decided to hold comments until after the opportunity to review the Heritage Impact Assessment of the two rehabilitation alternatives. Regional staff will forward the Heritage Impact Assessment to HPAC during the summer hiatus, when it becomes available, and HPAC can review and provide comments at the meeting in September. Regional staff encouraged the committee to provide comments as individuals on the Engage Waterloo Region webpage for the project.

b. Process for ROP Review and HPAC Comments During the Summer Hiatus

Regional staff questioned if HPAC would like to provide formal comments on the draft Regional Official Plan Chapters 1, 2 and part of Chapter 3. Due to the summer hiatus, HPAC will need a subcommittee to review the draft when it is available and formulate comments. W. Stauch and P. Arens volunteered for this subcommittee and Regional staff will follow up with the subcommittee and HPAC to coordinate comments and member consensus regarding providing the comments to the Region, in advance of the next HPAC meeting in September.

6. Other Business

a. Member Preference for Meeting In-person in September

HPAC indicated that they would like to meet again in person, but enjoyed the flexibility of meeting virtually, particularly for health reasons or if work/family commitments made accommodating travel time to the meeting difficult. Regional staff will look into

rescheduling hybrid meetings in the fall.

b. Applications for HPAC Membership 2023-2026

Regional staff reminded HPAC that all members' terms were coming to an end in December. According to Council policy, some current HPAC members will be eligible to reapply, others may have to wait a year to re-apply if so desired. Staff will email each HPAC member individually to let them know how many years they have consecutively served and if they are eligible to reapply. Further, Councillor Clark informed HPAC that she would not be running for re-election, so a new HPAC chair will need to be elected after the Municipal Election.

7. News and Events Roundtable

W. Stauch brought to HPAC's attention that the Highbank or Riverbank School, that recently withstood a devastating fire, has been demolished. He also stated that he believed the Freeport Bridge, that was refaced/re-rendered about 10 years ago, looks very poorly. Staff indicated that they were aware and that the render was faulty and was corrected prior to the refacing of the Bridgeport Bridge. Staff are unaware of plans to fix the render on the Freeport Bridge, at this point it is only an aesthetic concern and not a structural concern.

8. Adjourn

Moved by: A. Carswell

That the meeting adjourn.

Carried

Committee Chair, Councilor E. Clarke

Committee Clerk, B. Coady, Cultural Heritage Principal Planner

Michelle Pinto

From: Sherwin Meloney <smeloney@woolwich.ca>
Sent: February 12, 2024 11:00 AM
To: Michelle Pinto
Cc: Jeremy Vink; Darryl Schwartzentruber
Subject: West Montrose Bridge - Heritage Designation By-Law 60-2007 Amendment
Attachments: Substantial Amendment Flow Charts.pdf

****EXTERNAL ALERT** This email originated from outside the Region of Waterloo.**

Proposed Changes to West Montrose Heritage Attributes

Underlined text to be deleted. **Bold text is new**
Attributes that contribute to the cultural heritage value of the bridge and which should be retained include:
the original location of the bridge in the Village of West Montrose spanning the Grand River;
the original dimensions of the bridge, 208 feet in length and 17 feet wide;
the original truss configuration, a hybrid Queen Post – Howe timber configuration**;** reinforced by a recycled 1944 Bailey steel truss structure;
the **stone masonry** central pier;
the **wood exterior vertical siding** sheathing and **the interior vertical sectional** panelling **located on the north and south ends of the bridge;**
louvered wood window openings;
the **wood** shingled gable roof;
the system of illumination by decorative electric interior lamps;
views to and into the bridge from the north and south banks of the Grand River.

Hi Michelle,

After speaking with Jeremy, staff's recommendation to the Heritage Committee and to Council is on hold pending the results of the Heritage Impact Assessment. Please note the proposed changes above appear to meet the requirements of a substantial amendment under the Heritage Act, substantial amendments may include circumstances where:

- Changes to statement of cultural heritage value or interest or the description of heritage attributes go beyond clarification or correction.
- A new lot is created out of a designated property following a severance process.
- Amendments are required to facilitate a development application.

This process includes that:

- A notice of the proposed amendment is sent to the owner of the property and to the Ontario Heritage Trust and published in a newspaper. The notice of proposed amendment must include the following:
  - The adequate description of property so that it can be readily ascertained.
  - An explanation of the purpose and effect of the proposed amendment.
  - A statement explaining the amendments, if any, to the cultural heritage value or interest of the property and/or to the description of the heritage attributes of the property.
  - The statement of cultural heritage value or interest and the description of heritage attributes, as amended.

- A statement that notice of objection to the notice of intention to amend the bylaw must by filed with the municipality within 30 days after the date of publication of the newspaper notice.

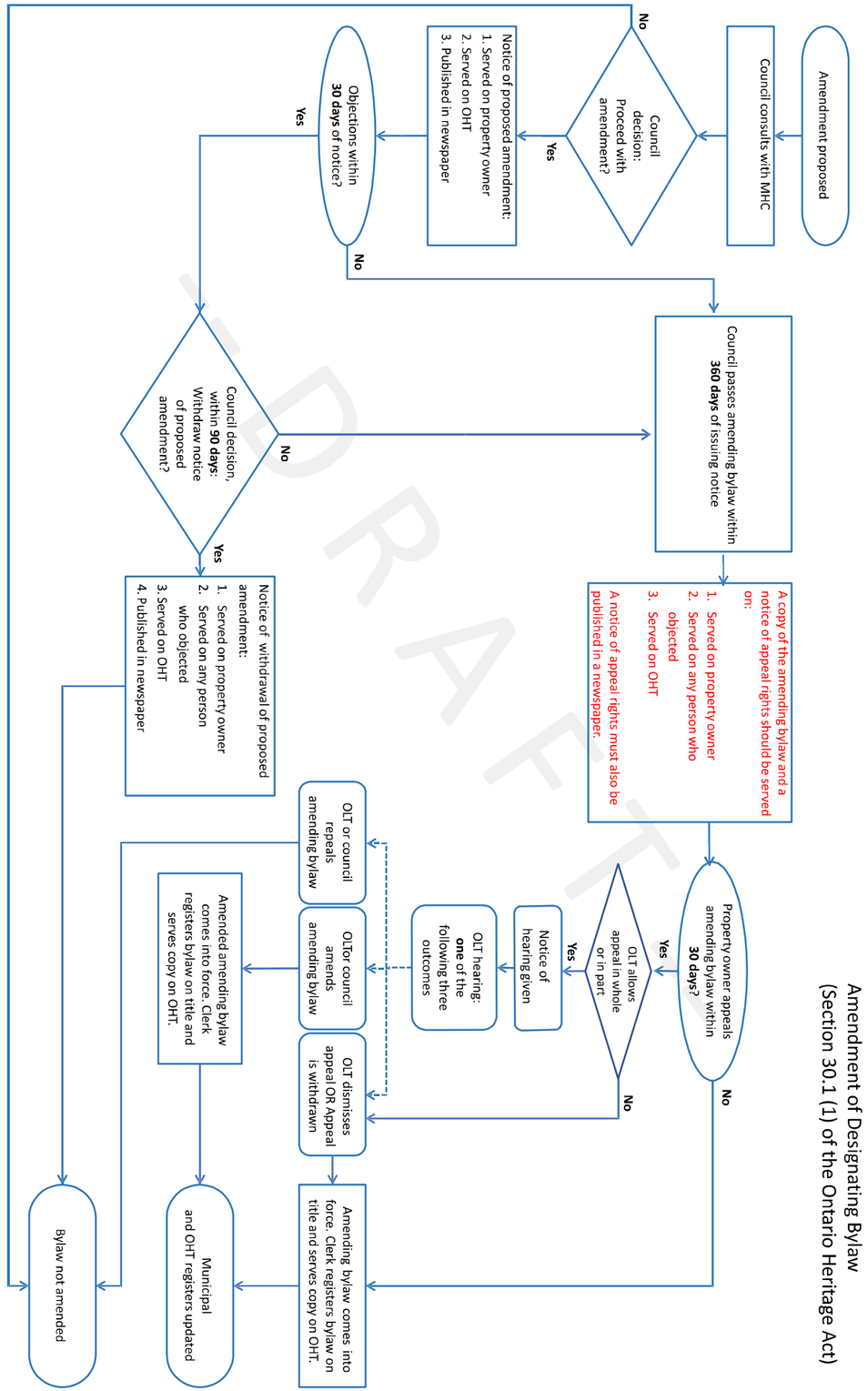
- The public notice must also include a statement that further information respecting the proposed amendment is available from the municipality.
- If anyone objects to the proposed amendment, council must consider the objection in a process similar to the objection process for designation. As with designations, council must consider the objection before deciding to go ahead with the amendment or to withdraw its proposed amendment. If there is no objection, or council decides not to withdraw the notice of proposed amendment, council may then pass an amending bylaw within 365 days (or any time if mutually agreed on between council and owner) of the date of publication of the newspaper notice. The municipality provides notice of the bylaw to the owner and the Ontario Heritage Trust and anyone who objected to the proposed amendment.

A flowchart outlining this process is attached, please consider timelines for an amendment.

Please provide the final Cultural Heritage Impact Assessment to allow for the Heritage Committee and staff to review and proceed to next steps.

Kind regards,

Sherwin Meloney
Planner – Department of Development Services
Town of Woolwich
24 Church Street West, P.O. Box 158
Elmira, ON N3B 2Z6
Phone: (519) 669-1647 Ext. 6033
Direct Line: (519) 514-6033
Toll Free: 1 877 969-0094 Ext. 6033
Email: smeloney@woolwich.ca
Web: www.woolwich.ca



Appendix N

Agency Correspondence

TRANSPORTATION AND
ENVIRONMENTAL SERVICES
Design and Construction
150 Frederick Street
Kitchener Ontario N2G 4J3 Canada
Telephone: 519-575-4400
TTY: 519-575-4608
Fax: 519-575-4430
www.regionofwaterloo.ca

Refer To:
John Stephenson, 519-575-4096

File No:
7626

Date:
March 26, 2021

RESIDENTS, BUSINESSES, AGENCIES, STAKEHOLDERS

RE: West Montrose Covered Bridge Rehabilitation

Dear Sir / Madam:

The Regional Municipality of Waterloo has initiated a project to develop detailed engineering plans for rehabilitation of the West Montrose Covered Bridge in the Township of Woolwich.

The project is being carried out in accordance with the provincial guidelines for a Schedule "A+" Municipal Class Environmental Assessment.

The Region has retained Doug Dixon and Associates (DDA) to undertake the engineering assignment.

Background information regarding the project may be obtained through the Region's "engage" on-line tool at engagewr.ca/regionofwaterloo. Further information on the proposed improvements will be added as the design progresses. If you'd like to be informed of future updates, please enter your email information in the "Subscribe" section of the "engage" page.

Following completion of the detailed engineering design, and subsequent to Council approval, the rehabilitation work is currently planned to commence in Spring 2022.

Please feel free to contact me should you have any questions, comments or concerns.

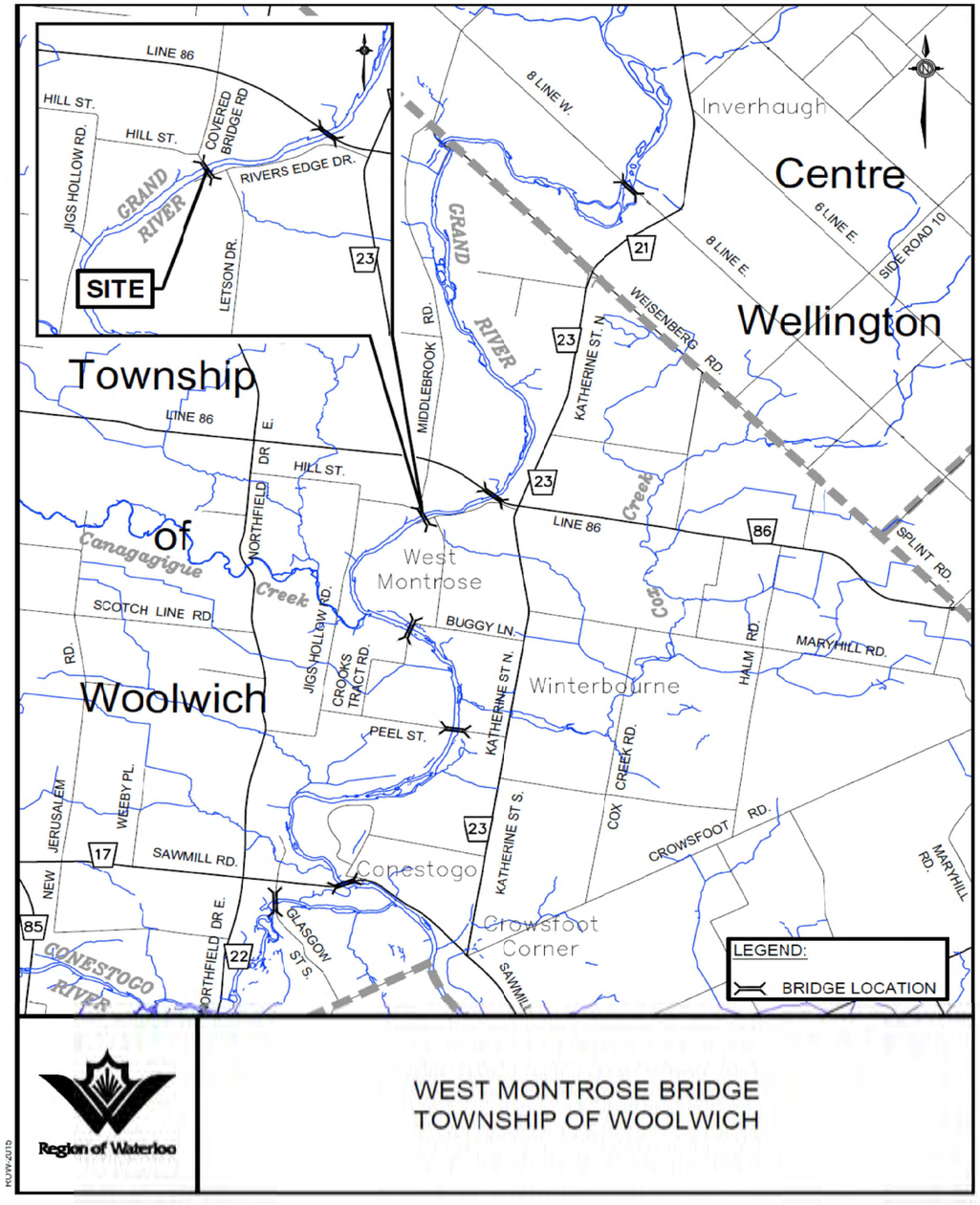
Sincerely,

John Stephenson
Senior Engineer
519-575-4096
jstephenson@regionofwaterloo.ca

Encl. Key Plan

cc. Frank Kosa, Head, Engineering
Doug Dixon, DDA

Key Plan



Region of Waterloo

ENGINEERING AND
ENVIRONMENTAL SERVICES
Design and Construction
150 Frederick Street
Kitchener Ontario N2G 4J3 Canada
Telephone: 519-575-4400
TTY: 519-575-4608
Fax: 519-575-4430
regionofwaterloo.ca

Refer to:
Michelle Pinto, P.Eng., M.B.A.

File No:
07626

Date:
January 8, 2024

To: Ministry of the Environment, Conservation and Parks, Environmental Assessment Branch

Re: West Montrose Covered Bridge Rehabilitation, Township of Woolwich
Elevation to Schedule 'C' EA

In June 2022, the Region of Waterloo held Public Consultation #2 for the West Montrose Covered Bridge rehabilitation and a preferred alternative was presented to the public at this time. After a detailed inspection and evaluation of the timber truss, we have revised the preferred alternative. Before presenting the preferred alternative to Regional Council in early 2024, we have undertaken a third round of public consultation.

The revised preferred alternative includes removal of the existing steel Bailey truss, replacement of deteriorated truss members and bridge elements, recommended from the inspection, and reinforcing select members to accommodate a 10-tonne design vehicular live load. This is preferred instead of the previous option shared, which considered reinforcing the bridge with fiber-reinforced polymers. The three-tonne load limit will be maintained and a height restriction bar is proposed to prevent damage to the bridge from oversized vehicles.

A comprehensive evaluation was undertaken using the Multi Attribute Trade-off System (MATS) methodology in which four criteria: Heritage, Structural, Social Environment and Cost were compared against six alternatives. The following weightings were assigned to the four factors: Heritage 46%, Structural 25%, Cost 17% and Social Environment 12%. Based on the MATS evaluation and confirmed by sensitivity testing, Alternative C2, described above, is the recommended preferred alternative. Alternative C2 strikes a balanced solution to minimize changes to the cultural heritage attributes of the bridge while also ensuring longevity of the structural capacity to extend the service life of the bridge another 50 years.

The project team has also reassessed the project classification under the Municipal Class Environmental Assessment (MCEA) Amended 2023 Schedule of Municipal Road projects. The combination of the bridge's major historical significance and the estimated cost of over $2.4 million has resulted in a change to Schedule C under the MCEA Amended 2023. An Environmental Study Report documenting the EA process will be prepared following Regional Council approval of the Preferred Design Concept in February 2024, followed by a 30 day public review and comment period.

The third round of public consultation provided an update on the work undertaken since the second public consultation and presented the revised preferred alternative. The following additional information has been presented for review and comment:

- Additional Alternative C options, their analysis and evaluation;
- Revised recommendations for the Preferred Alternative;
- Project schedule and next steps.

For more information, please visit the project webpage at engagewr.ca/west-montrose. Please provide your agency's comments directly to Michelle Pinto and Steve Taylor at the contact information below .

Michelle Pinto, P.Eng., M.B.A.
Region Project Manager
Region of Waterloo
Telephone: 226-751-4044
mipinto@regionofwaterloo.ca

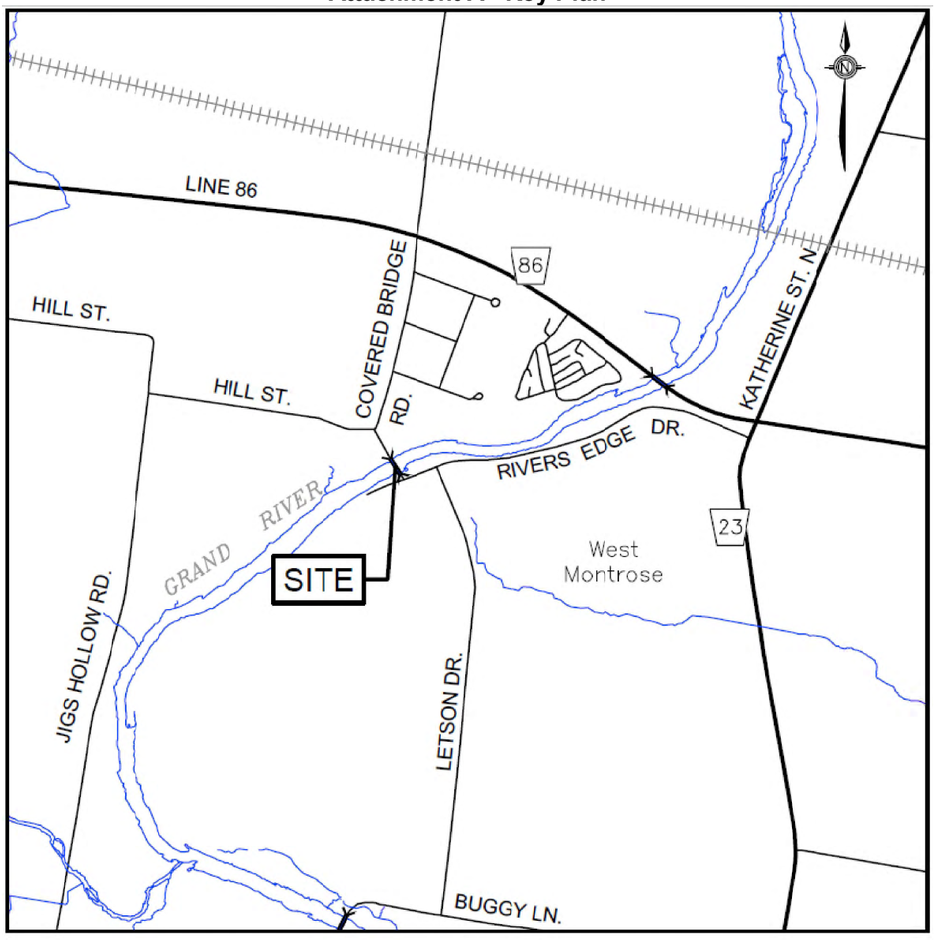
Steve Taylor, P.Eng., M.Eng., CVS-LIFE, P.E.
Consultant Project Manager
BT Engineering
Telephone: 519-672-2222
stevenj.taylor@bteng.ca

Best Regards,
Michelle Pinto
Michelle Pinto, Region of Waterloo Project Manager

We collect all comments and information regarding this project to assist the Region of Waterloo in making a decision. Under the Municipal Act, personal information, such as name, address, telephone number, and property location will become part of the public record in compliance with the Municipal Freedom of Information and Protection of Privacy Act, R.S.O. 1990.

Document Number: 4523383 Version: 2A

Attachment A - Key Plan



Fisheries and Oceans Canada
Pêches et Océans Canada

Ontario and Prairie Region
Fish and Fish Habitat Protection Program
867 Lakeshore Rd.
Burlington, ON
L7S 1A1

Région de l'Ontario et des Prairies
Programme de protection du poisson et de son habitat
867 chemin Lakeshore
Burlington, ON
L7S 1A1

November 2, 2021

Our file *Notre référence*
21-HCAA-02147

Lindsay Jackson
EcoTec Environmental Consultants Inc.

Subject: [Bridge Repair, Grand River, West Montrose] (21-HCAA-02147) – Implementation of Measures to Avoid and Mitigate the Potential for Prohibited Effects to Fish and Fish Habitat

Dear Lindsay Jackson:

The Fish and Fish Habitat Protection Program (the Program) of Fisheries and Oceans Canada (DFO) received your proposal on September 2021. We understand that you propose to:

- Place river stone around the center pier and north abutment of the West Montrose Covered Bridge resulting in a footprint of approx. 16m^2; and
- Isolate the work area by dragging a turbidity curtain out from the pier to exclude fish and scare away fish prior to conducting a fish rescue; and
- Work in isolation of flow to avoid sedimentation of the watercourse.

We understand the following aquatic species listed under the *Species at Risk Act* may use the area in the vicinity of where your proposal is to be located:

- Silver Shiner listed as Threatened
- Black Redhorse listed as Threatened
- Rainbow Mussel listed as Special Concern
- Wavy Rayed Lampmussel listed as Special Concern

Our review considered the following information:

- Request for Review form and associated documents.

Your proposal has been reviewed to determine whether it is likely to result in:

- the death of fish by means other than fishing and the harmful alteration, disruption or destruction of fish habitat which are prohibited under subsections 34.4(1) and 35(1) of the *Fisheries Act*;
- effects to listed aquatic species at risk, any part of their critical habitat or the residences of their individuals in a manner which is prohibited under sections 32, 33 and subsection 58(1) of the *Species at Risk Act*; and

.../2

Canada

The aforementioned impacts are prohibited unless authorized under their respective legislation and regulations.

To avoid and mitigate the potential for prohibited effects to fish and fish habitat (as listed above), we recommend implementing the measures listed below:

- Plan in-water works, undertakings and activities to respect timing windows to protect fish, including their eggs, juveniles, spawning adults
    - No in-water work [Mach 15 – July 15]
- Capture, relocate and monitor for fish trapped within isolated, enclosed, or dewatered areas;
    - If a Silver Shiner or Black Redhorse are captured and/or any other SAR shall be recorded and digitally vouchered and the species released unharmed to the watercourse. Photo vouchers shall be taken while SAR are fully submersed in a net or viewing box. Digital vouchers shall be retained and submitted to FisheriesProtection@dfo-mpo.gc.ca by email.
    - Dewater gradually to reduce the potential for stranding fish
- Conduct in-water undertakings and activities during periods of low water levels
- Screen intake pipes to prevent entrainment or impingement of fish;
    - Use the code of practice for water intake screens
- Use barges or shrouding to trap and prevent debris, concrete and/or other bridge materials from entering the watercourse;
- Limit the removal of material to that which is necessary to protect piers and abutments;
- Remove debris by hand or with machinery operating from shore or a floating barge;
- If replacement rock reinforcement/armouring is required to stabilize eroding areas around bridge structures (e.g., abutments and/or wing walls), the following measures should be incorporated:
    - Place appropriately-sized, clean rocks into the eroding area;
    - Do not obtain rocks from below the ordinary high water mark of any water body;
    - Ensure rock does not interfere with fish passage or constrict the channel width
- Limit impacts on riparian vegetation to those approved for the work, undertaking or activity;
    - Limit access to banks or areas adjacent to waterbodies
    - Construct access points and approaches perpendicular to the watercourse or waterbody
    - Re-vegetate the disturbed area with native species suitable for the site
- Restore stream geomorphology (i.e., restore the bed and banks, gradient and contour of the waterbody) to its initial state;
- Avoid introducing sediments (e.g., silts, clays and sand) in the water

.../3

- Develop and implement an erosion and sediment control plan to avoid or minimize the introduction of sediment into any waterbody during all phases of the work, undertaking or activity; and
    - Conduct all in-water works, undertakings or activities in isolation of open or flowing water to reduce the introduction of sediment into the watercourse
    - Monitor the watercourse to observe signs of sedimentation during all phases of the work, undertaking or activity and take corrective action
- Develop and implement a response plan to avoid a spill of deleterious substances.

Provided that you incorporate these measures into your plans, the Program is of the view that your proposal will not require an authorization under the *Fisheries Act*, or the *Species at Risk Act*.

Should your plans change or if you have omitted some information in your proposal, further review by the Program may be required. Consult our website (http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html) or consult with a qualified environmental consultant to determine if further review may be necessary. It remains your responsibility to remain in compliance with the *Fisheries Act*, or the *Species at Risk Act*.

It is also your *Duty to Notify* DFO if you have caused, or are about to cause, the death of fish by means other than fishing and/or the harmful alteration, disruption or destruction of fish habitat. Such notifications should be directed to (http://www.dfo-mpo.gc.ca/pnw-ppe/CONTACT-eng.html).

We recommend that you notify this office at least 10 days before starting your project and that a copy of this letter be kept on site while the work is in progress. It remains your responsibility to meet all other federal, territorial, provincial and municipal requirements that apply to your proposal.

If you have any questions with the content of this letter, please contact Lucas Coletti at our Burlington office at 905-317-1541 or by email at Lucas.Coletti@dfo-mpo.gc.ca. Please refer to the file number referenced above when corresponding with the Program.

Yours sincerely,

Lucas Coletti
Biologist, Triage and Planning

Administration Centre: 400 Clyde Road, P.O. Box 729 Cambridge, ON N1R 5W6
Phone: 519-621-2761 Toll free: 1-866-900-4722 Fax: 519-621-4844 www.grandriver.ca

June 29, 2022

Michelle Pinto
Project Manager
Region of Waterloo
150 Frederick Street
Kitchener ON N2G 4J3
mipinto@regionofwaterloo.ca

Re: West Montrose Covered Bridge Class Environmental Assessment
Covered Bridge Drive at the Grand River, West Montrose

Dear Ms. Pinto,

Grand River Conservation Authority (GRCA) staff are in receipt of the Public Consultation Centre 2 materials for the above-noted Class Environmental Assessment (Class EA).

The study area includes the Grand River and its associated floodplain and wetlands. We've been particularly interested in the Class EA as elevated flood flows make use of overbank areas on either side of the bridge under current conditions, and any profile modifications to the bridge or its road approaches could affect flooding.

We understand that the preferred alternative increases the height of the bridge by 30 centimetres, but it does not change the elevations of the bridge bottom or driving surface. As such, we don't anticipate significant impacts to the floodplain, and we have no concerns at this time. We offer the following comments as the Class EA moves towards completion and detailed design:

1. Repairs to the abutments and piers will require isolation works. During detailed design, please prepare a temporary works plan (either detailed, or a conceptual plan with detailed plans to be completed by a contractor) that show all isolation and de-watering. We generally request cofferdams are built to the 2-year flood elevation.

Member of Conservation Ontario, representing Ontario's 36 Conservation Authorities | The Grand – A Canadian Heritage River

2. We have attached river flow information as well as flood warning information to help inform detailed design and construction plans. A temporary works plan should consider equipment staging and material stockpiling locations that minimize flood risks. Equipment staging and material stockpiling must also be outside of any wetlands.

3. In addition to being a flood damage centre, the project area is downstream of our Shand Dam. As such, we will request the following in support of a GRCA permit:
   a. A contingency plan to ensure personnel and equipment are evacuated in the event of high flows.
   b. Primary contacts for the on-site contractor, consultant and the Region, so the GRCA can notify of high flow releases from the dam and/or forecasted flooding.

4. A GRCA permit will be required prior to construction. This will be considered a standard watercourse interference permit (2022 fee is $1,140).

We trust this information is of assistance. If you have any questions or require additional information, please contact me at 519-621-2763 ext. 2292 or theywood@grandriver.ca.

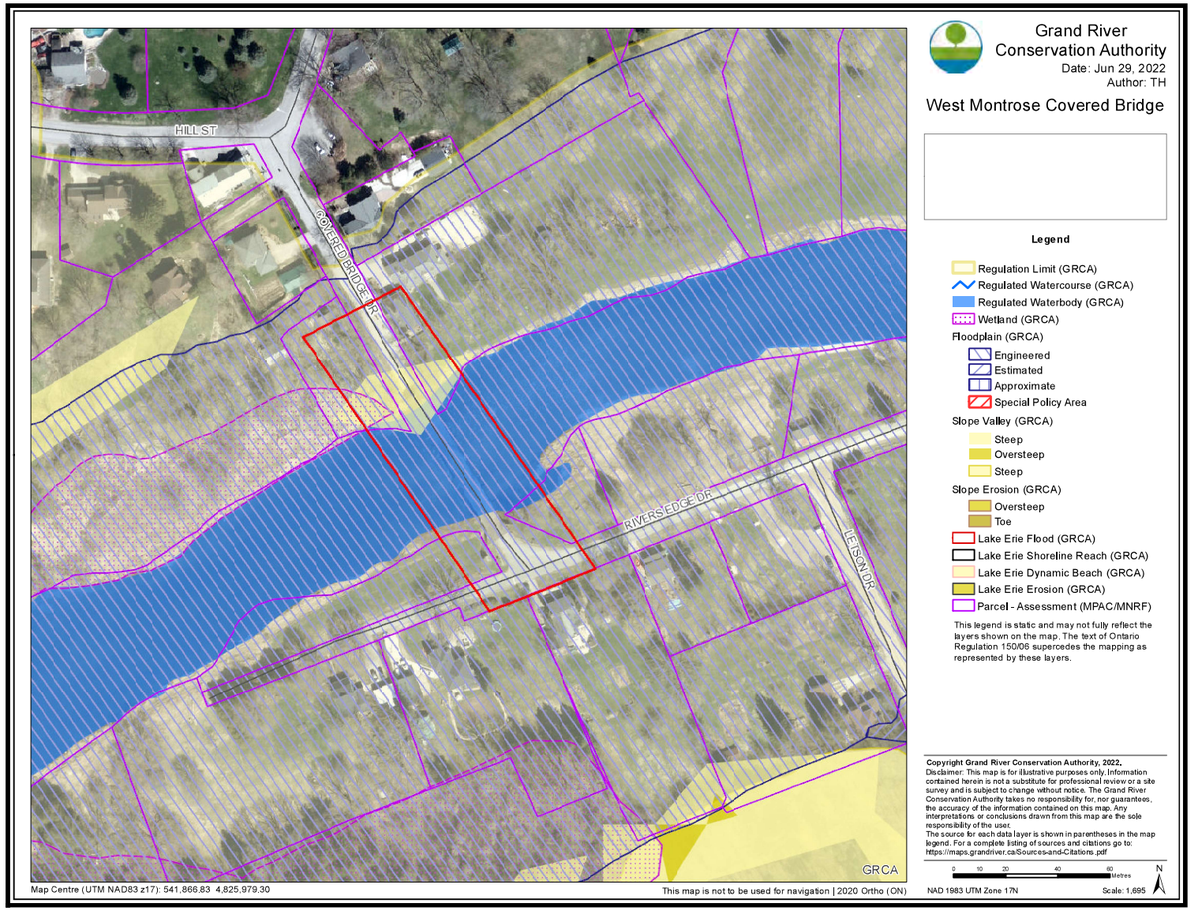
Sincerely,

Trevor Heywood
Resource Planner
Grand River Conservation Authority

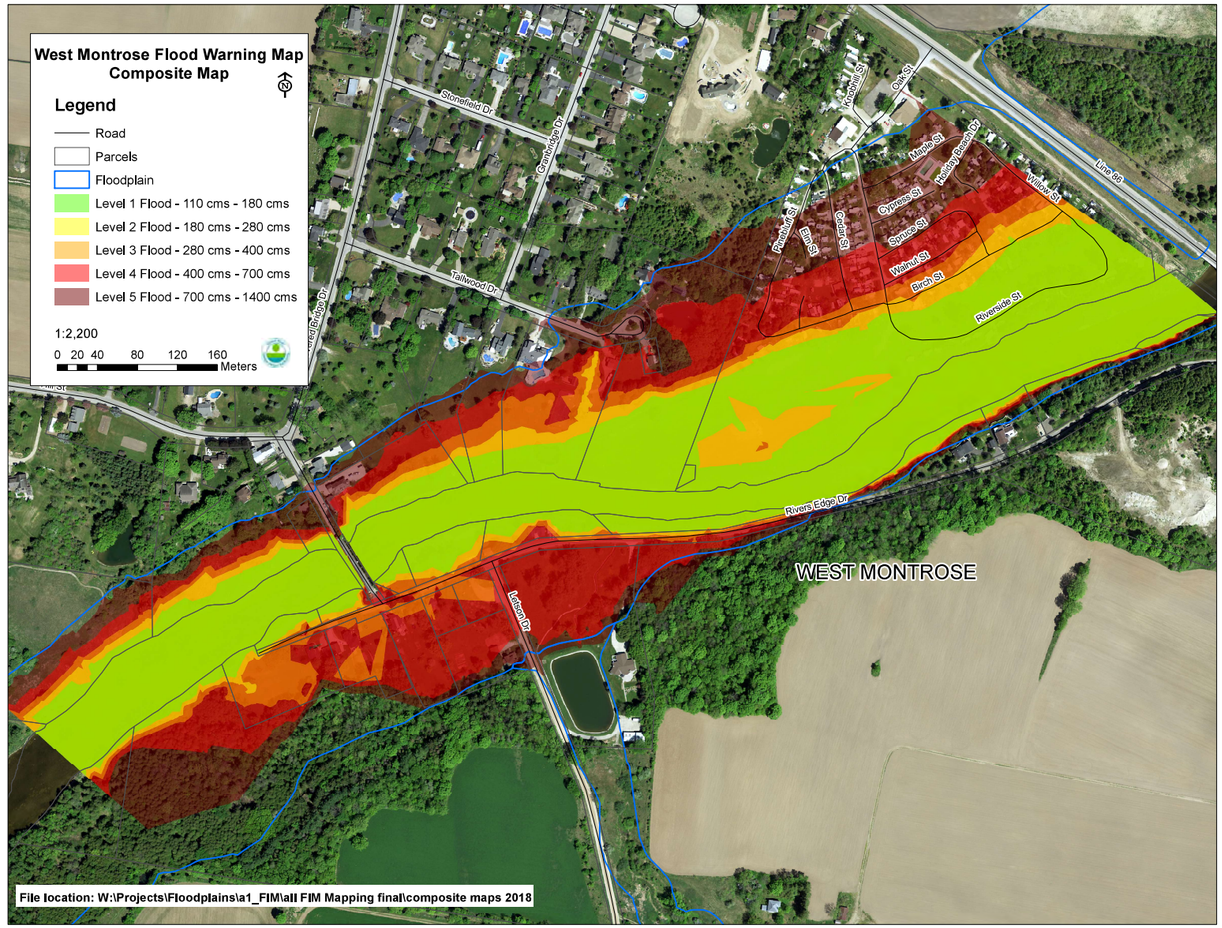
Encl. Resource Mapping
Flood Warning and Flow Information

cc: Jane Gurney, Region of Waterloo
Jared Puppe, Township of Woolwich
Doug Dixon, Dixon and Associates

Attachment 1
Resource Mapping



Attachment 2
Flood Warning and Flow Information



Storm Event	Flow (m^3/s)	Elevation (m, CGVD 28)	
		Upstream	Downstream
2-yr	331	322.41	322.26
5-yr	464	322.89	322.68
10-yr	603	323.32	323.06
25-yr	718.6	323.62	323.34
50-yr	827	323.88	323.57
100-yr	910	323.99	323.72
Regional	1356	324.83	324.44

Grand River Conservation Authority

Administration Centre: 400 Clyde Road, P.O. Box 729 Cambridge, ON N1R 5W6

Phone: 519-621-2761 Toll free: 1-866-900-4722 Fax: 519-621-4844 www.grandriver.ca

June 4, 2024

Michelle Pinto
Project Manager
Region of Waterloo
150 Frederick Street
Kitchener ON N2G 4J3
mipinto@regionofwaterloo.ca

Re: West Montrose Covered Bridge Class Environmental Assessment
Covered Bridge Drive at the Grand River, West Montrose

Dear Ms. Pinto,

Grand River Conservation Authority (GRCA) staff are in receipt of the draft Environmental Study Report (ESR) for the above-noted Class Environmental Assessment (Class EA).

In addition to our June 29, 2022 comments, we offer the following as the final ESR is finalized, and work enters the detailed design stage:

1. Some discrepancies in the hydraulic engineering report and civil drawings should be resolved in the final ESR:
    a. Table 6 indicates that regional storm average velocity is 3.3 m/s, but section 6.2 notes it is 3.7 m/s.
    b. Section 7.2 and the drawing (scour protection) notes suggest a layer of 1000mm thick rock protection, but section 7.3 notes it is 600mm.
    c. Cofferdam drawing notes indicate that the cofferdam shall be no more than 300mm above the elevation of water level during low flow condition, but the drawing indicates it is low flow plus 600mm.

2. As part of a GRCA permit, the final rock protection modification should be reflected in a revised HEC-RAS model, and shown not to impact flood elevations.

Member of Conservation Ontario, representing Ontario's 36 Conservation Authorities | The Grand – A Canadian Heritage River

3. While recognizing the balance of not impacting floodplain elevations upstream, cofferdam height should be determined based on a flow frequency analysis and will be a Region / consultant / contractor responsibility based on their risk assessment (lower cofferdam height = greater probability for work interruption). Please note the bridge rehabilitation area is located below Shand Dam and will be subject to GRCA dam operations. The GRCA could provide ~4 hours warning time before a flow adjustment before reaching the bridge rehabilitation area.

We trust this information is of assistance. If you have any questions or require additional information, please contact me at 519-621-2763 ext. 2292 or theywood@grandriver.ca.

Sincerely,



Trevor Heywood
Resource Planner
Grand River Conservation Authority

Michelle Pinto

From: [redacted]
Sent: June 20, 2023 2:31 PM
To: Michelle Pinto
Cc: [redacted]
Subject: FW: [External/Externe]: Application of Minor Works - Questions
Attachments: Minor works class – Watercourse crossings.pdf

Follow Up Flag: Follow up
Flag Status: Completed

****EXTERNAL ALERT** This email originated from outside the Region of Waterloo.**

Hi Michelle,

Based on [redacted] phone discussion with Transport Canada, we only need to post the public notice in the vicinity of the proposed work. This could be at the mailboxes north and at the park south of the bridge. They did not give a timing on when the notice needs to be posted other than before the work commences. I would suggest we post the notices 2-3 months before the construction work begins.

We will however submit a Notification of Minor Work to Transport Canada in the next few days if you have no other comments on the wording of our notification.

Thank you,

[redacted]

From: NPP ONT / PPN ONT <NPPONT-PPNONT@tc.gc.ca>
Sent: June 20, 2023 8:29 AM
To: [redacted]
Subject: RE: [External/Externe]: Application of Minor Works - Questions

Hi [redacted],

Thanks for speaking with me today.

The Navigation Protection Program (NPP) is responsible for the administration of the Canadian Navigable Waters Act (CNWA), which prohibits the construction or placement of any “works” in a navigable waterway without complying with the requirements of the Act.

Under the CNWA, the Minor Works Order allows for works to be constructed, placed, altered, rebuilt, removed, decommissioned, repaired or maintained without approval if the work meets the criteria for the applicable class of works, as well as specific terms and conditions for construction.

I’ve attached a Minor Works Awareness document for Watercourse Crossings. If all of the criteria can be met, approval by Transport Canada is not required and the proponent can proceed with the work. It is the proponent’s responsibility

to assess the criteria, maintain the project within the criteria, and to follow the General Requirements if they are proceeding in accordance with the Minor Works Order.

In addition to depositing information on the Common Project Search (CPS), the proponent is also responsible for posting a notice in a conspicuous place within the vicinity of the proposed work using the same official language used in the CPS. There's a template available on our External Submission Site if you work through "Create a notification of a minor work". The information just needs to be posted prior to work commencing.

Let me know if you have any questions.

Robert Kerr

Officer | Agent
Navigation Protection Program | Programme de protection de la navigation
Transport Canada | Transports Canada
100 Front St. South | 100, rue Front Sud
Sarnia ON N7T 2M4
519-383-1863 NPPONT-PPNONT@tc.gc.ca
Government of Canada | Gouvernement du Canada

From: [redacted]
Sent: Thursday, June 15, 2023 3:27 PM
To: NPP ONT / PPN ONT <NPPONT-PPNONT@tc.gc.ca>
Cc: [redacted]
Subject: [External/Externe]: Application of Minor Works - Questions

Good afternoon,

My team and I are currently in the design stage for a bridge rehabilitation over a navigable waterway.
We have determined that our project meets the requirements of Minor Works and are preparing to submit a Notification of a minor work through the transport Canada website.
Before we do so, we were hoping you could answer the following questions:

1. We understand that upon submitting the Notification of minor work, our project is immediately posted to registry of the Common Project Search (CPS). We also understand that we are also responsible for publishing (posting) a notice to notify the public that the project has been posted to CPS. However, we are unclear on the timing of the publishing of the public notice. Should this be done immediately after we submit notification of minor work? Is there a minimum/maximum amount of time the posting needs to be public for? For example, if it is posted in the local news paper, is a one time publication sufficient?

2. Once we have submitted the notification of minor work and published the public notice, will we be notified by Transport Canada that we are ok to proceed to construction?

We look forward to your response.
Please feel free to contact me if it is simpler to discuss over the phone.

[redacted]

Michelle Pinto

From: Michelle Pinto
Sent: January 15, 2024 3:54 PM
To: 'eanotification.wcregion@ontario.ca'
Cc: 'Gilbert, Shannon (MECP)'; Del Villar Cuicas, Joan (MECP)
Subject: Region of Waterloo, MEA Class EA (Municipal road projects), West Montrose Covered Bridge Rehabilitation
Attachments: West Montrose Covered Bridge Rehab - Notice of EA Elevation - MECP.pdf; WMCB - Notice of Commencement (Schedule A).pdf; Project_Information_Form_West Montrose Covered Bridge.xlsx

Good Afternoon,

Attached is the completed Project Information Form, Notice of Commencement (initially a Schedule A+ project), and the Transition Notice to a Schedule 'C' EA for the West Montrose Covered Bridge Rehabilitation in the Region of Waterloo.

Please let me know if you have any questions.

Thanks,
Michelle

Michelle Pinto, P.Eng., MBA
Engineer, Transportation Rehabilitation (Design & Construction)
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Ministry of the Environment, Conservation and Parks

Environmental Assessment Branch

1st Floor
135 St. Clair Avenue W
Toronto ON M4V 1P5
Tel.: 416 314-8001
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Ministère de l'Environnement, de la Protection de la nature et des Parcs

Direction des évaluations environnementales

Rez-de-chaussée
135, avenue St. Clair Ouest
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Tél. : 416 314-8001
Téléc. : 416 314-8452

Via E-mail Only

June 26, 2024

Michelle Pinto
Region Project Manager
Regional Municipality of Waterloo
mipinto@regionofwaterloo.ca

Re: West Montrose Covered Bridge Rehabilitation in the Township of Woolwich
Regional Municipality of Waterloo
Municipal Class Environmental Assessment, Schedule C
Project Review Unit Comments – Draft Environmental Study Report

Dear Michelle Pinto,

Thank you for providing the ministry with an opportunity to comment on the draft Project File Report for the above noted Class Environmental Assessment (EA) project. Our understanding is that in order to improve, update, and bring into compliance with current Regional municipality of Waterloo and provincial standards the West Montrose Covered Bridge, the Regional Municipality of Waterloo has determined that the preferred alternative is to rehabilitate the bridge using wood repairs (10 tonnes). The Ministry of the Environment, Conservation and Parks (ministry) provides the following comments for your consideration.

Introduction and Background

1. As described in section A.4.2.1 of the Municipal Class EA parent document, Chapter 1 of the Municipal Class EA parent document, project team should be identified in the ESR, giving names and affiliations of the principal parties involved. The type and extent of involvement of the proponent, and details of the consultants, sub-consultants, planners, special advisors and others involved in the planning process should be given.

Evaluation of Alternatives

2. The Municipal Class EA parent document Section A.2.3 Phase 2: Alternative Solutions requires that the proponent explain all the alternative solutions in detail. Please expand section 6.1 Alternative Planning Solutions to include the following:
   - magnitude of the net positive and negative effects of each alternative solution
   - identify mitigating measures
   - Evaluation of all reasonable alternative solutions, taking into consideration the environmental and other factors identified

Mitigation Measures

3. Section A.2.5 Phase 4: Environmental study report Step 1 Completion of the Environmental Study Report requires that "the mitigating measures which will be undertaken to minimize environmental effects" be included in the ESR. Table 3 identifies several mitigation measures but there are several additional mitigation measures identified in the Appendices. Appendix E – Natural Environment Report, Section 5.0 Potential Impacts and Mitigation lists many mitigation measures and so does Appendix F – Cultural Heritage Impact Assessment, Section 13.0 Mitigation Recommendations. The Ministry recommends that Table 3 be updated to include all the mitigation measures.

Project Description

4. The Ministry recommends that a discrete section be added to the ESR that discusses the construction process. Section A.4.2.1, Chapter 5 of the Municipal Class EA parent document requires that the construction process of the project be fully described. This should include a detailed project schedule, the anticipated hours of work, duration of the construction, the urgency of the works (if any), timing constraints for construction details of methods for disposal of waste materials, and the control of nuisances during construction e.g., dust, noise. Please add a section or expand the ESR to include all the requirements outlined in Chapter 5 of the MECA.

Monitoring

5. The ministry recommends that a discrete section be added to the ESR that discusses development and implementation of a monitoring program, as described in section A.4.2.1, Chapter 6 of the Municipal Class EA parent document. Where possible, the program should monitor and review the environmental impacts predicted and the commitments made to mitigation throughout the planning and design process and describe how unexpected environmental effects identified during the monitoring program will be addressed. Please add a section or expand the ESR to include all the requirements outlined in Chapter 6 of the MECA.

Land-Use Planning Objectives

6. A discussion of the provincial planning and policy context, particularly of the Provincial Policy Statement (PPS), 2020, is missing from the ESR. As noted in Section B.1.1 of the Municipal Class EA document, the PPS is a key consideration for identifying land-use

planning objectives and evaluating alternative solutions in Phases 2 and 3 of the Class EA process for municipal road projects.

Groundwater

7. Table 3 of Section 9.0 Effects and Mitigation of the ESR says that dewatering may be necessary, please note that any water extraction over 50,000 L/day will require MECP approval(s) under the Environmental Protection Act and Ontario Water Resource Act, such as a Permit to Take Water (PTTW). Certain water taking activities that have been prescribed by the Water Taking Regulation O. Reg. 63/16 may require registration in the Environmental Activity and Sector Registry instead of a PTTW. Regardless, a PTTW is required if the water-taking exceeds 400,000 litres per day. More information regarding PTTW is accessible online at this link: www.ontario.ca/page/water-taking-and-transfer-user-guide-clarifications-and-exemptions.

Thank you for circulating this draft Report for the ministry's consideration. Please document the provision of the draft Report to the ministry as well as this Project Review Unit Comments letter in the final report, and please provide an accompanying response letter to support our review of the final report. A copy of the final Notice should be sent to the ministry's West-Central Region EA notification email account (eanotification.wcregion@ontario.ca).

Should you or any members of your project team have any questions regarding the material above, please contact me at Joan.DelVillarCuicas@ontario.ca.

Sincerely,



Joan Del Villar Cuicas
Regional Environmental Planner – West Central Region
Project Review Unit, Environmental Assessment Branch

Cc: Aaron Todd, Manager, Guelph District Office, MECP