Suspended Spans Redecking Project

Information for Potential Bidders

Angus L. Macdonald
Bridge
Angus L. Macdonald Bridge
Suspended Spans Deck Replacement
Information for Bidders

April 2013
Executive Summary

This document provides information about the Angus L. Macdonald Bridge Suspended Spans Deck Replacement Project in Halifax, NS, Canada. Its purpose is to help potential bidders to decide on their interest in the project.

The deck (along with all of the suspended structure) will be replaced in segments during 10½ hour night-time closures to all traffic, Sunday night to Thursday night, and during eight full-weekend closures.

The new deck is of steel orthotropic construction with stiffening trusses below the deck. The approximate weight of the new fabricated permanent works is 4,700 tonnes. Fabricated deck segments will be prepaved in the shop with a thin running surface.

Work will start from the Dartmouth end. 20 m long segments (deck and suspended structure) will be lowered to a barge and replaced with a new segment brought up from a barge. Each new segment will be rigidly connected to its predecessor, and temporarily connected to the adjacent existing segment. The bridge will then be opened to traffic. During subsequent nights the Contractor's equipment will be moved forward 20 m, and the cycle will start again. Also during this time, further connections will be completed, and modifications will be made to the existing structure in preparation for subsequent removal.

As the Halifax Side Span is over buildings, the method there must change. Segments will be 10 m long, delivered over the bridge by truck, rotated 90° so that they will fit between the existing trusses and hangers, then be lifted, rotated back, and lowered into place.

Halifax Harbour Bridges (HHB) intends to issue a Request for Statements of Qualifications in 2013 May to pre-qualify tenderers, followed by an Issue for Tender in 2013 September and contract award in 2014 March. Construction is planned to begin in 2014 and end in 2016.

In order not to overstress any part of the bridge at any stage of its reconstruction, it is necessary to adjust the lengths of the hangers as work progresses. When, and by how much, the hangers must be adjusted has required a very detailed step-by-step analysis of the erection sequence by HHB's Engineer, Buckland & Taylor. The erection sequence is thus defined in the contract documents, as is detailed design of some equipment to be used by the contractor, including the main erection gantries.

When installation of all new segments is complete, the deck will be raised by up to 2.6 m to increase headroom for shipping by 2.1 m, and final paving will be added.
Other than equipment designed by HHB’s Engineer, the Contractor will be responsible for designing all temporary equipment and all methods. The Contractor will be responsible for safety of the public and of workers throughout construction.

A 24 inch (610 mm) diameter water pipe on the bridge, owned by Halifax Water, will be decommissioned and is planned to be replaced by a new water pipe as part of the deck replacement. However, the majority of the utilities carried on the bridge are intended to be kept functioning on temporary utility cable(s) without interruption during deck replacement.

A cable dehumidification system will be tendered as an optional item.

Bonding will be required including but not necessarily limited to a Performance Bond in an amount equal to fifty percent (50%) of the total contract price and a Labour and Materials Bond in an amount equal to fifty percent (50%) of the total labour and materials costs.
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1 Introduction

This report provides an overview of the Angus L. Macdonald Bridge Suspended Spans Deck Replacement Project in Halifax, Nova Scotia, Canada.

The bridge is owned, maintained and operated by the Halifax-Dartmouth Bridge Commission, doing business as Halifax Harbour Bridges (HHB). Buckland & Taylor Ltd. (B&T) is the prime consultant for the work. Other design team members include:

- Harbourside Engineering Consultants of Dartmouth, NS (structural engineering);
- Singleton Environmental Consultants of Halifax, NS (regulatory permitting);
- Rowan Williams Davies and Irwin of Guelph, ON (wind engineering);
- M&R Engineering of Halifax, NS (electrical and mechanical engineering);
- CBCL Limited of Halifax, NS (water pipe design);
- RWDI Air of Guelph, ON (sound studies);
- Mageba SA of Switzerland (monitoring of expansion joint movements);
- Allnorth Consultants Limited of Bedford, NS (survey); and
- Thompson Conn Limited of Halifax, NS (verification survey).

Throughout the rest of this report, reference to "Buckland & Taylor" may be interpreted as reference to the entire design team, with various members contributing as consistent with their area of specialization.

HHB has also commissioned Ammann and Whitney of New York to complete an independent check of the erection engineering analyses.

At the time of writing not all details of the project have been completed, so there may be some changes before tender documents become available. However, these are not expected to be substantial changes.

1.1 Purpose of Report

The purpose of this report is to give prospective bidders an idea of the scope and size of the project, so that they can decide whether they wish to pursue the project as a business opportunity, and, if so, what skills and facilities they will need to bring to their teams to complete the work.
1.2 **Background**

1.2.1 **About Halifax Harbour Bridges**

The Halifax-Dartmouth Bridge Commission (now Halifax Harbour Bridges or HHB) was formed by the Nova Scotia government in 1950 to construct, operate and maintain bridges that span the Halifax harbour.

In April 1955, the Angus L. Macdonald Bridge opened. To accommodate the growing community, just 15 years later, a second suspension bridge, the A. Murray MacKay Bridge opened in July 1970.

HHB’s purpose was to manage tolling, plowing and salting. While the work is essentially the same as in the 1950s, how that work is done now is vastly different. The number of crossings has gone from three million to 34 million; we’ve gone from collecting tolls through tickets, cash and tokens and from hand-painted signs to electronic message signs.

Now tolls are collected either by electronic toll collection (ETC) or cash with 75 per cent of all tolls collected through ETC.

HHB is an agency of the Nova Scotia government reporting to the Minister of Finance. HHB is self-funded which means the organization does not receive operating funds from the government – all operations and maintenance are funded through toll collection. All revenue stays with HHB to maintain and operate the bridges.

The bridges are integral links in the transportation network in HRM. During certain times of the day the bridges are at capacity, meaning any disruption can cause significant delays. When an incident occurs on one of the bridges congestion builds very quickly and has an impact on the entire network. As a result, HHB purposely schedules maintenance or capital works projects to occur outside the peak travel times to keep disruption to a minimum. And HHB works to proactively decrease the number of incidents that occur and to quickly clear them when they do occur.
1.2.2 The Angus L. Macdonald Bridge

The Macdonald Bridge is a suspension bridge and was named after former Nova Scotia Premier Mr. Angus Lewis Macdonald. He served as the Liberal premier of Nova Scotia from 1933 to 1940 when he became the federal minister of defence for naval services. After the war, he returned to Nova Scotia to become premier again and he died in office in 1954.

The Macdonald Bridge opened as a two lane bridge with a narrow sidewalk in 1955. It was converted to a three lane structure with a pedestrian walkway and bicycle lane in 1999. The third lane was achieved by widening the roadway and placing the sidewalk and bike lane outside the suspended structure. The Macdonald Bridge provides the only form of active transportation across the Halifax harbour.

The Macdonald Bridge is the sister bridge to the Lions Gate Bridge in Vancouver. The Macdonald Bridge opened 15 years after the Lions Gate and was designed by the same engineering firm, P.L. Pratley. There are approximately 50,000 crossings on the Macdonald Bridge on an average workday.

There are weight restrictions on the Macdonald Bridge. Vehicles over 3,200 kg are not permitted to cross the bridge.

The Macdonald Bridge has a reversible centre lane that helps smooth flow of traffic. In the morning there are two lanes to Halifax. The third lane is reversed depending on which way the traffic is flowing.
1.2.3 A Murray MacKay Bridge

The MacKay Bridge opened in July 1970 and is named after HHB’s former board chairman who was instrumental in the construction of the Macdonald and the MacKay bridges.

The opening of the MacKay Bridge drew international interest due to its design and the engineering techniques that were applied to its construction for the first time in North America using an orthotropic steel deck.

The MacKay Bridge is a four lane bridge and has approximately 60,000 crossings per weekday.

1.2.4 The Macdonald Bridge Suspended Spans Redecking Project

When the third lane was added to the Macdonald Bridge in the late 1990s, the old deck was kept and the old sidewalk and ductway created three traffic lanes. The bike lane and sidewalk was added to the outside of the bridge.

During the third lane project we knew the suspended spans would have to be replaced in the subsequent 12-15 years and as such the project was put in the long term planning. We have reached the point where the deck of the suspended spans must be replaced.

The bridge remains safe but after 60 years the deck is wearing out and needs to be replaced. The project is needed to extend the life of the bridge and reduce maintenance.

Once complete, much of the bridge infrastructure will be new – leaving the original towers, main cables and anchorages on the suspended spans.

The Angus L. Macdonald Bridge spans Halifax Harbour between Halifax on the west side and Dartmouth on the east side. The bridge structure is a suspension bridge, 762 m long with three spans of 160 - 441 - 160 metres with Approach Spans on each end of the suspension portion of the bridge. See drawing 1960-009 in Appendix A.
The bridge opened to traffic in 1955 with two traffic lanes, a narrow sidewalk and a utilities corridor. In 1998 and 1999 the bridge was retrofitted to add a third traffic lane. This was achieved by widening the roadway and placing a sidewalk and bikeway outside the suspended structure.

The intention now is to replace all of the suspended structure of the suspension bridge, while keeping traffic flowing during the daytime, but with the bridge closed to traffic during five nights per week and on a few weekends.

Figure 1 shows the existing bridge and Figure 2 shows a rendering of the final bridge after deck replacement is complete.

Figure 1: Existing Bridge

Figure 2: Completed Bridge Rendering
1.3 Abbreviations

Abbreviations used in this report include:

B&T  Buckland & Taylor Ltd.
CBCL  CBCL Ltd., water pipe design subconsultants
D/C  Factored demand divided by factored capacity
DND  Department of National Defence
HEC  Harbourside Engineering Consultants, structural engineering subconsultants
HBB  Halifax Harbour Bridges
HPA  Halifax Port Authority
HRM  Halifax Regional Municipality
kN  Kilonewton (a measure of force)
LGB  Lions’ Gate Bridge
m  Metre (also mm, km, etc.)
M&R  M&R Engineering, electrical and mechanical engineering consultants
NWPA  Navigable Waters Protection Act
RWDI  Rowan Williams Davis and Irwin Inc., wind engineering subconsultant
RWDI Air  Rowan Williams Davis and Irwin Air, sound studies subconsultant
s  Second (measure of time)
SEC  Singleton Environmental Consulting, environmental subconsultant, regulatory permitting
S6-06  Canadian Standard CAN/CSA-S6-06 “Canadian Highway Bridge Design Code” with Supplement Nos. 1 and 2, 2011
2 Overall Scheme

General arrangement drawings of the existing and final bridge condition are shown in Appendix A Drawing 1960-009 and Drawing 1960-051, respectively. The existing bridge and new bridge cross sections are shown in Figure 3, Figure 4, and Figure 5 respectively.

Figure 3: Existing Bridge Typical Cross Section

Figure 4: New Bridge Typical Cross Section at Floorbeam
2.1 Deck Segment Fabrication

2.1.1 Welding

The new structure has many one-sided partial penetration welds without backing bars, including trough to deck-plate welds on the orthotropic steel deck, and welds of hollow structural sections. The fabricator will require skill and experience in performing these one-sided partial penetration welds on thin plates.

2.1.2 Prepaving

Fabricated segments will be prepaved with a thin layer of wearing surface in an enclosed and heated area, so that traffic can run on this temporary surface until final paving once all segments are in place.

2.1.3 Assembly

New deck segments will be assembled and lifted into place, where possible, with the sidewalk, bikeway, and water pipe attached and outer barriers unattached. Deck segments, barriers and the water pipe will be corrosion-protected in the shop prior to prepaving.

2.2 Suspended Structure Replacement

A brief general overview of the erection sequence is as follows:
2.2.1 Preparatory Work

Before replacement of deck segments starts, the sidewalk and bikeway must be removed in order to reduce the weight of segments being lowered, and to keep stresses in the structure within acceptable limits. For similar reasons, the existing 24 inch water pipe must also be removed from most segments before lowering of the first segment.

Barricades and security will be required to prevent public access to the sidewalk and bikeway and a security fence will be added before the sidewalk and bikeway panels are removed.

2.2.2 Dartmouth Side Span at Cable Bent

The first segments to be replaced will be the two 20 m segments at the east end of the Dartmouth Side Span. The work will be done on a weekend and will involve:

• Cutting the deck and truss members and lowering the first existing 20 m deck segment onto a barge using the erection gantry supported by the bridge hangers;
• Raising the new deck segment, D1, from the barge and connecting it to the (adjustable) hanger connections;
• Moving the erection gantry forward to its next position;
• Cutting free and lowering the second segment;
• Raising the second new segment, D2, and connecting it to the existing deck segment D3 using the temporary deck connection.

This will require very careful planning in order for the bridge to be opened to traffic on the Monday morning.

2.2.3 Dartmouth Side Span and Centre Span

Typical Dartmouth Side Span and Centre Span segments will be replaced in a similar manner to 2.2.2, but one at a time. They will be replaced during a 10½ hour night closure about every three days (weather permitting).

2.2.4 Typical Replacement Cycle

On the two nights following replacement of a deck segment the lifting gantry (along with the strand jacks, pumps and other equipment) will be moved forward and reconnected, the next segment to be lowered will be prepared, the existing trusses will be strengthened, and the transverse splice between the previous two deck
segments will be welded, and bolting will be completed. The bridge will remain closed to traffic at night from 19:00 to 05:30 Sunday night to Thursday night (Friday morning).

2.2.5  **Dartmouth Tower**

The segments on each side of the Dartmouth Tower will be replaced on weekends because of the extra work involved, and the fact that the segments will have to be moved to and from the barge onto the rip-rap around the pier over a side or end ramp or pulled longitudinally on the barge with tackle connected to the barge.

Access platforms will be erected immediately after the first segment at the tower is replaced to allow installation of electrical systems.

2.2.6  **Halifax Tower**

The two centre span segments east of the Halifax Tower will be delivered by barge and unloaded over an end or side ramp onto the DND property directly below the bridge. Likewise, the existing segments will be moved onto the barge in the same manner. The actual replacement of the segments will be as described in Section 2.2.2, except that the deck segments will be lifted from the DND property.

Access platforms will be erected immediately after the first segment at the tower is replaced to allow installation of electrical systems.

2.2.7  **Erection Gantry Modifications**

Before moving into the Halifax Side Span, the erection gantry will be shortened and modified by adding a turntable, using cranes working on the deck during night closures.

2.2.8  **Halifax Side Span**

The Halifax Side Span is over DND buildings and property, so bridge segments cannot be raised from below as they will be for other spans.

The bridge segments above the DND buildings will be replaced in 10 m lengths.

Existing segments will be removed by cutting, lifting, rotating 90°, and skidding onto a special truck and trailer with a frame that can be cantilevered over a 10 m gap. The segments will then be driven off the Halifax end of the bridge where they will be cut up during the following day at least small enough to allow transport by road, and removed. The trusses will have to be cut and folded down while still on the bridge, for transport under the lane signal structures.
New segments will be delivered over the deck from the Dartmouth end on a similar special truck and trailer. They will be delivered rotated by 90° from their final orientation so that they will fit between the existing trusses and hangers. When over their final position they will be lifted, rotated to their final alignment and lowered into place.

The deck segment (H1) just west of the Halifax Main Tower will be replaced during a weekend closure.

2.2.9 **Halifax Side Span at Cable Bent**

The last two deck segments at the Halifax Cable Bent cannot be erected from above. Therefore, they will be transported to the DND parking lot below the bridge via a barge and a wharf and replaced, either by using the shortened erection gantry in its original configuration, supported by the cable bent and hangers, or by cranes from the ground.

2.2.10 **Field Welding of Deck Plates**

All deck plate butt welds made in the field are to be one-sided full penetration welds using ceramic backing bars.

2.2.11 **Hanger Shortening and Replacement**

Once all new segments of the deck are in place, hangers will be shortened to raise the deck to a higher elevation in order to increase the ship clearance envelope. The existing hangers will then be replaced with new ones.

2.2.12 **Final Paving**

When all the segments are connected, a final paving layer will be placed over the entire new deck.

2.2.13 **Similar Project**

The Lions' Gate Bridge (LGB) in Vancouver, BC, was similarly retrofitted with a replacement suspension bridge deck during overnight closures in 2000 and 2001. Figure 6 shows a typical deck segment being lifted into place on the LGB.
2.3 Need for Planning

The replacement of a suspension bridge deck is a complicated engineering and construction exercise that requires cooperation and planning by all parties involved.

The Contractor will be responsible for the coordination of various parties and timing of construction activities to ensure maintenance of overall schedule and minimal traffic disruptions, while ensuring safety, and minimizing impact on the environment and the shipping channel.

The deck replacement work is an unusual construction project in that there will be two deadlines per day in order to keep traffic running on the bridge safely. In-depth planning at early stages of the project will need to carefully consider the logistics of installing the deck segments on time.

In addition, the nature of the work will require a high level of engineering by the Contractor.

In order to reduce public inconvenience, HHB aims to minimize partial and full bridge closures and, therefore, bridge closures will not be permitted until sufficient planning in advance of construction activities has been completed by the Contractor to the satisfaction of HHB.
3 Schedule

3.1 Overall Project Schedule

The schedule for the project is as shown in Table 1.

Construction is planned to begin in 2014 and end in 2016, except for the painting of hangers, planned for 2017.

Table 1: Project Schedule

<table>
<thead>
<tr>
<th>Activity</th>
<th>Component</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design and Tender</td>
<td>Information Meeting in Halifax</td>
<td>2013 April 18</td>
</tr>
<tr>
<td></td>
<td>Issue Request for Statement of Qualifications (RSQ)</td>
<td>2013 May 31</td>
</tr>
<tr>
<td></td>
<td>Contractors Submit Statement of Qualifications (SOQ)</td>
<td>2013 Jul 31</td>
</tr>
<tr>
<td></td>
<td>HHB Select Tenderers</td>
<td>2013 Sep 13</td>
</tr>
<tr>
<td></td>
<td>HHB Issue Tenders</td>
<td>2013 Sep 30</td>
</tr>
<tr>
<td></td>
<td>Contractors Submit Tenders</td>
<td>2013 Dec 31</td>
</tr>
<tr>
<td>Fabrication and</td>
<td>HHB Contract Award</td>
<td>2014 Mar 31</td>
</tr>
<tr>
<td>Erection</td>
<td>First Segment Erection</td>
<td>2015 Apr 03</td>
</tr>
<tr>
<td></td>
<td>Construction Completion</td>
<td>2016 Aug 31</td>
</tr>
</tbody>
</table>

3.2 Detailed Schedule of Bridge Occupancy

Occupancy of the bridge by the Contractor will be restrained by the need to keep regular traffic flowing during all weekdays and most weekends. However, full or partial closures of the bridge to traffic will be permitted as follows.

3.2.1 Single Lane Closures

Single lane closures will be permitted only from 09:00 to 15:00 and 19:00 to 05:30 Monday to Thursday, and any time on Saturdays and Sundays.

3.2.2 Full Bridge Closures

Full closures of all three lanes of the bridge will be permitted only from 19:00 to 05:30 Sunday to Thursday nights, and on a limited number of weekends (probably 8) from 19:00 Friday to 05:30 Monday.
4 **Erection Engineering**

Because the design of the new deck system is fundamentally affected by the method of construction, the tender documents define certain aspects of the erection more than is typically the case for a bridge project.

4.1 **Control of Stresses**

In order not to overstress any part of the bridge at any stage of its reconstruction, it is necessary to adjust the lengths of the hangers as work progresses. Typically about three or four hangers behind the working front must be adjusted on both sides of the bridge as construction proceeds.

When, and by how much, the hangers must be adjusted has been determined by an exhaustive analysis.

4.2 **Erection Analysis**

Analyzing the bridge at every step of construction, including the application of live and wind loads for every stage of partial deck replacement, and "tuning" it to avoid overstress as described in Section 4.1 is a huge task that would typically be beyond the resources of a bidder during the tender time, and is likely to be on the critical path once a construction contract has been awarded. For this reason, HHB's Engineer has performed analysis ahead of time for all the step-by-step sequences of construction.

4.3 **Erection Sequence**

The sequence to be followed for erection will be defined on the tender/contract plans. Altering the sequence will not be permitted because of the large amount of re-analysis that would be involved.

"Sequence" in this context means not only the order in which segments of bridge must be removed and placed, but also the timing and amounts of hanger adjustments, and ballast needed to balance the forces and deflections.

4.4 **Erection Equipment**

Partly because the weight of temporary equipment must be known for analysis, and partly because the public will be using the bridge during reconstruction, certain pieces of erection equipment have been designed by HHB's Engineer. These are discussed in Section 5.
5 Design of Temporary Equipment

The Contractor will be responsible for designing all erection equipment as needed for the deck replacement, except for the temporary equipment that is defined in the tender/contract drawings.

5.1 Erection Gantries

Erection gantries will be used to remove existing deck segments after detachment from the structure and to replace them with new segments using a system of strand jacks. There are two variations of the erection gantry: typical and turntable.

The design of the erection gantries structural systems, raising/lowering system, and connections to the existing and new segments is given in the contract drawings. The Contractor will be responsible for the selection of the placement of the carriage assemblies on the erection gantries, power systems, controls, devices to move the carriages, positive lock-down devices for the carriages, devices to rotate the turntable, and positive lock-down devices for the turntable. HHB will review all Contractor designs.

5.1.1 Typical Erection Gantry

The typical erection gantry will lower and lift deck segments to and from a barge on the Dartmouth Side Span and the Centre Span where deck panels can be transported by barges in the harbour. Drawing 1960-941 shows the general arrangement of the typical erection gantry.

5.1.2 Turntable Erection Gantry

On the Halifax Side Span, 10 m long segments delivered over the deck will be lifted and lowered by a "Turntable Erection Gantry." This is designed to be constructed from part of the typical erection gantry, with equipment added that will rotate the segments through 90 degrees, and move them along and transversely to the bridge to avoid interference with other parts of the bridge. Drawing 1960-975 shows the general arrangement of the turntable erection gantry.

5.2 Temporary Deck Connection

The temporary deck connection connects the existing and new segments at the working front so that the roadway is continuous for traffic. It comprises a "nose" on
each new segment that is connected to a frame on the end of the existing deck structure. Drawing 1960-901 shows the temporary deck connection.

5.3 Ballast

In order to achieve the required geometry and stress conditions, new segments being lifted into place must be ballasted as shown on the contract drawings. It is expected that the new water pipe will form part of the ballast.

5.4 HHB and Contractor Design Responsibilities

Table 2 lists items of temporary erection equipment that will be designed by HHB's Engineer and will be defined in detail on the contract drawings.

Table 3 lists temporary equipment that will be designed conceptually by HHB's Engineer. Final design will be the responsibility of the Contractor, but loads and movements that must be accommodated will be provided by HHB's Engineer.

All other items of temporary equipment, including but not limited to those listed in Table 4, are to be designed by the Contractor. HHB's Engineer will provide loads and movements to be used for design.

**Table 2: Temporary Works designed by HHB's Engineer**

<table>
<thead>
<tr>
<th>Item #</th>
<th>Temporary Works Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Typical deck erection gantry (excluding strand jacks and hydraulics).</td>
</tr>
<tr>
<td>2</td>
<td>Corbel for gantry connection at cable bents.</td>
</tr>
<tr>
<td>3</td>
<td>Typical erection gantry connection to hangers.</td>
</tr>
<tr>
<td>4</td>
<td>Turntable deck erection gantry (excluding turntable drive mechanism, strand jacks and hydraulics).</td>
</tr>
<tr>
<td>5</td>
<td>Turntable gantry connection to hangers.</td>
</tr>
<tr>
<td>6</td>
<td>Special deck erection gantry for deck segments 45 and 46 at Halifax Cable Bent.</td>
</tr>
<tr>
<td>7</td>
<td>Reinforcement of diagonals and verticals of existing trusses prior to removal.</td>
</tr>
<tr>
<td>8</td>
<td>Lifting hitches on the new deck.</td>
</tr>
<tr>
<td>9</td>
<td>New truss diagonal strong backs (if needed).</td>
</tr>
<tr>
<td>10</td>
<td>Temporary deck connection frame under existing truss.</td>
</tr>
<tr>
<td>11</td>
<td>Temporary deck connection nose on new deck segment.</td>
</tr>
<tr>
<td>12</td>
<td>Adjustable hanger extensions for new deck segments.</td>
</tr>
<tr>
<td>13</td>
<td>Hanger adjustment frames on the existing trusses.</td>
</tr>
<tr>
<td>Item #</td>
<td>Temporary Works Description</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>14</td>
<td>Equipment for adjusting hanger lengths and raising the centre span 2.6 m at midspan.</td>
</tr>
<tr>
<td>15</td>
<td>Temporary traction rods on the existing bridge.</td>
</tr>
<tr>
<td>16</td>
<td>Temporary traction rods and connections on the new bridge (adjustable in the centre span).</td>
</tr>
<tr>
<td>17</td>
<td>Reinforcement as needed of existing traveler rails and connections.</td>
</tr>
</tbody>
</table>

### Table 3: Temporary Works for which Contractor is responsible for final design based on conceptual design by HHB’s Engineer

<table>
<thead>
<tr>
<th>Item #</th>
<th>Temporary Works Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Temporary hanger supports for gantry at both towers.</td>
</tr>
<tr>
<td>2</td>
<td>Beams between hangers and temporary hangers, supporting deck segments H1 &amp; H2.</td>
</tr>
<tr>
<td>3</td>
<td>Jacking frame to relieve truss load on bearings at Dartmouth cable bent.</td>
</tr>
<tr>
<td>4</td>
<td>Hanger fixed length extensions for new deck segments (if required).</td>
</tr>
<tr>
<td>5</td>
<td>Traffic plates between existing deck and the new deck at erection connection.</td>
</tr>
<tr>
<td>6</td>
<td>Expansion joint temporary traffic plates at towers and Dartmouth cable bent.</td>
</tr>
<tr>
<td>7</td>
<td>Temporary transition roadway barriers between old and new barriers.</td>
</tr>
<tr>
<td>8</td>
<td>Longitudinal jacking frames at towers and cable bents.</td>
</tr>
<tr>
<td>9</td>
<td>Special transporters with expandable decks to handle existing and new 10m deck segments of the Halifax side span.</td>
</tr>
<tr>
<td>10</td>
<td>Turntable and drive mechanism for the turntable erection gantry.</td>
</tr>
<tr>
<td>11</td>
<td>Deck lifting frame for segments H1 to H14.</td>
</tr>
</tbody>
</table>

### Table 4: Temporary Works entirely designed by the Contractor

<table>
<thead>
<tr>
<th>Item #</th>
<th>Temporary Works Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Barges with ramps (or side skid frame) as required to handle and dispose of existing deck segments and to deliver new deck segments to the erection front.</td>
</tr>
<tr>
<td>2</td>
<td>Tugs as required (and possibly a control barge with hoists and anchors) to deliver and control barges carrying new and existing deck segments to and from their final location on water or to the applicable wharfs for unloading.</td>
</tr>
<tr>
<td>3</td>
<td>Transporter for loading all deck segments onto barge at fabrication storage yard.</td>
</tr>
<tr>
<td>4</td>
<td>Strand jacks hydraulics and controls, Hilman rollers, tifors, jacking frame (above...</td>
</tr>
<tr>
<td>Item #</td>
<td>Temporary Works Description</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>5</td>
<td>Below deck construction travellers for existing and new decks.</td>
</tr>
<tr>
<td>6</td>
<td>Deck lifting beams for deck segments H15 and H16.</td>
</tr>
<tr>
<td>7</td>
<td>Frames on truck and trailer with jacking adjustment to move both main gantry and modified gantry with turntable.</td>
</tr>
<tr>
<td>8</td>
<td>Support beam and connections for existing stringers and bracing.</td>
</tr>
<tr>
<td>9</td>
<td>Jacking system for removal of existing hanger socket pins. To be tested and proven effective on existing hangers prior to replacement of any deck segments.</td>
</tr>
<tr>
<td>10</td>
<td>Wind and segment alignment cross bracing at towers and cable bents.</td>
</tr>
<tr>
<td>11</td>
<td>Alignment cross bracing and closure jacks for new to new deck segment splicing.</td>
</tr>
<tr>
<td>12</td>
<td>Lateral supports at towers, if needed.</td>
</tr>
<tr>
<td>13</td>
<td>Lifting hitches on the existing deck.</td>
</tr>
<tr>
<td>14</td>
<td>Detailed procedures for delivery and replacement of each of the 46 deck segments.</td>
</tr>
<tr>
<td>15</td>
<td>Procedures for access and installation equipment required to install and tension bolts in cable bands.</td>
</tr>
<tr>
<td>16</td>
<td>Procedures for access and installation and equipment required to install new hangers, traction rods and their cable bands and cable wrapping.</td>
</tr>
<tr>
<td>17</td>
<td>Procedures, equipment design and supply for installing construction and procurement of under deck travellers, lifting gantry, temporary deck connection expansion joints and all other contract material.</td>
</tr>
<tr>
<td>18</td>
<td>Safety nets and other protection required to protect shipping, DND buildings and others from falling objects during erection.</td>
</tr>
<tr>
<td>19</td>
<td>Access scaffolding and stairways as required.</td>
</tr>
<tr>
<td>20</td>
<td>Design, supply and use of any further facilities and equipment required for the fulfillment of the contract requirements for shipping and site work for the replacement of the deck segments including modifications required to the existing bents, towers and suspension system.</td>
</tr>
<tr>
<td>21</td>
<td>Temporary netting to prevent egress from the roadway through the existing trusses.</td>
</tr>
<tr>
<td>22</td>
<td>Temporary barriers to prevent egress between the temporary netting and the outer SW/BW barrier on the new deck front end, and at the Halifax cable bent from the approach spans SW/BW.</td>
</tr>
</tbody>
</table>
6 Design Criteria

In general, the design criteria provided are in accordance with Canadian Standard S6-06 “Canadian Highway Bridge Design Code”. In some cases, criteria have been derived specifically for the bridge. Some of these are based on the design criteria used in previous studies for the Macdonald and Lions’ Gate Bridges.

6.1 Live Load

Trucks are banned from the Macdonald Bridge, so the live loading specified in S6-06 is not appropriate.

The live loading to be used for design is based on that used on the Lions’ Gate Bridge, which experiences very similar traffic, and which has been studied extensively over the years.

6.2 Wind Loads

Wind loads have been developed from a site-specific study of the wind, buffeting analyses and wind tunnel testing completed by RWDI, wind engineering specialists.

Stresses in the existing bridge during construction are kept below stresses that they may have experienced during their 58 years in service. In other words: if there is a theoretical overstress during construction, that is considered acceptable provided it is no more than the theoretical stress that would be calculated for the existing condition.

6.3 Criteria for Erection Equipment and Procedures

The contract documents will specify minimum criteria for the design (by the Contractor) of erection equipment and procedures.
7 Other Considerations

7.1 Work over DND Property

The land below the Halifax Side Span and Halifax Approach Spans is owned by the DND and the Contractor shall take all necessary steps to protect DND property, buildings and personnel throughout construction. The Contractor will be responsible for requesting approval to access DND lands in advance of construction activities.

7.2 Halifax Port Authority

HHB has been in consultation with the Halifax Port Authority (HPA) but it will be up to the Contractor to make satisfactory arrangements with HPA regarding access and control of shipping in the port.

7.3 Water Pipe

There is currently a 24 inch diameter water pipe supported by the bridge structure under the deck. The pipe is owned and operated by Halifax Water. When the deck and its supporting structure are replaced, it is Halifax Water's intent that the pipe will be emptied and removed from the bridge prior to the start of the re-decking, and to replace it with a new 24 inch pipe with new couplings, valves, etc. that will be made operational when the reconstruction work is complete.

The water pipe will typically be lifted with the deck segments and later shifted into its final position.

7.4 Utilities

There are about ten communications utilities on the bridge plus cables for HHB's services. Temporary cables will be used to keep the majority of these utilities functioning without interruption during the deck replacement.

Temporary fibre optic communication cables are to be installed by the Contractor across the bridge to new communication shelters on land at each end of the bridge. The shelters shall contain secure cabinets for each service provider. The temporary cables are to be designed, installed, maintained, managed, repaired and removed by the Contractor. The temporary cables are to be lashed to a messenger cable that will be attached to the hangers on the suspended spans using strand clamps, all of which will be installed a few months before the first deck segment is replaced. The temporary cables are to be moved to the outside of the new outer barrier prior to replacement of the hangers.
7.4.1  **HHB Utilities**

HHB has a variety of utilities on the bridge that are used for operation of the bridge. These include power distribution, lighting and special systems, as described individually following.

7.4.1.1  **Power Distribution System**

The power distribution currently is fed from the Halifax Anchorage, with a back-up emergency power system powered from the Dartmouth administration building. Because of the construction sequence, to maintain power to the bridge, replacement of the system is planned during the deck replacement project. Power will be fed from the Dartmouth Anchorage with new distribution panels at the cable bents and towers.

7.4.1.2  **Lighting**

Lighting comprises deck lighting, structure highlighting and aerial/navigation lighting. More modern fixtures, such as LED’s, will be utilized in the final design.

**Deck Lighting**

No more than two lights shall be out of service at one time while traffic is running.

**Structure Highlighting**

HHB desires structure highlighting to be out of service for less than one month.

**Aerial and Navigation Lighting and Markings**

This lighting must remain in service at all times. Additional lights are to be installed for the navigation channel, supplemented with wide painted stripes.

7.4.1.3  **Special Systems**

A variety of special systems require attention during construction to ensure their continued operation during and after construction, as listed below:

- Lane Control System (to remain in service, no more than one sign bridge out of service at a time);
- Air Gap Measuring System;
- Video surveillance system (to remain in service with some disruptions permitted on suspended spans); and
- Two-way radio communication repeaters.
An existing fog signal system has been decommissioned and is no longer required. Other systems currently in place on the bridge which will not be maintained during construction include:

- Variable Message system;
- ICEcast system (weather condition monitoring);
- Emergency phone system (off-line during construction on suspended spans only);
- Water line heat trace; and
- Compressed air lines (off line during construction on suspended spans only).

7.4.2 Utilities Carried for Others

HHB has agreements with the following organizations for carrying their services across the bridge:

- Department of National Defence;
- Aliant Telecom Inc.;
- MTS Allstream Inc.;
- Bragg Communications Inc. (Eastlink);
- Internetworking Atlantic Inc.; and
- Call-Net Technology Services Inc. (Rogers).

The Contractor will be responsible to design, supply, install, maintain and remove temporary utility cables.

7.5 Increased Vertical Shipping Clearance

During the deck replacement project, HHB requires that the shipping clearance at the edge of the navigation channel be increased by 2.1 m over the existing clearance.

Because the new deck system is deeper below roadway level than the existing deck system is, it will be necessary to raise the roadway by about 2.6 m at mid span in order to increase the shipping clearance by 2.1 m. This will be achieved by reusing the adjustable hanger extensions that will control geometry and stresses during deck replacement operations.
7.6 Bridge Survey

During the final design phase, HHB’s Engineer performed a detailed survey of the existing bridge to determine the following:

- Verticality of the towers and cable bents;
- Existing roadway profile;
- Main cable elevations at towers, cable bents and mid span;
- Position of tower and cable bent bases;
- Elevations of cross beams at towers and cable bents;
- Longitudinal position of the stiffening trusses;
- Positions of travelers; and
- Hanger and main cable chord lengths.

All results of the design phase surveys will be made available to the Contractor. The Contractor will be expected to perform surveys prior to and throughout construction to verify dimensions on drawings as well as to maintain geometry control during the deck replacement.

Surveying a suspension bridge is a difficult and complicated task. The bridge deck geometry changes continuously due to several factors including temperature and wind speed. Therefore, it is necessary to have experience in dynamic surveying methods, and specialized surveying equipment may be required.

7.7 Tonnage of Steel

The approximate weight of new fabricated permanent works is 4,700 tonnes.

The approximate weights of the heaviest lift for the 20 m and 10 m deck segments are 143 tonnes and 71 tonnes, respectively.

7.8 Modifications to Existing Structure

7.8.1 Existing Truss Strengthening

Temporary strengthening of the existing truss diagonals will be necessary before they are removed. Strengthening will be added to the structure in advance of the erection front.
7.8.2 **Cable Bent Strengthening**

It has been found that some of the cable bent horizontal struts and the diagonal bracing are overstressed under the final design loading. To increase the axial and bending capacity, angles will be added along the lengths of horizontal members and some diagonal members will be replaced.

The top struts of the cable bents are also currently overstressed and the bottom plates of these struts are heavily corroded. During construction, the loads acting on these top struts will be significantly reduced when the stringer supports are removed and the existing wind pins are replaced with wind guides. At that time, the bottom plates of these top struts will be replaced with new and thicker plates, which will increase the capacity of the struts prior to replacing the deck segments. The struts will still be theoretically overstressed until the new wind guide and deck have been installed, but the overstress will be less than in the existing conditions. In the final condition the strut will not be overstressed and will satisfy the design criteria.

7.9 **Cable Band Bolts**

The existing hangers and cable bands will be subject to higher loads during the re-decking project than in their present condition. With additional loads placed on the hangers, care must be taken to ensure the existing cable bands remain in place and do not slip along the cable. The cable bands are held in place through friction over the surface of the main cable. The amount of friction is a function of clamping pressure caused by tension forces in the cable band bolts, and the coefficient of friction between the cable and cable band. Therefore, the resistance to sliding of a cable band along a main cable is controlled by adjusting bolt tensions in the cable band.

During the Preliminary Engineering Phase, field measurements of cable band bolt tensions in the current condition were taken at six cable band locations. Data from this investigation was used as part of a preliminary statistical analysis to determine the number of bolts requiring re-tensioning or replacement to avoid cable band slippage during erection.

The preliminary analysis found that 16 cable bands will need their bolts replaced. In order to finalize the analysis, further field measurements of bolt tensions at each of the bolts replaced will be taken and added to the analysis to determine if more cable bands need their bolts replaced.
7.10 **Delivery of Used Bridge Parts**

In the interests of sustainability, HHB would like to see as many of the replaced parts of the bridge as possible being made available for other uses, rather than being scrapped or recycled.

HHB has an agreement with the Halifax Regional Municipality (HRM) for supply of specific quantities as follows:

- 280 m of outer sidewalk/bikeway barriers;
- 120 m of inner sidewalk/bikeway barriers;
- 600 m of sidewalk/bikeway deck; and
- 173 m of hanger ropes.

HHB requires two 20 m complete segments of stiffening truss which the Contractor shall neatly separate from the deck and floor beams. Additional parts may be identified for re-use by others.

The Contractor will be responsible for unbolting and removing the requested parts and delivering them intact to a storage yard for pick-up by others.

7.11 **Cable Dehumidification (optional item)**

HHB, at its sole discretion, may order a cable dehumidification system that comprises:

- One dehumidification plant placed in the Halifax Anchorage;
- The two cable splay chambers in each anchorage and the connecting passageway will be sealed and connected;
- Ducting which will connect the Halifax Anchorage with an injection point on each main cable at the middle of the main span; and
- A control and monitoring system that will record and report key data at the plant, in the Halifax Anchorage, at tops of towers, and at the injection and exhaust points.

Cable dehumidification is considered an optional item by HHB. A decision on whether it will be included in the project scope will be made at time of award.
8 Safety and Security Requirements

8.1 Safety

Safety of the public and of workers throughout construction is of utmost importance to HHB. The Contractor is expected to maintain a safe work site and ensure that adequate training and processes are in place to ensure safety of workers and the general public, including people under and near the bridge. The goal is to have no injuries or lost time incidents on the project.

Historically there have been many more accidental deaths on construction sites than on or in completed structures. In the case of the Macdonald Bridge Deck Replacement Project, the public will be using the bridge while it is under construction, thus placing the public at more risk than normal. In order to mitigate this extra risk, it is necessary to take more precautions than are usually the case on a construction site.

Since the sidewalk and bikeway will be removed from the bridge at the beginning of construction, no pedestrians or cyclists will be permitted on the bridge throughout construction.

8.2 Security during Construction

Security during construction will be important, to safeguard workers and bridge users.

A great variety of construction equipment will be needed at the work front, in particular "strand jacks" and their ancillary equipment, consisting of hydraulic fluid pumps and associated hoses. Because of the vital role the strand jacks play in the safety of the construction program, protection of this equipment against vandalism will be of utmost importance.

A high level of security will be required at both ends of the bridge to keep the public away from the structure when deck panels are being removed, lowered and lifted.
Communications during Erection

HHB has a comprehensive communications plan for the project. The communications objectives leading into the project are as follows:

- Audiences are educated about the project and how it will impact them; and
- The public understands this project is necessary to significantly extend the life of the Macdonald Bridge.

When the Contractor is selected and the on-site work begins, HHB will be the lead in communicating to stakeholders (DND, Halifax Port Authority, neighbours, etc.), the general public and the media. This will include managing a complaints process, communicating changes to schedules for bridge closures and openings, and providing project updates.

Representatives from HHB will be the official spokespeople for the project and the Contractor will be asked to defer to HHB if asked specific questions about the project.

There will be occasions when the Contractor will be asked to participate in stakeholder and or public sessions.
10 Environmental Considerations

10.1 Permits

The only regulatory permit anticipated is a Transport Canada - Navigable Waters Protection Act (NWPA) Permit which HHB is working to secure prior to the project going to tender. This permit will contain terms and conditions that the Contractor will be responsible for observing and implementing.

However, should the Contractor determine that additional marine infrastructure (such as cofferdams, wharves, etc.) is required, then the Contractor will have to obtain additional permits under the Department of Fisheries and Oceans’ Fisheries Act and the Nova Scotia Department of Natural Resources’ Crown Land/Beaches Act. It may be that an additional review under NWPA will be required and that will be the responsibility of the Contractor to secure.

10.2 Environmental Protection Plan

The Contractor will be responsible for the preparation and implementation of an Environmental Protection Plan that will likely have to include the following project-specific plans:

- Health and Safety Plan;
- Environmental Emergency and Contingency Plan;
- Hazardous Materials Management Plan;
- Reuse, Recycling and Waste Disposal Plan;
- Air Quality Management Plan;
- Marine Environment Protection Plan;
- Sediment and Drainage Management Plan;
- Avian Handling Plan;
- Sound Mitigation Plan; and
- Site Lighting Mitigation Plan.

10.3 Parties Without Regulatory Authority - Project Stakeholders

Interested parties without regulatory authority are recognized as project stakeholders. Although they do not hold formal decision-making power, stakeholder
consultation is recognized as an important component of the Canadian Environmental Assessment Act process. Stakeholders associated with the project are likely to include:

- Halifax Regional Municipality (HRM);
- Metro Transit;
- Halifax Cycling Coalition;
- Residents living near the bridge,
- Bridge commuters; and
- Halifax Harbour users.

HHB is taking the lead in consulting with these groups. A stakeholder consultation plan is being prepared by HHB's Communications Manager. The Contractor will support and assist HHB in stakeholder information sessions and follow-up.
11 Bonds

11.1 Bonding Capacity

Bonding will be required including but not necessarily limited to; a Performance Bond in an amount equal to fifty percent (50%) of the total contract price and a Labour and Materials Bond in an amount equal to fifty percent (50%) of the total labour and materials costs. Such Bonds shall be in a form and with a surety approved by HHB. The Bonds will be required to remain in force in favour of HHB during all phases of the work. Tenderers shall be required to submit to HHB evidence of such Bonds as it may reasonably require from time to time during the construction period evidencing that such Bonds are and shall remain in good standing and that the surety continues to meet the Owner's requirements.

11.2 Lien Holdback

All payments made by HHB in respect of Work shall comply with the holdback requirements of the Builder's Lien Act RS 1989 c. 277.
12 Insurance

Insurance to be provided by the Contractor will include the following:

- Damages to the existing structure to be covered by a builders risk policy (minimum 110% of contract value);
- A minimum liability limit of $50,000,000 for the Wrap-up General Liability;
- Wrap-up General Liability to have a completed operation cover for 3 years (even if the construction period is only 18 months) and have a sudden & accidental pollution cover at full limit and all other standard coverage extensions;
- Marine Liability, $25,000,000 minimum; and
- The builders risks insurance to include all risks including flood, earthquake and other natural perils. Other coverage extension included: Debris Removal, Extra Expenses, Inland Transit, Offsite Storage, Increased Costs Due to By-laws, Service Interruption, etc.

HHB is exploring the possibility of providing course-of-construction insurance.
13 Prequalification of Tenderers

HHB will undergo a process of prequalification for tenderers to ensure that only well-qualified entities bid the work. A Request for Statement of Qualifications is scheduled to be issued at the end of 2013 May.

Through this process it is HHB’s intent to pre-qualify and issue tenders by invitation to a limited number of tenderers, probably three.
14 Acknowledgements

Acknowledgements for their contributions to this report are extended to:

• Jon Eppell, P.Eng., of HHB, review;
• Kiran Bal, EIT, of B&T, author;
• Peter Buckland, C.M., P.Eng., of B&T, author;
• Dusan Radojevic, P.Eng., of B&T, review; and
• Keith Kirkwood, P.Eng., of B&T, review.
Appendix A
Reference Drawings

The following drawings have been included for reference.

<table>
<thead>
<tr>
<th>Drawing Number</th>
<th>Revision</th>
<th>Date</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>1960-021</td>
<td>PJ</td>
<td>2013 Mar 28</td>
<td>Existing General Arrangement</td>
</tr>
<tr>
<td>1960-022</td>
<td>PG</td>
<td>2013 Mar 28</td>
<td>Existing Main Towers</td>
</tr>
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<td>1960-023</td>
<td>PG</td>
<td>2013 Mar 28</td>
<td>Existing Cable Bents</td>
</tr>
<tr>
<td>1960-051</td>
<td>PJ</td>
<td>2013 Mar 28</td>
<td>Final Condition General Arrangement</td>
</tr>
<tr>
<td>1960-107</td>
<td>PH</td>
<td>2013 Mar 28</td>
<td>Typical Deck Cross Sections</td>
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<td>PG</td>
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<td>Typical Deck Plan</td>
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<td>1960-109</td>
<td>PG</td>
<td>2013 Mar 28</td>
<td>Typical Truss Segment</td>
</tr>
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<td>1960-110</td>
<td>PG</td>
<td>2013 Mar 28</td>
<td>Typical Floorbeam and Deck Details Sheet 1</td>
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<td>2013 Mar 28</td>
<td>Typical Floorbeam and Deck Details Sheet 2</td>
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<td>1960-201</td>
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<td>Hangers, Traction Rods &amp; Cable Bands General Arrangement</td>
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<td>PF</td>
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<td>Hanger Details</td>
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<td>Water Pipe &amp; Utilities General Arrangement</td>
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<td>PH</td>
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<td>Deck Replacement Summary</td>
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<td>PD</td>
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<td>Temporary Deck Connection General Arrangement Sheet 1</td>
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<td>1960-941</td>
<td>PC</td>
<td>2013 Mar 28</td>
<td>Erection Gantry Framing Plan</td>
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<td>1960-975</td>
<td>PC</td>
<td>2013 Mar 28</td>
<td>Erection Gantry- With Turntable Turntable Traveller Frame</td>
</tr>
</tbody>
</table>
ELEVATION
1:1000

NOTES:
1. FOR GENERAL NOTES AND DESIGN CRITERIA SEE DRAWINGS FIG. 01 TO 221.
2. FOR EXISTING CABLE BAND BOLT REPLACEMENT SEE DRAWING 226A.

Preliminary

Angus L. Macdonald Bridge
Suspended Spans Deck Replacement
Hangers, Traction Rods & Cable Bands
General Arrangement

Buckland & Taylor Inc.
A CONV Company
Existing Cable Band – Bolt Replacement Sequence

ELEVATION
Cable bands requiring bolt replacement are circled north and south side of the bridge. To be marked with a metal tag, at all of bands to be marked. See Note 1
See Note 1

PRELIMINARY

1. For each cable band requiring bolt replacement, field measurements of existing tension in each bolt must be taken and submitted to the consultant. After receiving the measurement data, the consultant will determine if additional cable bands will also require bolt replacement and replacement. See specifications for further details

2. Existing bolt tension to be measured before removal of existing lead calleving

ANGUS L. MACDONALD BRIDGE
SUSPENDED SPANS DECK REPLACEMENT
HANGERS, TRACTION RODS & CABLE BANDS
CABLE BAND BOLT REPLACEMENT DETAILS

BUCKLAND & TAYLOR
a CONV. company

1960-209
NOTES:
1. FOR GENERAL NOTES AND DESIGN CRITERIA REFER TO DRAWINGS 00-2-007.
2. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE STATED.
3. STRUCTURAL STEEL SHALL BE IN ACCORDANCE WITH CSA STANDARD CAN/CSA-G40.21.
4. ROLLED SECTIONS AND STEEL PLATES SHALL BE GRADE 350.
5. HSS SHALL BE GRADE 300 OR GRADE B.
6. STEEL PINS SHALL BE A2 OR A3.
7. 8.2 K/L WITH UNP R = 740 MPa
8. 10.5 K/L WITH UNP R = 750 MPa
9. BOLTS TO BE ENSURED WITH LUBRICATING OILS AND NUTS UNLESS IDENTIFIED WITH DURABLE MARKS
10. HELS SHALL BE FROSTY, PULLS HEOUS UNLESS IDENTIFIED.
11. ALL STEEL TO BE SHIPPED WITH A 1 COAT OF INDOOR OR OUTDOOR WELDING SURFACES WILL BE THICKENED AND PAINTED WITH A 3 COAT OF INDOOR OR OUTDOOR WELDING SURFACES.
12. ONLY ONE LATERAL SPACE BETWEEN ROLLER BEAMS MAY BE LOCATED AT A TIME DURING LIFTING OPERATIONS.
13. FOR GANTRY SUPPORT AT GANTRY HEIGHT REFER TO GGA MIN 250.
14. GANTRY SUPPORT AT GANTRY HEIGHT REFER TO GGA MIN 250.
15. CONSTRUCTION OF GANTRY SUPPORTS COULD AFFECT CLEARANCES WITH CABLE REQUIRED PREVIOUS TO TRANSIENT.

PRELIMINARY

ANGUS L. MACDONALD BRIDGE
SUSPENDED SPANS DECK REPLACEMENT
ERECTIO GANY - FRAMING PLAN

BUCKLAND & TAYLOR
a CCWI company

ERECTIO GANY - FRAMING PLAN

1:50

TYPICAL ERECTION GANY - FRAMING PLAN

1:50

1:50