

Replacement of the City of Saskatoon's Historic Traffic Bridge

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ABSTRACT

Originally built in 1907, the Traffic Bridge was Saskatoon's first bridge to carry vehicular traffic. The Traffic Bridge was designed as a 5-span Parker through truss and came into being when residents of the Village of Nutana agreed to merge with the Town of Saskatoon and the Village of Riversdale to form the City of Saskatoon. The heritage value of the Traffic Bridge lies in its status as a landmark in the community, its form, massing, and location, the engineering technology used (steel truss architecture), and the original concrete piers and abutments.

Throughout its 103-year history, the bridge has been used for horse and carriage, street car, and modern vehicle use. The bridge also has historical notoriety as Saskatoon's only marine disaster when the sternwheeler *S.S. City of Medicine Hat* collided broadside into the southern-most pier of the bridge and sank on June 10, 1908.

The bridge was closed in August 2010 due to public safety concerns due to advanced deterioration of critical structural members. In 2010, the City commissioned a needs assessment and planning study of the Traffic Bridge, which investigated multiple alternatives and potential replacement, included extensive public consultation, regulatory review and debate, as well as City Council presentations.

Many elements of the existing bridge were to be incorporated into the new bridge. Engineering studies were completed on the existing elements to determine strengths and compatibility with the new structure.

A P3 model was used for the design and construction of the replacement bridge. Many challenges presented themselves during the design and construction of the structure and these challenges provided unique resolutions. The bridge is currently under construction, and upon completion, the contractor will be responsible for the maintenance of the bridge for the next 30 years.

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Acknowledgements: City of Saskatoon

HISTORY

The Saskatoon Traffic Bridge opened in 1907, uniting the communities of Nutana, Riversdale, and Saskatoon, ultimately creating the City of Saskatoon. While it wasn't the first bridge to cross the river, it was the first bridge dedicated to vehicular traffic, and the logic behind the name "Traffic Bridge". Previously, an unreliable ferry service had been used to transport vehicles from one side of the river to the other, as the only other bridge around at the time was a train bridge.

Construction of the original Traffic Bridge commenced in August 1906 with a completion in October 1907. The Government of Saskatchewan, through the Department of Transportation provided the funding of the \$105,000 total construction cost. The Canadian Bridge Company completed the steel work and John Gunn and Son's completed the concrete work.

The structure itself was originally designed as a 950' long five span Parker Truss bridge, consisting of shorter outer spans of 53.5 metres each, and three identical interior spans of 61.9 metres. A Parker truss is a variant of the Pratt truss. In a Pratt truss the diagonal members of the truss all face toward the center of the truss and the top chord of the truss is flat. In a Parker truss, the top chord forms a polygon arc.

Less than a year after opening, on June 7, 1908, a steamboat called the SS City of Medicine Hat ran into a steel cable that was stretched across the river. The boat lost control and collided with the South pier of the Traffic Bridge.

In 1908, a 2-metre-wide pedestrian walkway was added on the upstream side of the Traffic Bridge.

In 1922, a streetcar was de-railed when turning onto the bridge from what is now Saskatchewan Crescent. Due to the large vertical grades and ice build-up on the South approach of the bridge, transportation had difficulties maneuvering.

In the 1960's, the South portion of the river was covered by landfill to create what is now Rotary Park.

In 1961, the South end of the bridge was raised to reduce the slope of the Victoria Ave approach. This allowed Saskatchewan Crescent to pass under the bridge.

Throughout the 1990's, the Traffic Bridge was closed a few times after oversized vehicles drove across.

On September 6, 2005, The City of Saskatoon closed the bridge for inspection in preparation for upgrades such as the roundabout on the North end as well as the River Landing development.

On November 2, 2005, the Traffic Bridge was closed to vehicular traffic because of the Stantec inspection findings. Severe corrosion in portions of the lower chord, floor beams and the floor beam connections were found in the inspection.

Repairs costing \$500,000 lead to the re-opening of the Traffic Bridge on September 8, 2006.

In 2006, divers conducting training dives with the Saskatoon Fire and Protective Services near the South bank of Broadway Bridge encountered a large metal object buried in the river bed. The object turned out to be the kedje anchor of the SS City of Medicine Hat.

On August 24, 2010, The City closed the bridge to all modes of transportation, following a preliminary inspection. This inspection performed by Stantec found that there was excessive corrosion to integral structural steel members and could not conclude that the bridge was safe for the public to use.

The repairs performed in the 2006 repair did repair some of the corrosion in the main load carrying elements, but corrosion had extended past the anchorage zones of the repairs to the lower chord. Further deterioration of the connection plates for the floor beam to lower chord were also found. Large amounts of debris were still resting on the bottom chord which held moisture and helped to accelerate corrosion of the steel in the lower chords.

PUBLIC ENGAGEMENT

As the Owner's Engineer, Stantec conducted a Needs Assessment and Functional Planning Study and presented 3 alternatives:

Option 1- Complete Rehabilitation

This alternative would maintain the bridge in its existing form and function. Heritage aspects would be preserved where possible. Two 2.9m traffic lanes (one per direction) would be maintained, with new 3.0 m pedestrian/cyclist lanes on each side. The estimated Capital Costs were \$24M-\$34M with annual operating costs of \$150,000 for repainting steel members as well as deck maintenance. The existing substructure elements were to be salvaged and as many of the original steel sections would remain in place.

Option 2-Conventionally Designed Concrete Bridge

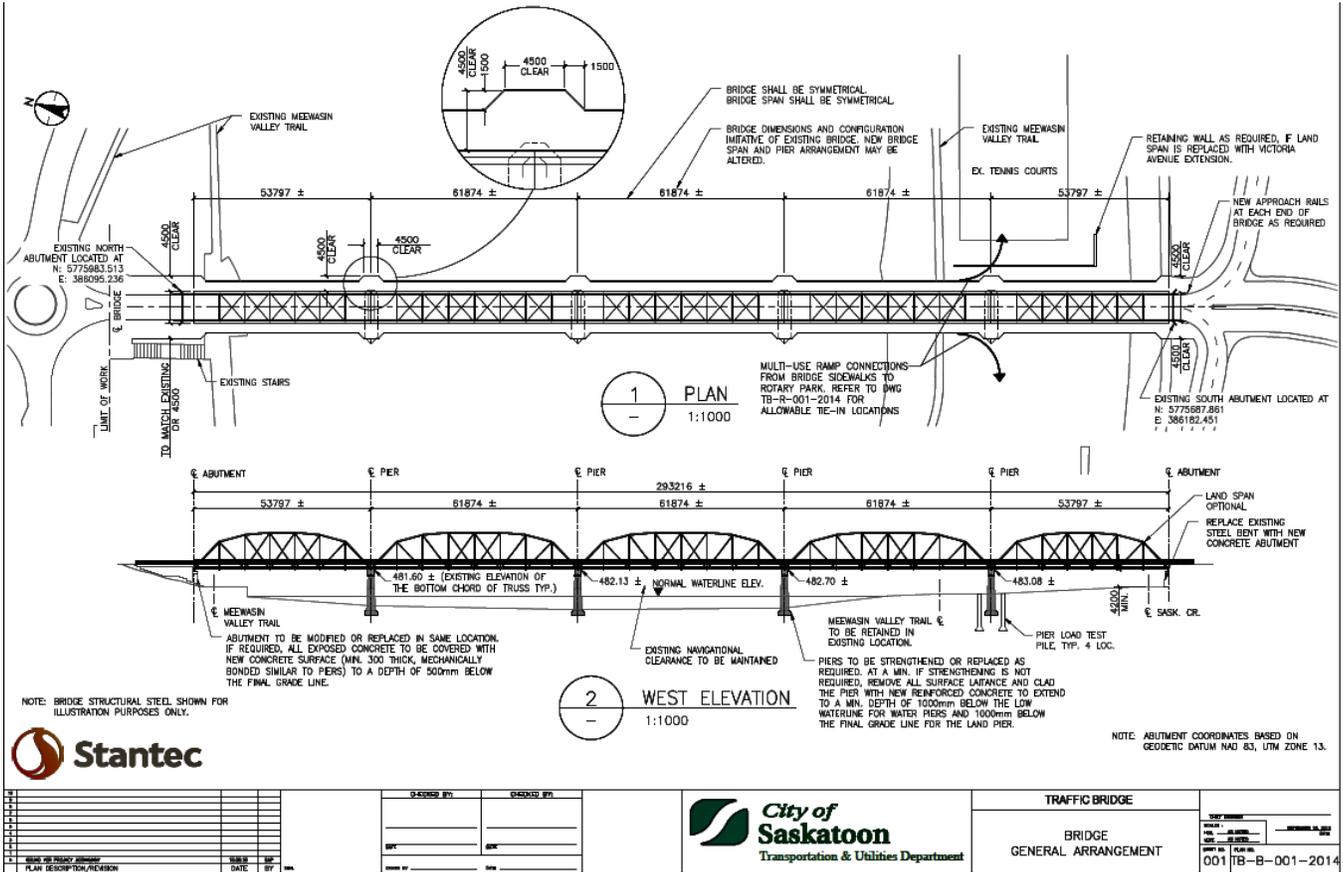
This alternative would completely replace the existing structure with a modern concrete structure. Two 3.7m traffic lanes (one per direction) would be implemented with 1.5m shoulders/cyclist lanes and 3.0m pedestrian/cyclist walkways on each side. The estimated Capital Costs were \$26M-\$35M with annual operating costs of \$16,000 for deck and asphalt maintenance. The existing elements would be demolished as all new elements would be constructed to construct this bridge option.

Option 3-Modern Steel Truss

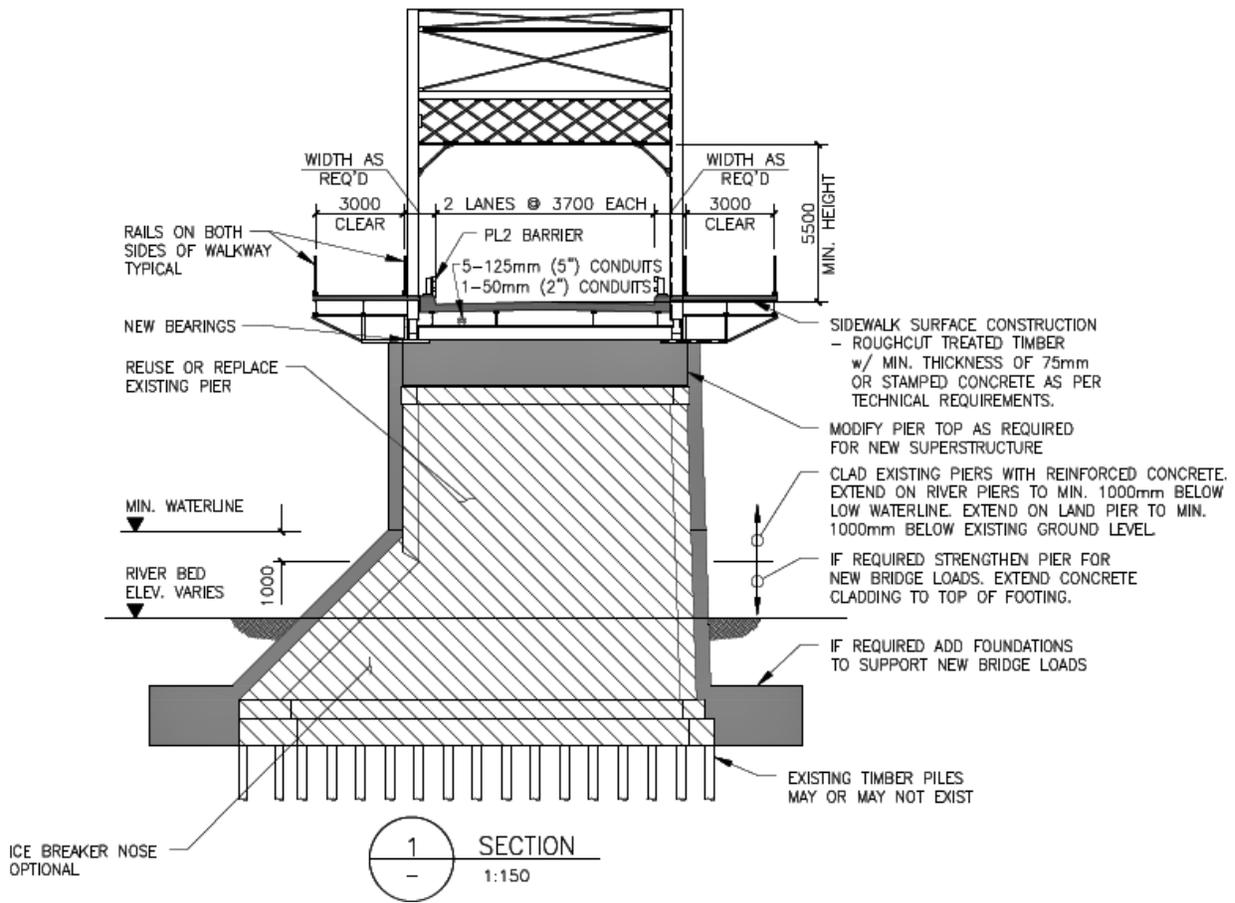
This alternative would optimize the best qualities of the first two alternatives. It would involve replacing the existing structure with a modern steel truss like the existing bridge. It would utilize weathering steel with solid members on existing piers. Three sub-alternatives all included the double 3.0m wide pedestrian/cyclist walkway but varied the traffic lanes from 3.3m to 3.7m with the possibility of a 1.5m shoulder. The estimated capital costs ranged from \$25M-\$33M for option A to \$29M-\$37M for option C. The annual operating costs ranged from \$15,000 to \$20,000 depending on the option.

All three alternatives would have an 80-year design life, and would facilitate vehicular, pedestrian, and cyclist use. The main differences between them was the estimated capital and operating costs, the heritage value, level of function, and aesthetics.

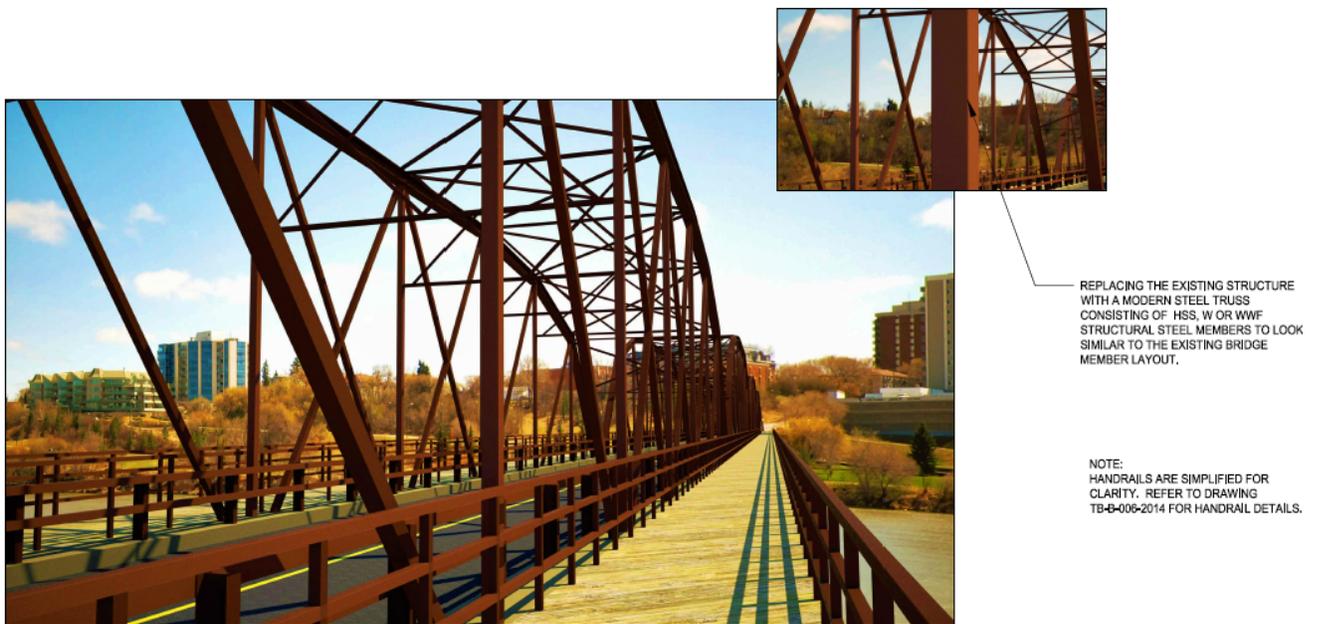
Public meetings were held to describe the various options. Renderings of the various options were presented so that the public could get an idea of what the bridges would look like at the existing bridge location. After public opinion of the options was collected and presentations were made to council at the City of Saskatoon, the heritage value of the existing bridge was found to be an important issue for the citizens of the City of Saskatoon and a new truss similar to the existing truss was selected as the bridge replacement option. In order to keep as much of the original style of the old bridge, a new modern Parker truss matching the shape of the existing bridge was selected. The existing foundation elements, the piers, were to be salvaged. A drawing showing the proposed layout of the replacement bridge is shown on the following page.



A cross section of the proposed bridge is shown on the following page.



A rendering of the finished truss bridge is shown below.

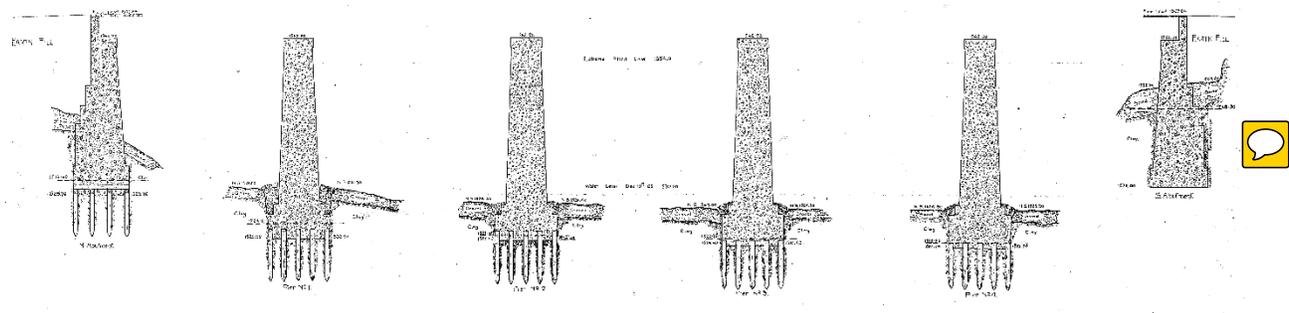


RECONSTRUCTION

The City of Saskatoon originally determined that the replacement of the bridge was to be completed as a design build delivery model. In order to provide the engineers with the proper information on the bridge and the fact that the existing piers were to be salvaged, a load test on one of the piers was performed.

The design of the bridge was to be wider and support larger loads than the original substructure was supposed to support and strengthening, or replacement of the existing substructure elements were required. The southernmost pier was selected as the test pier since it was the only one of the piers that was located on land which would aid in placing the required equipment to perform the load test.

A review of the as-built drawings for the traffic bridge suggested that the existing piers are supported on footings which are supported on driven timber piles. (add figure).



The footings of each of the piers rest on a hard-glacial clay till. Other bridges constructed in the City of Saskatoon are supported on raft footings placed directly on this clay till. This material is a hard material and it was assumed that the timber piles shown on the plans were not installed into this hard material. A raft foundation placed in this hard clay till could potentially have more capacity than the driven timber piles shown on the drawings.

The southernmost pier was selected as the load test pier since it was located on land greatly reducing the regulatory approvals to perform the work. While access was simplified at this pier, complications were introduced due to the backfill around the pier providing additional capacity in the form of skin friction between the fill and the pier shaft.

Initially, this fill was not considered an issue as the original investigative program developed for the site included an excavation component around the pier for the purpose of confirming the presence and extent of the shipwreck remains of the SS City of Medicine Hat which crashed and capsized against the pier on June 7, 1908, shortly after the bridge was completed. This excavation would have provided the means by which the backfill friction could be ignored for the pier load test. However, due to budget and time constraints the archeological investigation was removed from the scope of the project to be investigated further by the City at a later date. Removal of this portion of work, and subsequently the initial pier excavation, required a re-assessment of the load testing procedure in order to address the additional capacity imparted by the skin friction between the soil and pier shaft.

The initial evaluations of the skin friction component of the backfill surrounding the pier would have a significant increase in the loads that would be required to overcome this resistance. It was decided to remove the fill around the pier shaft would reduce the cost of the jacking equipment and reaction frame, reduced the potential

risk of damaging the unreinforced pier and having the load test be more representative of the soil conditions that exist at the river piers.

Detailed load estimates of the existing elements of the bridge were found as well as the expected future loads on the piers based on the proposed bridge cross section. In addition, pier modifications consisting of a 150 mm thick concrete cladding of the pier and a cap beam to support the new wider truss.

Two live load conditions were evaluated for the load test. The first was based on the bridge deck surface being used for traffic alone, while the second assumed the deck would be used for a public space. Both options resulted in a similar total live load reaction supported by the piers.

The procedure for the load test on the pier was based on the “Quick Test” (Procedure A) in ASTM D1143/D 1143-087 “Standard Test Methods for Deep Foundations under Static Axial Compressive Load”. Four concrete belled piles were placed adjacent to the existing pier and steel jacking frames were attached to these piles. Steel brackets were securely attached to the pier shaft. Between the jacking frames and the steel brackets were placed the 3000 kN jacks and load cells. As the load test progressed, the settlement of the pier was measured, and it was found that there was no measurable settlement that occurred during the load test.

The results of the load test revealed that the existing piers would be able to support the existing and future loads applied to them. Based on these results the design build teams could use the existing substructure elements in their designs for the replacement bridge.

ARCHAEOLOGY

There exists an important archeology site and at the time “the greatest marine disaster in the history of Saskatoon”¹ lies at the base of the southernmost pier of the existing Traffic Bridge. This site has been covered by fill placed near the bridge when Rotary Park was created between 1960 and 1965.

On June 7th, 1908, the *S.S. City of Medicine Hat*, a steam powered sternwheeler wrecked against the south-most pier of the traffic Bridge. The *S.S. City of Medicine Hat* was built in 1906-07, was 130 ft (39.6 m) long had a beam of 25 feet (7.6 m) and a draft of only 2 ft (0.3 m). The boat was commissioned by Horatio Hamilton Ross, a Scottish nobleman and remittance man. The *S.S. City of Medicine Hat* is shown in Photo 1.²

¹ Barris, T. 1977. *Fire Canoe*. McLelland and Stewart. Toronto.

² Amundson, Leslie J (Butch) et al, “Archaeological Investigation of the Wreck of the *S.S. City of Medicine Hat*, Saskatoon, Canada”, March 2015



Photo 1 – S.S. City of Medicine Hat ca 1907

The *S.S. City of Medicine Hat* departed on May 29th, 1908 with 22 of Ross' friends and a crew of 9. The ship was not loaded to capacity – carrying only the guest's luggage, some hunting and fishing equipment, a shipment of flour and the coal to power the boilers, some of which was being transported on an attached barge (Polachic, 1991). The 643km trip was uneventful even though the river was extremely high due to spring runoff. The *S.S. City of Medicine Hat* was successfully maneuvered under both of Saskatoon's railway bridges – first the Grand Trunk Pacific Railway bridge (Photo 2), then the Canadian National Railway bridge (Photo 3).



Photo 2 - The Grand Trunk Pacific Railway bridge in Saskatoon



**Photo 3 - The Canadian National Railway bridge
(demolished and replaced by the Senator Sid Buckwold Bridge)**

At the Grand Trunk Railway bridge Ross tied the boat just below to order the passengers off, hoping the water levels would drop if they waited. Instead, the water levels rose. Ross calculated that if he removed the smoke stack, the ship would fit under the bridge. Once through, Ross moored the ship near the powerhouse and measured the space between the river and the next bridge – the Canadian National Railway Bridge. The *S.S. City of Medicine Hat* successfully navigated under this bridge, but got caught on the telegraph cable, which was obscured by the high water, spanning the river (Polachic, 1991). The cable disabled the steering gear, making the ship un-navigable. The attempts to tie the ship to a tree and run it aground were unsuccessful. The strong current of the river sent the ship careening into the steel girder and swung around to hit the concrete pier of the Traffic Bridge (Polachic, 1991) (Photo4)³.

³ Polachic, Darlene. 1991. "Stern-Wheelers on the Saskatchewan". Canadian West Magazine, July/August/September 1991, Volume 7 No. 3.

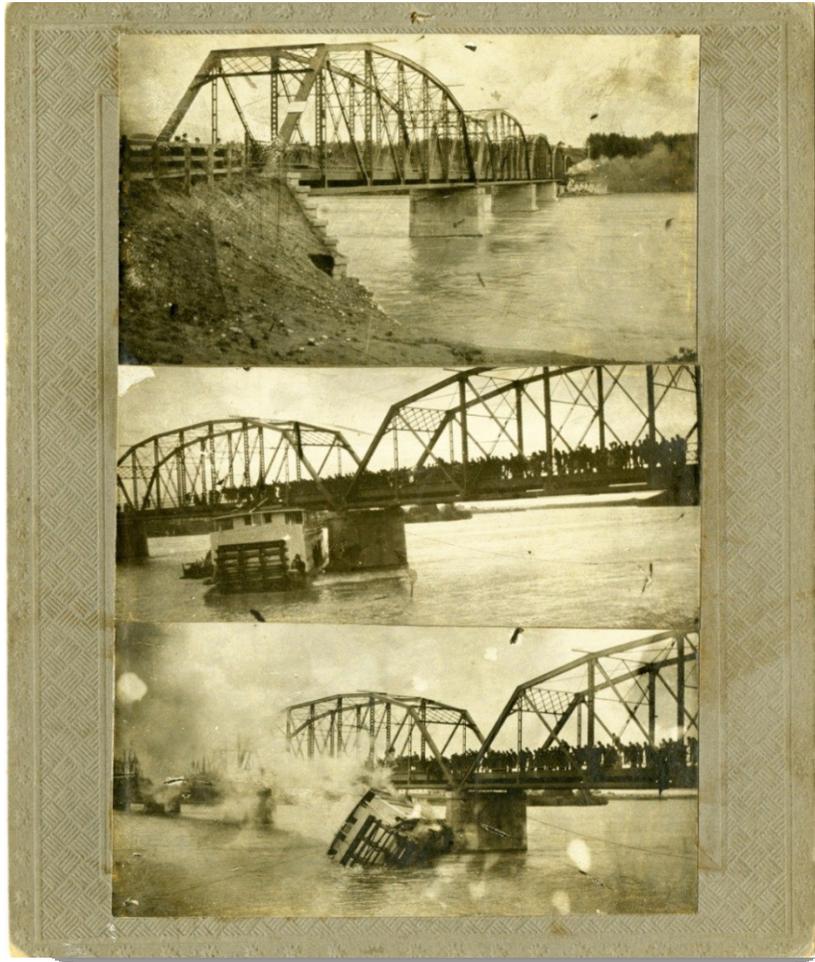


Photo 4 - Time lapse photos of the S.S. City of Medicine Hat

The crew safely abandoned ship, but all of the passenger's belongings, the shipment of flour, and the barge carrying 50 tons of coal were all lost in the river. As was Ross' \$28,000 ship that was only insured against fire (Polachic, 1991) (Photo 5).



**Photo 5 - S.S. City of Medicine Hat capsized
with crowd gathered on bridge**

There have been some attempts to salvage what is left of the wreck but to date only artifacts found when the anchor was discovered in 2006, an underwater search in 2008 and during the pier load test in 2011. Items found in these investigations included;

- The location of the wreck at the base of the south pier of the Traffic Bridge is well- documented in contemporary photographs, eye-witness accounts, news reports and scholarly works.
- The discovery of the anchor suggests that some remains of the ship are still on the riverbed.
- Significant remains from an apparently large wooden structure were recovered from the historically documented site of the wreck. Some of these items are painted white, the colour of the ship.
- In addition to wood remains, we recovered ceramic tableware, silverware, food containers and personal items that are consistent with an early 20th century event.
- We recovered iron and brass objects that may be structural elements of the ship and parts of the engine. One object bears a patent date of 1900.
- The artefact collection is buried under 3 m of river sand below the landfill layers that were deposited in the 1960's.'
- The artefact collection appears to be from a brief span of time, not an extended period of generalized garbage tossed from the bridge in the 53 years between the wreck and the land fill events.

- The collection is similar to that from a turn of the 20th century hotel or household, and the ship was essentially a floating hotel.

CONSTRUCTION

Work began on the replacement of the traffic bridge in 2011. The City had decided to have the bridge replacement project to be a design build project. As the project progressed, another project the City had been investigating, the North Commuter Parkway project, was also progressing. Federal funding for projects such as these was available and both projects were combined into one project that became a design build and maintain project.

Demolition of the bridge began in May of 2012 with the removal of the pedestrian access ramp on the South side. This enabled load testing to be done on the pier. The first span on the South side was torn down in October of 2012. In January of 2016 two of the longer spans were removed by explosives. The last long span was removed by explosives a month later. The final span was torn down in November of 2016.

In March of 2014, City council approved the rebuilding of the Traffic Bridge as part of a P3 project that includes the North commuter bridge.

In November of 2015, Graham Commuter Partners was selected to build and maintain both bridges for 30 years.

After various public engagement events, the City of Saskatoon selected the Modern Steel Truss Bridge as the preferred alternative. The final design consisted of a new 4-span steel truss structure on top of the existing rehabilitated piers. The piers were reinforced with an outer layer of concrete to extend the design life and accommodate the larger bridge deck and truss structure. The new bridge deck allowed for two 3.7m driving lanes and two 3.0m wide cantilevered concrete pedestrian/cyclist walkways with pier lookouts. Extra mass earth fill and rip-rap was added at the South side to eliminate the need for a 5th span. MSE Walls would be used to elevate the approach slab at the South abutment, as well as facilitate a concrete box girder land span over Saskatchewan Crescent.

The expected date for completion of both the Traffic Bridge and North Commuter Bridge is October 1, 2018.