

JOHNSON STREET RAILWAY BRIDGE

NEW CYCLING AND PEDESTRIAN WALKWAY

FEASIBILITY REPORT

JANUARY 2000

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EXECUTIVE SUMMARY

A pedestrian and cycling trail system has been developed up to the west side of the Johnson Street Railway Bridge. This report examines the feasibility of extending this trail system across the Johnson Street Bridge with a 5 m widening on the north side.

The existing bridge was designed for steam locomotives travelling at a reasonable velocity. With current speeds limited to 10 mph the impact allowance is reduced resulting in some spare capacity for added pedestrian traffic.

The study showed that this spare capacity could be utilised on the fixed spans (east and west of the Bascule truss structure) to support a 5 m sidewalk (cycle way) off the north side.

On the Bascule span – the members forming the linkage between the lift span and the counterweight have no spare capacity to carry the additional self-weight of the proposed walkway. Strengthening is considered a very difficult proposition and therefore a separate Bascule for pedestrian/cycle use was examined and this was included in the cost for this crossing estimated at \$1,506,000.00.

The City then suggested we examine (in concept form only) reducing the trail width on the bascule down to about 2.5 m (off the north side) and also adding a 1.5 m path on the south side of the railway truss. These additions, to be constructed in lightweight material, would be compensated for by removing steel grating and railings – typically as shown on Drawing S8. This scheme was estimated at \$1,098,000.00.

The cost of both these schemes is high and a more cost effective scheme is to obtain approval from the Railway operating company to cover the steel deck grating with lightweight plastic decking to ensure pedestrian comfort and safety. Some form of public traffic control will be required when trains are in operation.

1.0 INTRODUCTION

Graeme & Murray Consultants Ltd. has been associated with the structural assessment and maintenance of the Johnson Street Bridges for 30 years. Major restoration work was undertaken to both highway and railway bridges in 1978-79 and again to the highway bridge in 1999.

This report examines the feasibility of adding a 5.0 m wide cycling/pedestrian walkway on the north side of the railway bridge.

2.0 REFERENCES/RESOURCES

The existing bridge was built in 1922. The original engineer's design drawings and the steelwork fabricator's shop drawings exist (in the Engineering Department storage) and are invaluable for reference purposes.

For the bascule bridge, these records include a drawing (Stress Sheet) giving the design loadings for all main members, i.e. Dead, Railway, Live and Impact allowance.

Wind loading values are not given, although design for wind would have been undertaken as part of the original design and may govern the size of some members; particularly the bracing ones.

The original design loading was Coopers E50, which is essentially an idealized train loading still in use today, but for new bridges is 60% heavier (as Coopers E80). Bridges designed for (Coopers E50) loading exist on many lines and this we consider an appropriate load to be concurrent with the pedestrian loading being added to the structure. In real terms, the Dayliner cars will be substantially less than Cooper E50 but the use of old steam locomotives on the E&N Railway for tourism purposes remains a possibility.

In North America the American Railway Engineering Association (AREA) covers the design of steel railway bridges and moveable bridges and their 1991 Manual has been used for reference. This manual includes a section on the Assessment of Existing Bridges.

This type of assessment would consider the bridge condition and the type of loading that the bridge is evaluated for. Of benefit to this study of the Johnson Street Bridge, is the significant change in railway technology from steam engines to diesel and electric.

The latter two have much smoother operating machinery - as distinct from the hammer blow of the steam piston and therefore the impact loading is reduced. Also a major factor in impact loading is the speed of the train, and with train speeds of 10 mph (at the most) occurring at the site, this value is reduced to a minimum.

In checking the existing structure for spare capacity that can be utilized for an additional cycle/pedestrian walkway, the two most beneficial factors were found to be:

1. A general change from steam to diesel/electric locomotive.
2. A maximum speed at the bridge of 10 mph.

For purposes of the evaluation, a Cooper E50 design load was applied with the impact loading being from steam locomotives at 10 mph.

3.0 DESIGN AND DEVELOPMENT

The study is divided into three sections and is illustrated by nine drawings. For the general plan, see Drawing 4834-S1.

- Walkway on the east and west approaches.
- Walkway on the fixed east and west spans.
- Walkway on the bascule bridge.

These are discussed separately and conclusions drawn.

3.1 Walkway on the East and West Approaches, Drawing 4834-S2

Topographical survey work was undertaken to supplement the basic information provided by the City. This added information on the embankment slopes and lower ground to the north, as well as in the area of the CRD parking area south of the bridge.

Trail alignment west of the bridge would run parallel to the rail tracks - connecting at the west end to that running to Harbour Road. Closer to the bridge, sidehill fills will be required to provide the necessary walkway width and the toe of slope (2 horizontal to 1 vertical) is shown on the drawings. Raising of the manhole will be required. Ownership of this land is assumed to be within the control of the City. Adjacent to the wing wall the walkway is an elevated structure, supported on piles or posts on the north side and by the wing wall on the south.

At the east end of the bridge the walkway is supported by braces from the wing wall. The trail alignment runs into the existing parking lot north of the railway station, which will require some loss of stalls and adjustment of others. A preliminary alignment of a trail connection to the harbour walk south of the bridge is shown routed under the bridge adjacent to the abutment. To be at a grade (8%) appropriate for the handicapped this loops onto the land north of the parking lot and requires fill. The required toe of slope is shown. Ownership or control of the land by the City is assumed. To avoid fills beyond the existing shoreline, approximately half of this section would be structure. The problem of fills also impacts on the walkway off the bridge beyond the east abutment. To accommodate this, and the future lower walkway, approximately 18 m of the upper walkway is on structure (supported at the south side on existing ground).

3.2 Walkway on the Fixed East and West Spans **Drawings 4834-S3, S4 and S5**

The fixed spans were designed by the City Engineering Department to the same loading as the bascule (which was designed by the Strauss Bascule Bridge Company in Chicago).

A design check for the original Cooper E50 loading, but with train speeds limited to 10 mph, results in sufficient structural capacity to support the proposed walkway.

The method of attachment would be adding brackets that perform as extensions to the existing floor beams, i.e. at approximately 15 ft (there is a small variation in these centres at each span). The brackets have been designed and the typical arrangement is shown on Drawing 4834-S5. The connection detail to the existing steelwork has not been designed. The load of the walkway adds load to the adjacent (north) girder and reduces the load on the south girder.

For the west span, with the full live load on the walkway and none on the bridge, stability of the structure is met, but anchorage to meet the required safety factors requires improving the anchorage of the girder to the abutments and pier.

3.3 Walkway on the Bascule, Drawings 4834-S6 and S7

Two design conditions occur:

1. Bridge in the down position - for live loadings, the truss acts as a simply supported span onto the piers at either side of the main channel (known as the rest pier on the west and trunnion pier on the east).

- .2 Bridge in the raised position - where the dead loads are balanced by the concrete counterweight. Wind loading on the bridge in this position will be significant but no original design information is available.

With the bridge in the down position the forces in the bascule span members were checked for the concurrent load case of:

- Dead loads.
- Cooper E50 train with speed limited to 10 mph.
- Full walkway live load.

Analysis shows that, for all the members in the north truss, this load is approximately equal to the original design with the full steam impact allowance.

With the bridge in the moving condition when the loads acting are:

- Dead load.
- Live load due to wind - this condition was not evaluated but is discussed below.

The dead load of the walkway - being applied on the north side has the effect of increasing the load on the north truss and reducing that on the south truss. Analysis shows that in those members (on the north side), whose size was determined by the original bridge in motion design case, the mass of the walkway produces an overload condition of up to 29%. These members are:

- Bascule Span
 - The end two diagonals near the bearing pins.
 - The bottom chord of the two (east) end panels.
 - The north main bearing.
- Counterweight Truss
 - All members on north side.
 - Counterweight link to bascule truss.
 - The main north counterweight bearing pin.

The net mass of the counterweight would have to be increased by 11% and contrived to also shift the centre of the counterweight mass 2.3 ft. to the north.

The work would also probably require a major upgrade of the motor system and, most certainly, a new system of braking to resist wind loads on the increased 'sail' area when in the up position.

3.4 Conclusion

Work to provide a walkway on the north side of the railway bascule bridge is not considered viable. Instead, a separate pedestrian bascule bridge was studied (the mechanical operation needs were not investigated).

3.5 Pedestrian Bascule

A truss frame, triangular in form, was developed and is shown on Drawing 4834-S6. The panel length matches that of the adjacent railway bridge. Analysis was taken to the extent that permitted sizing of the members for self-weight and pedestrian loading. Wind loads and the mechanical needs were not investigated nor were the foundations pursued in any detail. Some difficulty will occur with locating piles adjacent to the existing piers.

The deck finish was investigated, with a plastic composite deck grating being preferred to wood decking, because of it being unaffected by moisture (causing weight changes, between the dry and wet seasons, which affect the balance). Steel decking and concrete decking were not considered because of ice hazards and weight considerations, respectively.

3.6 Alternate Route On Railway Bridge, Drawing 4834-S8

The railway line is offset, to the north, from the centreline of the bascule bridge. The distances to the approximate face of the steel trusses (from the centreline of track) are:

to the north 9 ft. and
to the south 12 ft.

The 3 ft. difference, presumably being the space available for workmen outside the clearance line, is applicable to a normal operating track.

In AREA, this clearance line is 9 ft. on either side of the track centreline, but each rail system will have their own requirement. The current user may allow this space to be fenced off to provide a secure, but narrow, pedestrian route. Discussions would need to take place to explore any possible reduction of the clearance and to see if a wider path is possible. (For instance, at the doorway to train sheds, the clearance is 8 ft.)

3.7 Alternate North Side of On Highway Bridge Bascule

The clear distance between the main members of the road and rail bridges is more than 5 ft. and it appears feasible to utilize this space, as structurally, it appears relatively easy. This walkway surface can be extended into the spaces between the main members for an overall width of 6ft., and this would be a useful refuge to aid people passing in the opposite directions. I would suggest cyclists should be required to dismount. For security, the path should have closed circuit TV service to the operator's hut. Operationally, the control of this walkway would be part of the existing phasing. This walkway would not prevent the continued unsanctioned use of the railway bridge but the closely spaced grid of the walkway decking would be more attractive to pedestrians.

While any spare capacity of the bascule span has not been studied (the original railway use may again help), the north counterweight truss does appear to have 10% spare capacity. Modifications to the maintenance gantries and access ladders, plus some extra counterweight mass, would be required.

#4834

April 25, 2000

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Attention: Mr. Tim Galavan

Dear Sir:

**RE: JOHNSON STREET RAILWAY BRIDGE NEW CYCLING AND
PEDESTRIAN WALKWAY - FEASIBILITY REPORT**

Please find enclosed the completed report and drawings.

If you have any questions please don't hesitate to contact myself or Patricia Gosselin.

Yours truly,

GRAEME & MURRAY CONSULTANTS LTD.

Per:

Andrew J. Rushforth, P.Eng.
AJR/zs

Enclosure