



**STAFF REPORT
ACTION REQUIRED**

**Strategic Plan for the Rehabilitation of the
F.G. Gardiner Expressway; and Contract Award for
Tender Call No. 314-2013 F.G. Gardiner Expressway
West Deck Replacement**

Date:	February 20, 2014
To:	Public Works & Infrastructure Committee
From:	Executive Director, Engineering & Construction Services General Manager, Transportation Services Director, Purchasing & Materials Management Division
Wards:	Ward 5 – Etobicoke-Lakeshore Ward 6 – Etobicoke-Lakeshore Ward 13 – Parkdale-High Park Ward 14 – Parkdale-High Park Ward 19 – Trinity-Spadina Ward 20 – Trinity-Spadina Ward 28 – Toronto Centre-Rosedale Ward 30 – Toronto-Danforth
Reference Number:	P:\2014\ClusterB\TEC\PW14016 (AFS #18688)

SUMMARY

The report presents a summary of the proposed Strategic Plan for the rehabilitation of the F.G. Gardiner Expressway, extending from Highway 427 to the eastern limit at Logan Avenue, including the "at-grade" and "elevated" sections is presented in this report. The report includes an assessment of the current condition of the Expressway, a prioritization of rehabilitation works, and presents a comparison between the conventional and accelerated approaches for the rehabilitation in terms of project schedule, capital costs and user impact costs associated with the construction of the rehabilitation works.

The approval of an innovative, accelerated approach for the rehabilitation of the Expressway is being recommended. The approach involves scheduling rehabilitation work for the "at-grade" section with the replacement of deck for the "elevated" section, which has reached the end of its service life, using prefabricated deck/girder sections. While this approach represents an initial increase of an estimated \$400 million in Transportation Services' 2014 to 2023 Capital Budget and Plan, the longer term cost differential over the 25 year implementation period using the conventional approach is estimated to be \$115 million. This increase in capital costs is more than offset by the

reduction in traffic and user impacts by an estimated eight years and user impact cost of \$3 billion.

This report also advises on the results of Tender Call No. 314-2013 issued for the replacement of the West Deck of the elevated section of the Expressway from Exhibition Place to Grand Magazine Street (west of Bathurst Street).

RECOMMENDATIONS

The Executive Director, Engineering & Construction Services, the General Manager, Transportation Services; and Director, Purchasing & Materials Management Division recommend that:

1. City Council approve the accelerated approach for the rehabilitation of the F.G. Gardiner Expressway as outlined in Appendix F attached to this report.
2. City Council request that the Executive Director, Engineering & Construction Services and the General Manager, Transportation Services; and the Deputy City Manager and Chief Financial Officer report back to Budget Committee, in support of Transportation Services' 2015 Capital Budget and 2016 to 2024 Capital Plan on the:
 - a. Project delivery schedule, multi-year cashflow requirements and financing strategy for the implementation of the Strategic Plan for the rehabilitation of the F.G. Gardiner Expressway; and
 - b. Revised Strategic Plan for the rehabilitation of the F.G. Gardiner Expressway, including project delivery schedule, multi-year cashflow requirements and financing strategy for the implementation of the Strategic Plan should City Council opt for either the remove, replace or improve option for the Gardiner East Environmental Assessment Study.
3. If Recommendation 2 b. is approved, then Council grant authority to amend Purchase Order No. 6036736 with Marshall Macklin Monaghan Ltd to reflect the additional work required to revise the Strategic Rehabilitation Plan by an additional amount not to exceed \$350,000.00 net of all taxes, including contingencies and revising the current contract value from \$ 2,068,005.90 net of all taxes (\$2,140,402.80 net of HST recoveries) to an upset limit of \$2,418,005.90 net of all taxes (\$2,460,562.80 net of HST recoveries).
4. City Council grant authority to award Contract 13SE-19S, Tender Call No. 314-2013 to Grascan Construction Ltd., for the "F.G. Gardiner Expressway, CNE to Grand Magazine Street, Deck Replacement and Garrison Road Bridge Demolition", in the amount of \$66,500,000.00 net of HST (\$67,670,400.00 net of

HST recoveries) having submitted the lowest compliant bid and meeting the specifications in conformance with tender requirements.

Financial Impact

The recommended accelerated approach to the F.G. Gardiner Rehabilitation project will result in an estimated increase of \$400 million to the Transportation Services 2014 to 2023 Capital Budget and Plan of \$535 million for this project. However for the implementation of the Strategic Rehabilitation Plan, this accelerated approach, versus the conventional construction approach, when viewed over a 25 year period (2014 to 2038), represents an increase of an estimated \$115 million or 6% (vs. \$400 million over 10 years) over the estimated 25 year total cost of \$1.763 billion.

However, the increase in initial cashflow, is more than offset by the reduction in traffic or user impact, by an estimated 8 years (valued at an estimated \$3 billion in user impact). In addition, there are a range of project delivery options and financing models which could further accelerate the construction schedule and reduce the short term capital costs, which will be further explored through the Deputy City Manager and Chief Financial Officer's report back during the 2015 Capital Budget process.

The accelerated construction approach also provides for a longer service life of the “elevated” section of the Expressway which would further reduce annual maintenance costs for the deck and girders. The annually cash flow requirements for the conventional and accelerated construction approach, respectively, are presented in Appendix A.

The recommended accelerated construction approach for the F.G. Gardiner Rehabilitation will result in a change to the sub-project structure and timelines. The order of repairs for the areas identified in the Strategic Rehabilitation Plan will be determined once the procurement process and project delivery model has been finalized.

Capital Financing Adjustments

The Deputy City Manager and Chief Financial Officer will report to Budget Committee as part of the 2015 Budget Process on a detailed financing strategy in conjunction with the completion of Project delivery schedule and multi-year cashflow requirements for the implementation of the Strategic Plan for the rehabilitation of the F.G. Gardiner Expressway.

Contract Awards

The total contract award (Contract 13SE-19S, Tender Call No. 314-2013) and purchase order amendment (Purchase Order No. 6036736) identified in this report is \$66.850 million net of HST.

Funding for this contract award is included in Transportation Services' 2014 Approved Capital Budget and 2015-2023 Capital Plan within the F.G. Gardiner Expressway Rehabilitation project.

The Deputy City Manager and Chief Financial Officer has reviewed this report and agrees with the financial impact information

DECISION HISTORY

F. G. Gardiner Expressway Rehabilitation

At its meeting of May 16, 2012, the Public Works & Infrastructure Committee received a presentation from the Executive Director, Technical Services on the Condition of the Gardiner Expressway. A copy of the presentation can be found at:

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2012.PW15.13>

At its meeting of August 29, 2012, the Bid Committee awarded Tender 130-2012, for the F.G. Gardiner Expressway Structure Repair from York Street to Jarvis Street, to Grscan Construction Ltd. and Torbridge Construction Ltd. in accordance with the revised Contract. The Bid Committee Report associated with this contract award can be found at: <http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2012.BD89.2>

In considering the City's 2013 Capital Budget and 2014 to 2022 Capital Plan on January 15 to 16, 2013, City Council approved a \$505 million budget for the F.G. Gardiner Expressway Rehabilitation Project. Council also directed that Capital and Repair/Maintenance cost items relating to the Gardiner Expressway east of Jarvis Street be tracked as a distinct Capital Project and that the General Manager, Transportation Services, in consultation with the Executive Director of Technical Services provide, as part of the 2014 to 2023 Capital Budget and Plan submission, impacts arising from the strategic plan for the rehabilitation, repair and maintenance of the F. G. Gardiner Expressway, including an assessment of its asset value. These budget allocations were identified through Recommendations 68 to 75 and can be found at:

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2013.EX27.1>

In considering the City's 2013 Capital Budget and 2014 to 2022 Capital Plan on January 15 to 16, 2013, City Council reallocated \$4.41M within the Waterfront Revitalization Initiative budget for the Gardiner Expressway and Lake Shore Boulevard Reconfiguration Environmental Assessment (EA). This budget reallocation was identified as Recommendation 84 and can be found at:

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2013.EX27.1>

At its meeting of April 10, 2013, the Public Works and Infrastructure Committee received a presentation from the Deputy City Manager, Cluster B on Revision to the F.G. Gardiner Expressway Rehabilitation Project. The Council Decision Document associated with this report can be found at:

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2013.PW22.1>

At its meeting on May 7, 2013, Council requested the General Manager of Transportation Services and the Executive Director, Engineering and Construction Services to incorporate options to accelerate the phasing of the F.G. Gardiner Expressway Rehabilitation in their report to the Public Works and Infrastructure Committee early in 2014 on the F.G. Gardiner Expressway Strategic Rehabilitation Plan. Details: decision document, item # 2, 2013.EX31.26 - Revisions to the F.G. Gardiner Expressway Rehabilitation Project (Item PW22.1). The Council Decision Document associated with this report can be found at:

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2013.EX31.26>

At its meeting of May 29, 2013, the Bid Committee awarded Tender 139-2013, for the F.G. Gardiner Expressway - Interim Repairs - Jarvis Street to Don Roadway, to Grascan Construction Ltd. and Torbridge Construction Ltd. in accordance with the revised Contract. The Bid Committee Report associated with this contract award can be found at: <http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2013.BD126.5>

At its meeting of September 25, 2013, the Bid Committee awarded Tender 274-2013, for the F.G. Gardiner Expressway - Bent Repairs (5 Bents), to Grascan Construction Ltd. and Torbridge Construction Ltd. in accordance with the revised Contract. The Bid Committee Report associated with this contract award can be found at:

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2013.BD143.9>

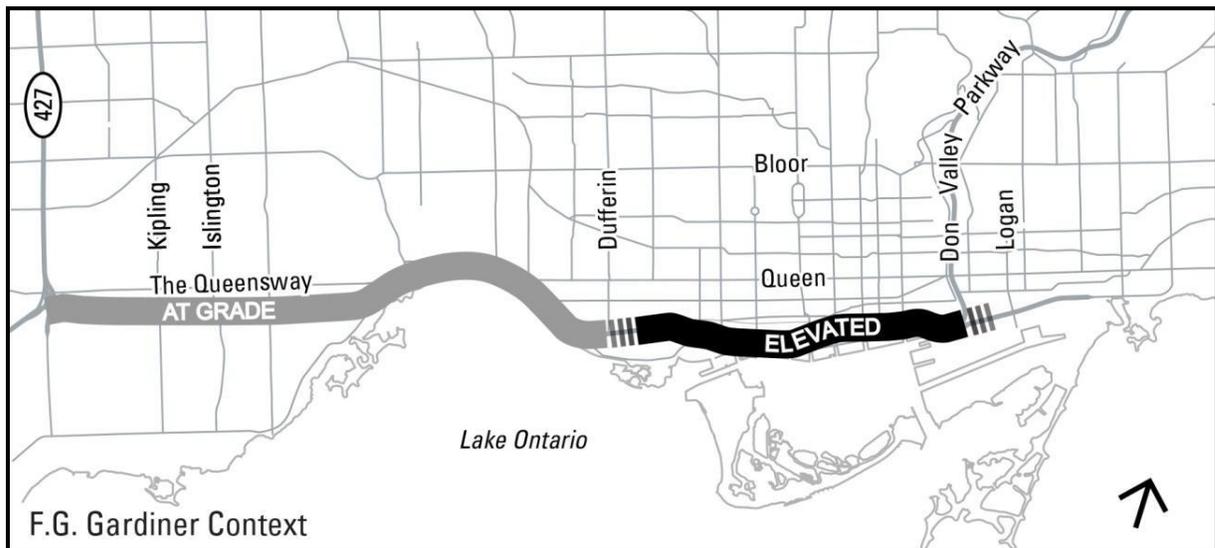
At its meeting of December 18, 2013, the Bid Committee awarded Tender 308-2013, for the F.G. Gardiner Expressway - Median Replacement - from Ellis Ave to Dufferin Street, to Holcim Inc. C.O.B as Dufferin Construction Company in accordance with the revised Contract. The Bid Committee Report associated with this contract award can be found at: <http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2013.BD158.5>

ISSUE BACKGROUND

The Frederick G. Gardiner Expressway (Expressway) is a key transportation artery that extends 18 kilometres from the Queen Elizabeth Way at Highway 427 to east of the Don Valley Parkway. It is owned and maintained by the City of Toronto. The western limit of the Expressway, from Hwy 427 to the Humber River, was transferred from Province of Ontario to the City of Toronto (City) in 1997.

Like much of the public infrastructure in Canada, the Expressway is near the end of its original design life and is the subject of ongoing maintenance and repair. Constructed in sections between 1955 and 1966, the effects of weathering, salt, and the loads and impacts imposed daily by thousands of vehicles are taking their toll. The period in which the Gardiner was built coincided with the construction of many of the City's bridges, although some reinforced concrete bridges have been in service since the early 1900s. The 18-kilometre long Expressway consists of an 11 kilometre "at-grade" section in the west and a 7 kilometre "elevated" section in the east.

Figure 1: F.G. Gardiner Expressway Context Map



The "at-grade" section of the Expressway extends from Highway 427 to approximately 300m east of Dufferin Street, and includes 32 structures (eg. bridges and culverts). The number of driving lanes along the "at-grade" section ranges between six-to-ten lanes, west of the Humber River, and six lanes east of Humber River. The posted speed is 100 km/h west of Humber River and 90 km/h east of the Humber River.

The elevated section of the Expressway extends from just east of Dufferin Street to approximately Logan Avenue in the east. The "elevated" section consists of a series of approximately 335 bridge spans, supporting 6 driving lanes; and includes, 17 ramps, The total deck area extends approximately 300,000 square metres.

As shown in Figure 2, the "elevated" section of the Expressway, is supported by girders resting on a series of 334 steel reinforced concrete bents which consist of a top pier cap supported by columns. The average span between bents is 25 metres, and varies from about 20 metres (near Exhibition Place) to 32 metres (in the area between Jarvis Street to the Don Valley Parkway). Three different types of girders: concrete T beams, steel girder and concrete box girder, were used in the construction of the Expressway, and they are located in the areas shown in Figure 3.

Figure 2: Typical Steel Girder Cross-Section of Elevated Expressway

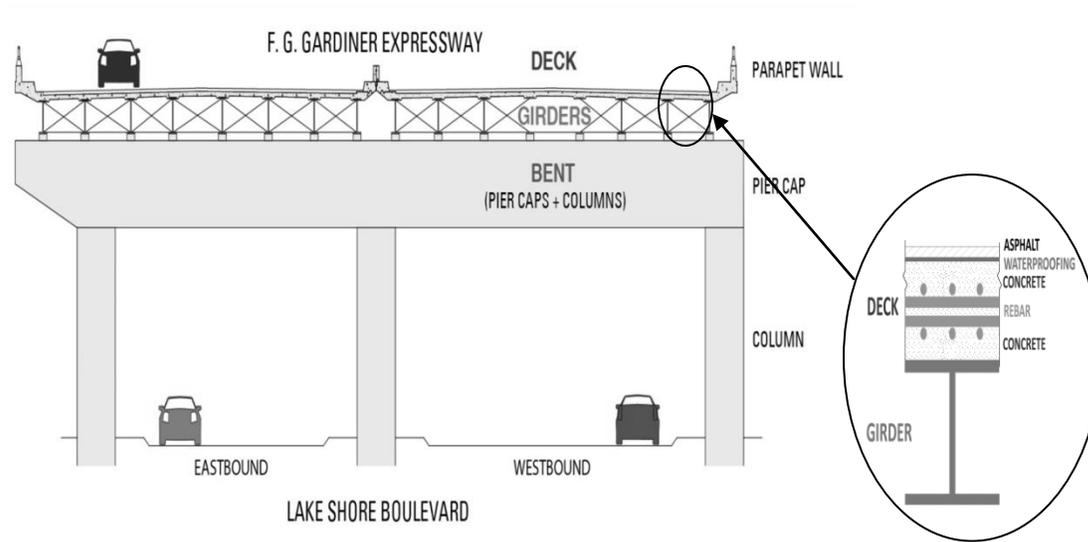
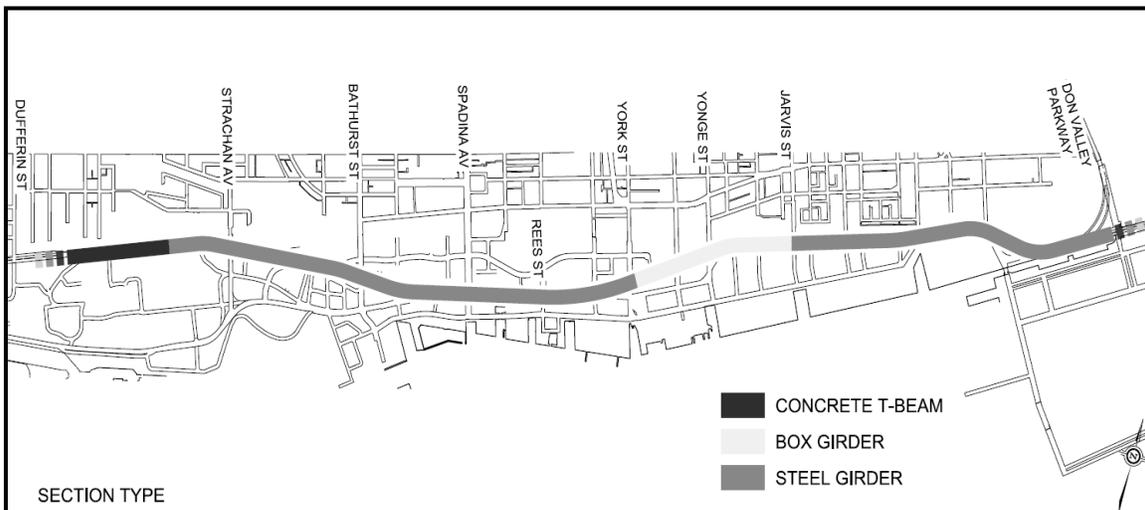


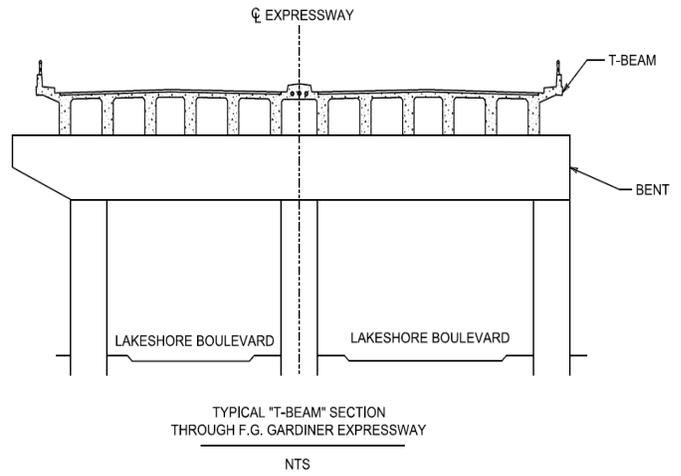
Figure 3: Locations of Structure Types



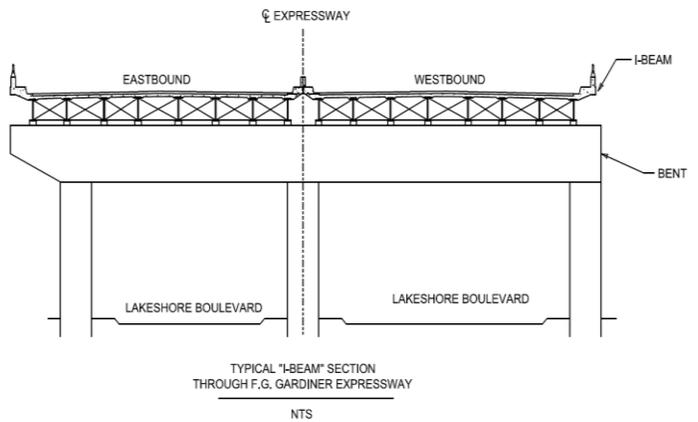
The reinforced concrete slab-on-steel girder construction comprises approximately 80% of the elevated Expressway. Precast concrete box girders with a cast-in-place deck, from York Street to Jarvis Street, make up an additional 15% of the elevated expressway. The remaining 5% of the deck consists of cast-in-place reinforced concrete T-beams.

Figure 4: Elevated Section Structure Types

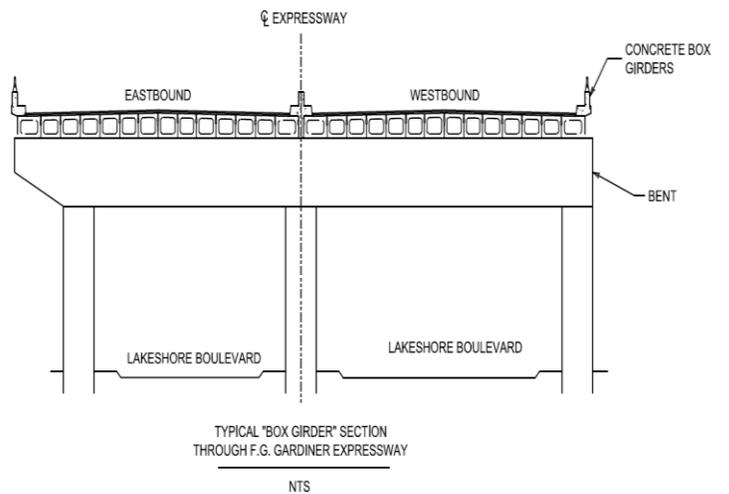
Concrete T-beams:



Steel Girders:



Box girders:



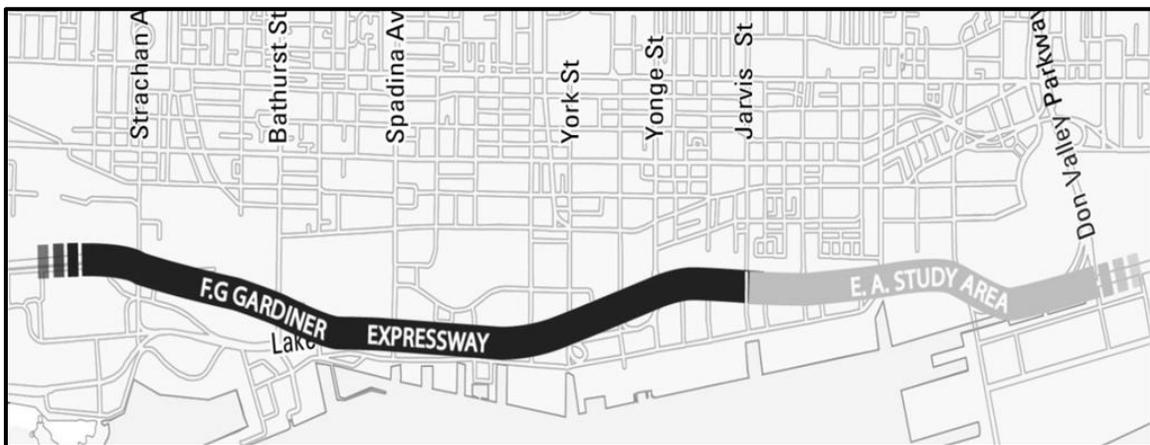
F.G. Gardiner East Environmental Assessment

In July 2008, City Council authorized the City to act as co-proponent with Waterfront Toronto to undertake an Individual Environmental Assessment (EA) for a 2.4-kilometre section of the Gardiner Expressway and Lake Shore Boulevard from Jarvis Street to just east of the Don Valley Parkway at Logan Avenue, as shown in Figure 5.

The EA Study approved by Council and the Minister of the Environment in 2009, assesses the following alternatives for the east elevated Expressway which include:

1. "Do Nothing," other than the planned structural rehabilitation;
2. Retain the existing structure and improve the urban fabric;
3. Replace the Gardiner with a new at- or below-grade expressway; and
4. Remove the elevated expressway east of Jarvis Street and reconfigure Lake Shore Boulevard as a Great Street featuring a new bridge to the Don Valley Parkway.

Figure 5: F.G. Gardiner EA Study Area (Jarvis Street to Don Valley Parkway)



The EA study has necessitated revisions to the previously planned rehabilitation program for the expressway, which advanced the replacement of the 800 metre long West Deck (from 240 metres west of Strachan Avenue to 480 metres east of Strachan Avenue), while deferring the full deck replacement of the East Deck (Jarvis Street to Logan Avenue), pending the outcome of the EA. In considering a staff report titled "Revisions to the F.G. Gardiner Expressway Rehabilitation Project" from the Deputy City Manager, Cluster B, the Public Works & Infrastructure Committee at their meeting of April 10, 2013, endorsed this revised rehabilitation program.

The report also presented a 10 and 13 year budget, necessary to support the rehabilitation works planned for the period 2013 to 2022 at an estimated cost of \$495M; and 2013 to 2025 at an estimated cost of \$663M, inclusive of engineering and construction costs.

City Council, at its meeting of May 7, 2013, in considering the recommendations from the Public Works & Infrastructure Committee, approved the revisions to the rehabilitation plan, and also requested the General Manager of Transportation Services and the Executive Director, Engineering & Construction Services to incorporate options to accelerate the phasing of the F.G. Gardiner Expressway Rehabilitation Plan in their report to the Public Works & Infrastructure Committee early in 2014.

Consequently, two separate projects were initiated:

- (1) The detailed design of the replacement of the West Deck in the vicinity of Strachan Ave. for which bids were received on December 16th, 2013, in response to Tender No. 314-2013, "F.G. Gardiner Expressway, CNE to Grand Magazine Street, Deck Replacement and Garrison Road Bridge Demolition"; and
- (2) The development of a Strategic Rehabilitation Plan for the F.G. Gardiner Expressway from Highway 427 to the eastern limit at Logan Avenue.

COMMENTS

In 2013, the consulting firm of McCormick Rankin (a member of Marshall Macklin Monaghan Ltd Group), was retained to develop the Strategic Plan for the rehabilitation of the F.G. Gardiner Expressway. A copy of the F.G. Gardiner Expressway Strategic Rehabilitation Plan, prepared by Marshall Macklin Monaghan Ltd (February 21, 2014), is available for viewing through the City Clerk's Office. The scope of work for the Strategic Plan was to identify the immediate, short and long term rehabilitation needs of the Expressway and to develop an implementation schedule for the necessary rehabilitation works to maintain the Expressway in a safe and serviceable condition for the next 25 years.

The Strategic Plan took into consideration, rehabilitation work recently completed and underway for the Expressway, which is summarized in Appendix B. In prioritizing the required rehabilitation work, the development of the Strategic Plan took into consideration the needs of the Expressway and other factors including:

- User impacts and associated costs;
- Capital costs;
- Life cycle costs;
- Current Capital Budget allocations and previously forecasted cash flow requirements; and
- Assuming traffic restrictions of no more than a single lane closure in each direction.

The Strategic Plan also took into consideration, the timelines associated with completing the Gardiner East EA, and the work identified in three recently completed Municipal Class EAs:

- 1) Gardiner Expressway Improvements EA from Kipling Avenue to Park Lawn Road (2012);
- 2) Dufferin Street Bridges EA (2011);
- 3) York/Bay/Yonge Ramps Reconfiguration EA (2013)
- 4) Gardiner East EA, ongoing

The costs associated with the works identified in the completed EAs, were not included in the Strategic Plan as these costs are being funded separately as enhancement works. Further, because the Gardiner East EA was underway concurrently with this study, and no final decision has been made, the costs included in the Strategic Plan for this section of the Expressway, represent the costs associated with the "maintain" option considered in the EA.

The Strategic Plan considered the pros and cons of using conventional construction versus an accelerated construction approach, with a particular focus on assessing the construction related impacts on users of the Expressway.

Condition Assessment

The Strategic Plan drew on detailed investigations and available condition assessment data for both the "at-grade" and "elevated" sections which included:

- Compiling and reviewing existing reports;
- Visual inspection of many of the major components of the Expressway;
- Performing more detailed inspections of some components of the Expressway (mostly the bridges and elevated section);
- Reviewing other available sources of information on the existing condition such as that gathered during previous maintenance and rehabilitation; and
- Ground Penetrated Radar surveys used to assess the condition of the deck along the elevated section.

Based on the above, the following conclusions were made on the overall condition of the Expressway decks and barriers of the "elevated" section are in poor condition and as a result are at the end of their life;

- a) The decks and barriers of the "elevated" section are in poor condition and are considered to be at the end of their service life;
- b) Rehabilitation work on the precast concrete box girders section between York Street to Jarvis Street which is underway is expected to extend the service life of this section by approximately 20 to 25 years. However, a complete replacement of the precast box girder and deck slab will be required subsequently;
- c) Coating of the entire steel girders is recommended every 30 years;

- d) The substructure components (bents) vary in condition and some require extensive rehabilitation, and where possible would be scheduled in conjunction with deck replacement work; and
- e) Most of the bridges, within the "at-grade" section, are in no immediate need of a replacement or major rehabilitation, generally requiring only minor rehabilitation.

As a result, the Strategic Plan recommends replacing the existing deck on the “elevated” section as soon as possible. Replacement of the barriers with new barriers will be undertaken at the same time as the deck replacement. Coating of the girder ends would be undertaken at the time the deck is replaced and minor steel repairs would also be undertaken.

The rehabilitation of the bents will be an ongoing activity throughout all stages of the Strategic Plan.

The Strategic Plan's detailed condition survey and assessment has confirmed the rehabilitation needs documented in the previously referenced Staff Report to the Public Works Committee in 2013. However, the Strategic Plan has also identified additional repair and deck replacement requirements beyond the original 13 year period rehabilitation plan. The overall rehabilitation needs are summarized in Appendix C and the limits of the work shown schematically together with the estimated time period through which the repairs should be made in Figures 6 and 7, for the "elevated" and "at grade" sections, respectively.

Figure 6: Expressway Rehabilitation Timeline Requirements for the Elevated Section

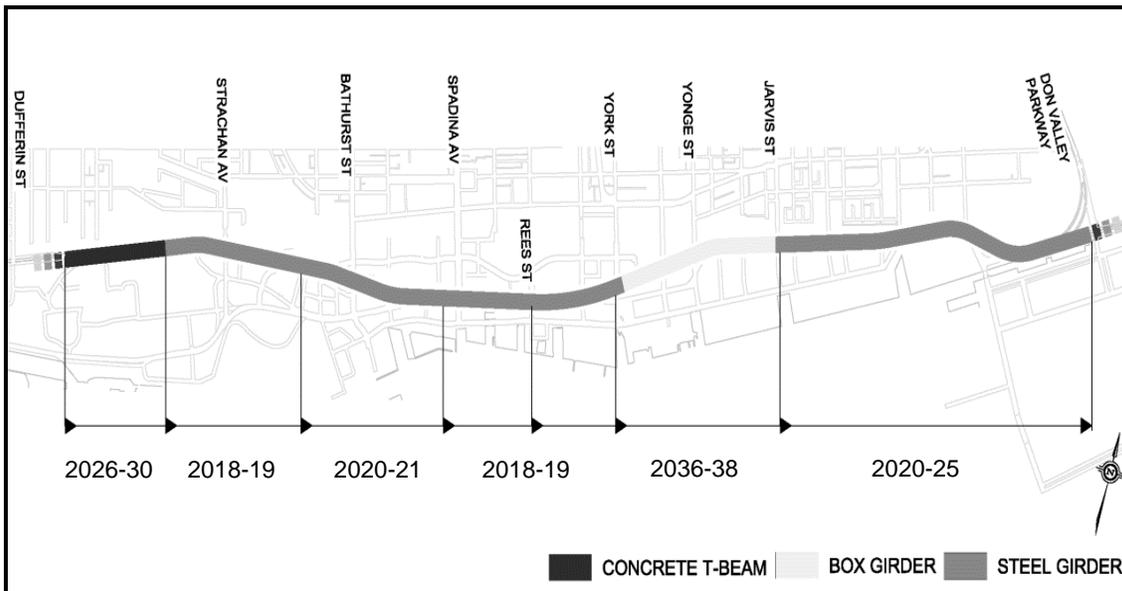
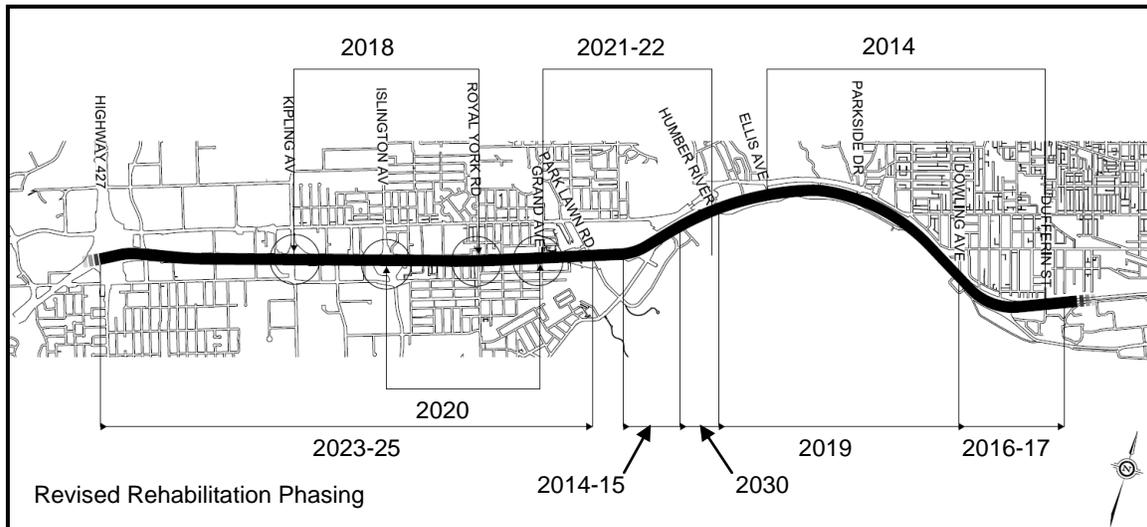


Figure 7: Expressway Rehabilitation Timeline Requirements for the At-Grade Section



Conventional Construction Approach

The recommended scope of work for the "elevated" section of the Expressway includes complete deck replacement. Deck replacement is typically conducted by saw-cutting and chipping the existing deck concrete, retaining the steel girders followed by forming and constructing a new cast-in-place reinforced concrete deck. This conventional rehabilitation construction method has been typically used due to its simplicity, cost effectiveness and familiarity to local contractors. However, the conventional method of removal and new deck construction, using cast-in-place concrete is relatively slow and causes significant traffic delays and disruption during construction. Conventional removal method also generates significant noise and dust nuisance during construction and is based on two 10-hour shifts (20 hours total) per day; and six working days of construction activity per week. The construction season for a typical deck replacement begins in April and, depending on weather, typically continues through to the end of December. The duration of a typical 800 to 1000 metre deck replacement contracts, using conventional construction, is usually about two to three years depending on the area of the deck to be rehabilitated

A typical conventional construction contract will require three construction stages:

- i) Creating a work zone area to provide a large protected work area for long durations, thus maximizing construction work operations and minimizing daily impacts to traffic. The first construction work zone staging requires the removal of the centre-line median and placement of temporary safety barriers to

accommodate two lanes of traffic for each direction eastbound (EB) and westbound (WB). For example, if the work were to begin on the two northerly most west bound lanes, two sets of temporary safety barriers would be installed: one set immediately south of the work zone, to protect the work zone; and another set placed two additional lanes south, separating the westbound and eastbound traffic.

- ii) The second construction stage involves shifting the westbound traffic to the recently rehabilitated section and shifting the work zone area to the middle two lanes (the temporary safety barriers remaining in place to protect the work zone from the westbound and eastbound traffic on either side of the work zone, respectively).
- iii) The third and final stage is similar to the second in that work zone area is shifted to the final two southern lanes of the elevated expressway with the eastbound traffic shifting into the recently rehabilitated section. Once completed, the centre median is installed, and traffic restored to the original three lanes per westbound and eastbound directions, respectively.

It has been estimated, that the conventional construction method will present construction related traffic restrictions for a 20 year period.

The advantages and disadvantages of this conventional construction method are summarized below:

Advantages

- Low capital construction cost;
- The scope of work is well understood by the local contractors and the contractors have the equipment readily available to undertake the work;
- Flexibility to construct irregular deck shapes; and
- Flexibility to address unforeseen conditions.

Disadvantages

- Long construction duration (removal of existing concrete deck is the critical path activity);
- Generate large amount of noise and dust during the removal process;
- Risk of damaging girders during saw-cutting and chipping;
- Poor productivity and quality during winter construction; and
- New deck is prone to cracking during construction if not constructed properly.

Figure 8: Photos of Deck Replacement Using Conventional Construction Methods



It has been estimated that the rehabilitation of the Expressway, based on the needs identified above, will take approximately 25 years to complete if conventional construction methods were used. Additional minor repair and general maintenance work will be required for the period beyond 25 years.

The schedule for rehabilitation of the “elevated” and “at-grade” sections within the Strategic Plan using the conventional construction approach is presented in Figures 9 and 10, respectively, and is closely aligned with the timing of rehabilitation needs identified above. Consistent with rehabilitation plan presented in the Staff Report to the Public Works Committee in 2013, and the funding contained with Transportation Services’ 2014 Capital Budget and 2015 to 2023 Capital Plan, the conventional construction approach

rehabilitates the “elevated” section to a “state of good repair” condition within the first 13 years of the plan (by 2025). However, additional rehabilitation works have been identified through to 2038 which would include annual and continued deck repairs at T-beam and ramp locations, bent repairs, re-coating of steel girders, waterproofing and the replacement of the deck and concrete box girder for the elevated section of the Expressway from York Street to Jarvis Street from 2036 to 2038.

Figure 9: Conventional Rehabilitation Phasing for the Elevated Section

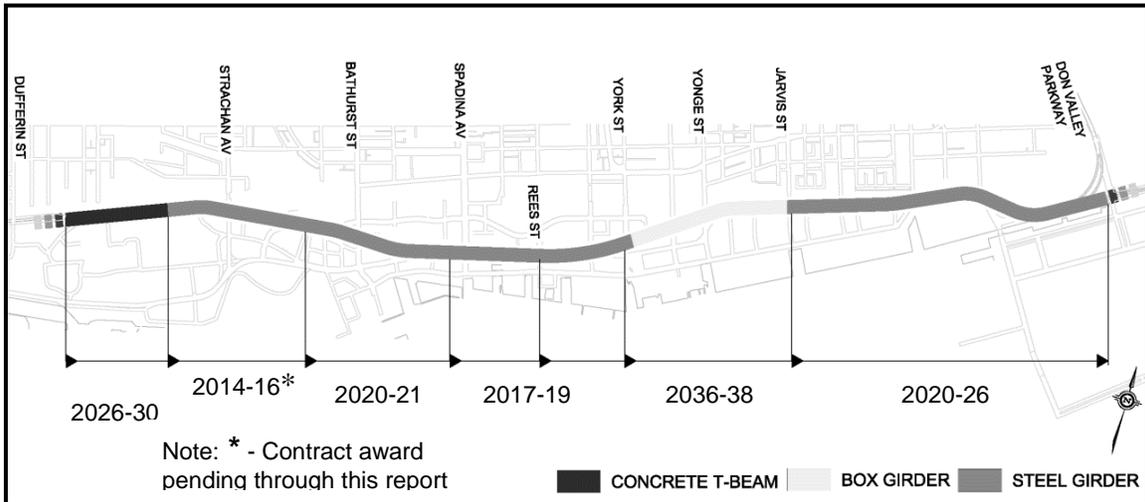
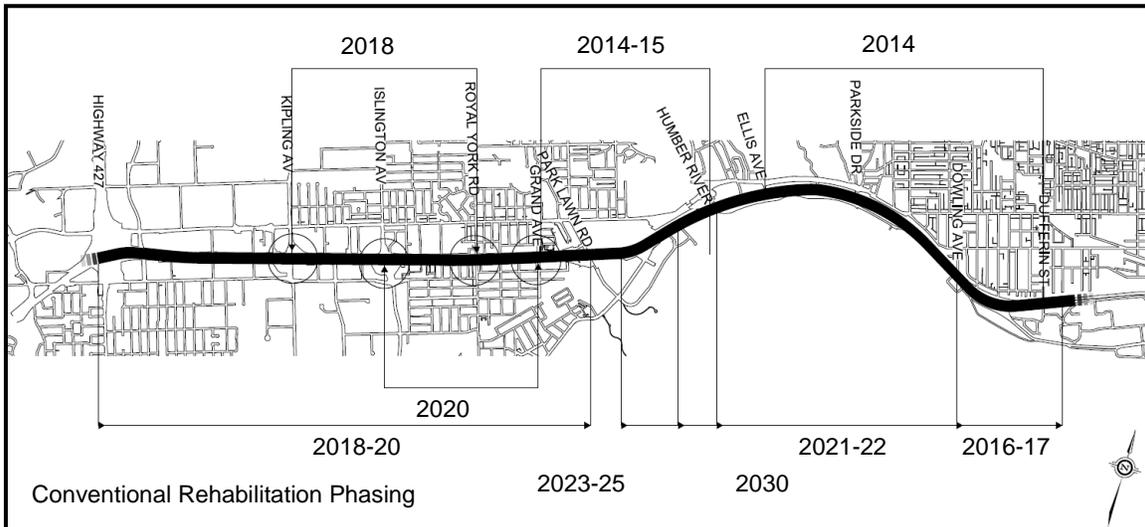


Figure 10: Conventional Rehabilitation Phasing for the At-Grade Section



Accelerated Bridge Construction Approach

In developing the Strategic Plan, the feasibility of using an Accelerated Bridge Construction approach to reduce the construction schedule and mitigating traffic impacts from construction was explored. Through this option, shown schematically in Figure 11, new girders and deck segments would be prefabricated in advance, at a remote facility and then transported to the site and placed in their final locations, using crane hoisting equipment. The existing deck would be saw cut in sections and each deck section, together with the supporting girders, would be hoisted and removed utilizing the same equipment used to handle the prefabricated components.

The advantages and disadvantages of this accelerated construction method have been summarized below:

Advantages

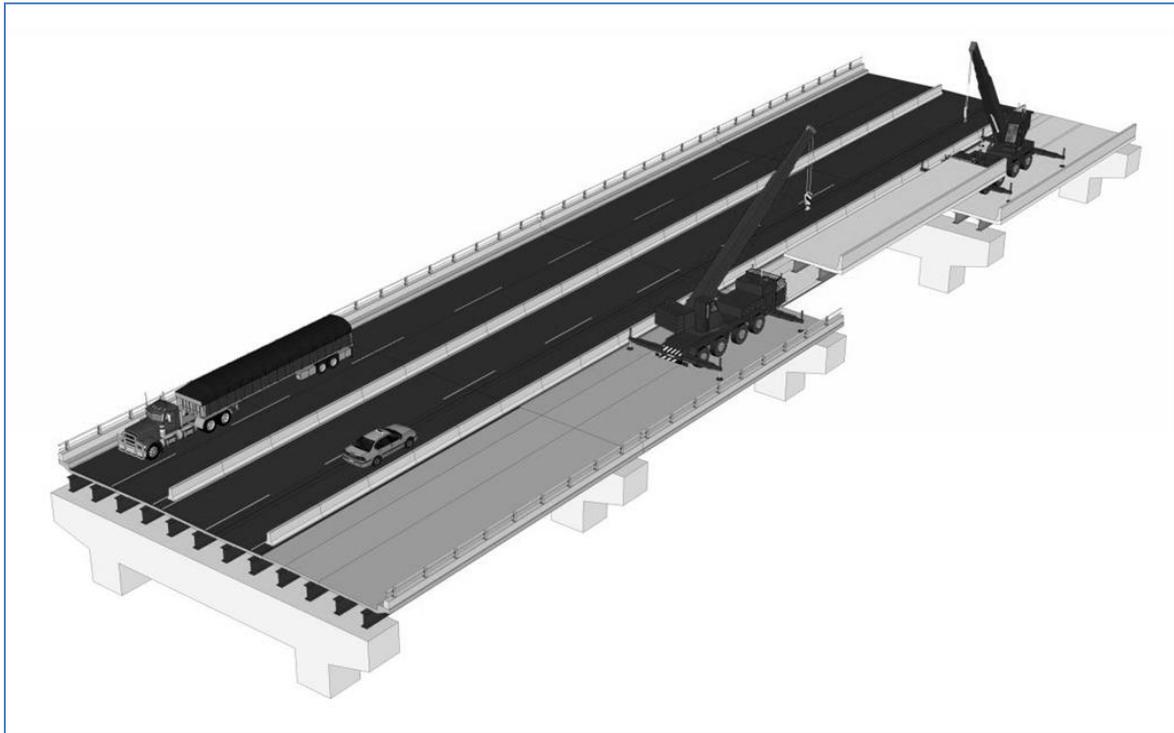
- Construction duration is greatly reduced;
- Traffic delays and public disruption on the Expressway is minimized by reducing the duration of reduced lanes thereby mitigating the user cost;
- Noise and dust from the removal work is mitigated;
- Construction quality is improved since the replacement components are fabricated in a more controlled environment;
- A minimum of a fifteen year increase in service life, and
- Construction with prefabricated components is less weather dependent.

Disadvantages

- More capital construction cost is required due to the cost of the new girders and the cost premium of the accelerated construction method;
- Tight tolerance is required during fabrication and construction to avoid possible installation problems;
- Precise survey data and detailed design is required; and
- Unforeseen risks inherent with unconventional methods exist.

This method has an additional advantage, over conventional construction rehabilitation, with respect to cost savings associated with not having to recoat the steel girders in future years. However, it also means that girders which have not reached the end of their service life, would be replaced and hence represents some loss in residual value.

Figure 11: Schematic of the Accelerated Construction Method



While this operation would require lane restrictions similar to the conventional method, it would significantly reduce the construction schedule. It has been estimated that a typical bent to bent span of 22 metres could be replaced within a few days; and it has been estimated that the accelerated construction approach, would reduce the overall construction impact time by about a 40% over the conventional approach. The net effect is that the rehabilitation of the “elevated” Expressway could be reduced from an estimated 20 year construction period to 12 years or less, if the rehabilitation was undertaken as one continuous project. This represents a significant reduction in impact on users of the Expressway.

The schedule for rehabilitation of the “elevated” and “at-grade” sections within the Strategic Plan using the accelerated construction approach is presented in Figures 12 and 13, respectively, if separate contracts were issued for each component of the rehabilitation.

Figure 12: Accelerated Rehabilitation Phasing- Elevated

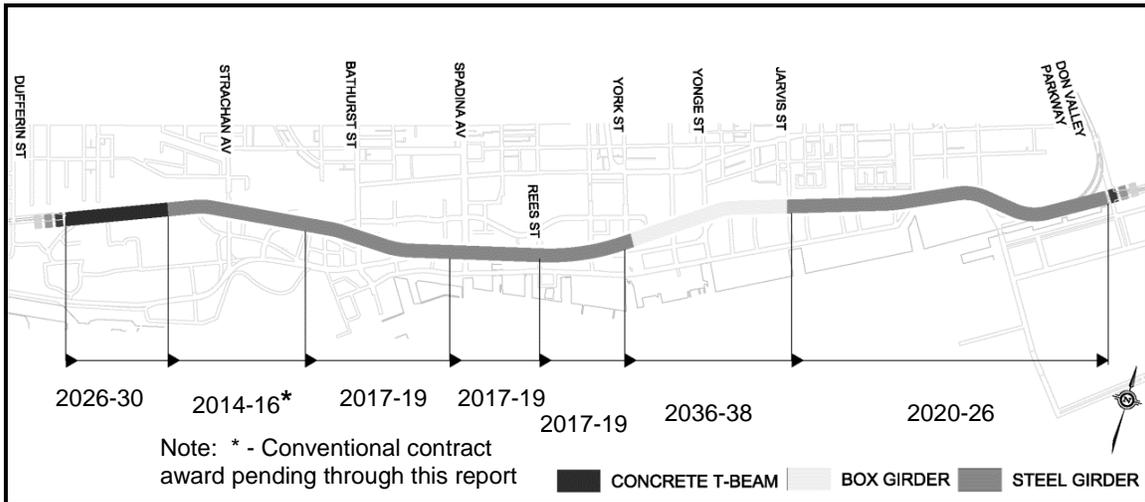
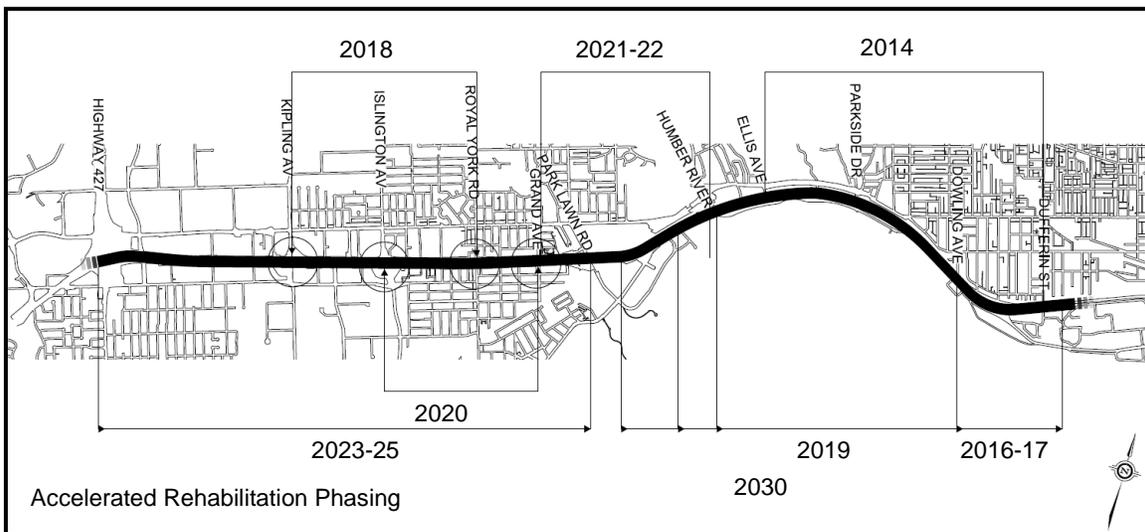


Figure 13: Accelerated Rehabilitation Phasing- At-Grade



Bridge replacements or rehabilitation using this type of accelerated method have become more widely employed in recent years in order to mitigate traffic delays during construction. Recent examples where this approach has been used in North America include:

- Eastern Avenue Bridge (District of Columbia): typical two year project was completed in less than a year;
- 24th Street Overpass Bridge (Iowa): typical two year project was completed in less than a year;

- FAST 14 Project (Massachusetts): typical four year project was completed in one summer
- Jacques Cartier Bridge (Quebec)
- Mercier Bridge (Quebec)

Traffic Impact Assessment

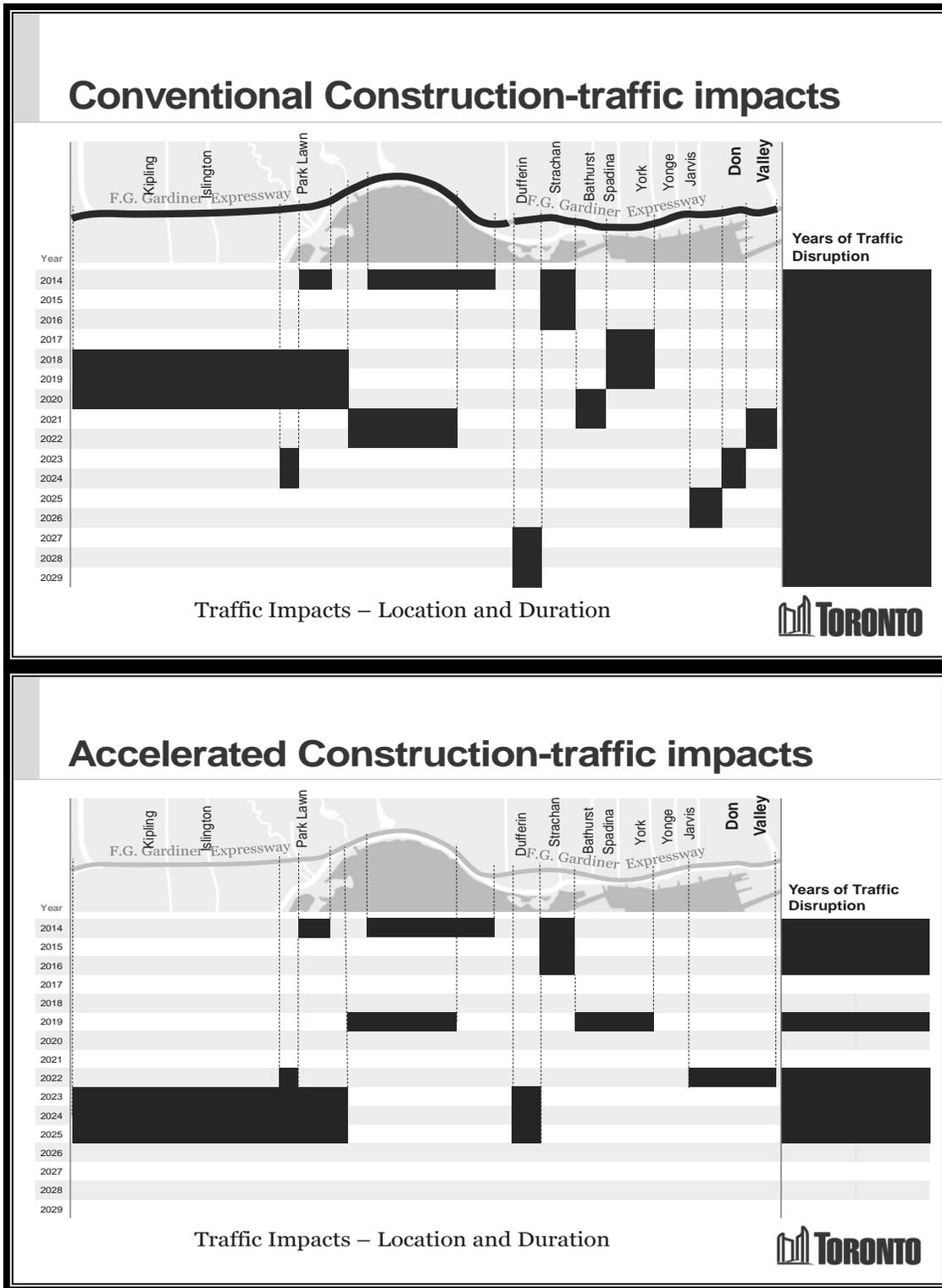
A traffic impact assessment was carried out to identify the level of traffic impacts and delays that can be anticipated during the planned rehabilitation of the Expressway. The assumptions used in the development of road user costs related to the rehabilitation of the Expressway can be found in Appendix D. The user cost summary for the rehabilitation of the elevated portion for both the conventional and accelerated construction approach is presented in Appendix E.

Construction Methodology Evaluation

The Strategic Plan presents two construction options for the rehabilitation of the Expressway: conventional and accelerated. The schedule of work for the “at-grade” and “elevated” sections using the conventional construction approach is prioritized based on condition assessments and need; and represents the lowest initial capital construction cost. The cash flow requirements for this approach are well aligned with the cash flow forecasts presented in the Staff Report to the Public Works Committee in 2013, and reflected in Transportation Services’ 2014 to 2023 Capital Budget and Plan. However, as noted previously, the Strategic Plan has identified the need for rehabilitation works, beyond the original 2025 rehabilitation plan, through to 2038.

The alternative, Accelerated Bridge Construction approach, significantly reduces the construction scheduled for the elevated Expressway and thereby significantly reduces the total duration of construction related traffic restrictions, as shown in Figure 14 by sequencing the rehabilitation works for the “at-grade” section in conjunction with the rehabilitation of the “elevated” section. The traffic restrictions created for the “at-grade” section would impose one set of restrictions, rather than two, if the work on these two sections were undertaken out of sequence eg. undertaken in separate years.

Figure 14: Construction Schedule & Related Traffic Impacts for Conventional and Accelerated Construction



The anticipated cash flows for both construction options, from year 2013 to 2038, are shown in Appendix A, where the annual cash flows include a 2.5% per annum inflation rate.

The capital construction cost (net present value) and user impact costs during the period of construction for the conventional and accelerated construction approaches have been summarized in Table 2. It should be noted that traffic impacts are assessed based on traffic restrictions associated with construction along the “at-grade” section and deck replacement work for the “elevated” section. The complete rehabilitation work includes bent repairs and recoating of the steel girder members through to 2034; and the replacement of the deck and concrete box girder for the elevated section of the Expressway from York Street to Jarvis Street planned for 2035 to 2038.

Table 2: Cost Comparison Summary for the Accelerated and Conventional Approaches for Rehabilitation Works Planned for 2014 to 2038

Evaluation Criteria	ACCELERATED	CONVENTIONAL	DIFFERENTIAL
Total Cost (NPV)	\$ 1,310 M	\$ 1,210 M *	\$ 100 M
Years of Traffic Impact	12 years	20 years	8 years
User Cost	\$ 4.5 B	\$ 7.4 B	\$2.9 B

Note: * - Includes steel coating cost planned before 2038 of approximately \$80 million (net present value)

As shown in Table 2, the differential in the capital construction cost in present value between the two options represents a \$100 million cost premium for the accelerated construction approach

The total years of traffic impact and user cost comparison presented in Table 2, shows that the accelerated construction approach reduces the construction related traffic congestion by 8 years, at an estimated reduction in user cost of almost \$3 billion. Additional benefits of the accelerated approach over the conventional deck replacement include the following:

- mitigation of noise, vibration, and dust
- less weather dependent;
- highest quality achievable by fabricating the structural elements in a more controlled environment;
- 15 year longer service life;
- reduction in ‘interim’ repair requirements;

- new steel girders will be incorporated instead of salvaging the existing girders; and
- reduction of costs for future steel coating requirements.

Given the above, the additional capital cost associated with the accelerated construction over the 25 year period, is more than offset by the significant reduction in traffic impact and user costs; and the reduced annual maintenance costs for the deck and girders given the longer service life of the “elevated” section.

In addition, there are a range of project delivery and financing models which could further accelerate the construction schedule and reduce the short term cash flow needs, which include:

- Municipal managed design-build contract(s);
- Multi-year contract bundling and;
- Alternative Financing and Procurement (AFP) delivery.

The Ontario Ministry of Transportation, for example, has considerable experience with bundling bridge rehabilitation projects using design-build and traditional design-bid-build approaches.

In addition, Infrastructure Ontario has partnered with municipalities to successfully deliver major projects using the AFP approach, and has significant experience with the AFP procurement process, the preparation of performance-based specifications, establishing payment mechanisms, and the preparation of project agreements (contracts). Infrastructure Ontario undertook a study in 2011 which identified that AFP procured projects can achieve significant cost savings and provide additional benefits such as:

- An accelerated project schedule;
- Reduced design, pre-engineering services, construction management costs for the owner;
- Bidder innovation;
- Avoidance of scope creep; and
- Various economies of scale and efficiencies.

While staff have had initial discussions with Infrastructure Ontario, a more formal partnering arrangement may be pursued, should Council approve the accelerated construction approach.

Given the size and scale of the rehabilitation works, which include fundamentally different construction activities for the “at-grade” and “elevated” sections, further investigation and analysis is required to assess all the technical and program management challenges, and financial risks associated with each delivery model.

West Deck Replacement (Tender Call No. 314-2013)

Tender Call No. 314-2013 was issued by Purchasing and Materials Management Division and was advertised on the City's Internet Website on October 29, 2013. The tender was issued in parallel with the development of the Strategic Plan.

The design for the replacement of the West Deck, Tender Call No. 314-2013, "F.G. Gardiner Expressway, CNE to Grand Magazine Street, Deck Replacement and Garrison Road Bridge Demolition," was based on using "conventional construction" methods and includes:

- Replacement of approximately 860 metres of deck from approximately 400 metres west of Strachan Avenue to approximately 460 metres east of Strachan Avenue;
- Replacement of the drainage systems;
- Replacement of the median barrier;
- Placing new deck-waterproofing and asphalt surface; and
- Demolition of the Garrison Road bridge to facilitate the completion of the Fort York Visitor's Centre.

The Purchasing and Materials Management Division, at its Public Opening held on December 16, 2013, opened the following bids for Tender Call No. 314-2013, Contract No. 13SE-19S, for construction of the F.G. Gardiner Expressway, CNE to Grand Magazine Street, Deck Replacement and Garrison Road Bridge Demolition:

Bidders	Price Complete Including HST
Grascan Construction Ltd.	\$75,145,000.00
*Soncin Construction Corp	\$80,309,390.41
Dufferin Construction Co.	\$81,776,062.16
Aecon Construction	\$92,231,881.13

* Tender prices corrected for mathematical errors. Purchasing and Materials Management has verified that the mathematical errors were corrected.

The Tender documents submitted by the recommended bidder have been reviewed by the Executive Director, Engineering & Construction Services and have been found to be in conformance with the Tender requirements.

Engineering & Construction Services staff has compared the bids to the estimated cost and found the price of the recommended bidder to be reasonable.

The lowest bidder for this project is \$75,145,000.00 including all applicable taxes and charges. The cost to the City, net of HST Recoveries is \$67,670,400.00.

Construction using conventional techniques is expected to start in the summer of 2014 and be complete by the end of 2016. Funding is available in Transportation Services' approved 2015 Capital Budget - F.G. Gardiner Capital Budget- 13SE-19S Deck Replacement account, WBS number CTP122-06-03.

The following table summarizes the cash flow requirements, net of HST Recoveries, for the contract award:

Account #	2014	2015	2016	Total
CTP122-06-03	\$22,000,000.00	\$28,000,000.00	\$17,670,400.00	\$67,670,400.00

The Fair Wage Office has reported that the recommended firm has indicated it has reviewed and understands the Fair Wage Policy and labour Trades requirements and has agreed to comply fully.

While the accelerated rehabilitation approach is being recommended in this report, award of the contract, which advances the replacement of the West Deck using the conventional approach at this time, is being recommended for the following reasons:

- a) It has been estimated that a period of about 3 years may be required to prepare the necessary bid documents, award a contract for the design and construction of the rehabilitation works, and mobilization of the contractor including the setup of a prefabrication facility. This represents a scheduling risk in undertaking the necessary repairs within the rehabilitation timelines set for this section of the Expressway.
- b) As noted in Appendix B, work for the "at-grade" section (contracts 13SE-21S and 13SE-20S) is planned for 2014, which already creates traffic restrictions on the Expressway, and therefore no additional traffic restrictions result from this contract in the first year.
- c) The lowest bid was considered to be reasonable.

CONTACT

Frank Clarizio, P.Eng.
Director, Capital Works Delivery A
Engineering & Construction Services
Tel: 416-392-8412
Fax: 416-392-8410
Email: fclarizi@toronto.ca

David Ferguson
Manager, Construction Services
Purchasing & Materials Management
Tel: 416-392-7323
Fax: 416-397-7779
Email: dfergus4@toronto.ca

SIGNATURE

Michael D'Andrea, M.E.Sc., P.Eng.
Executive Director
Engineering & Construction Services

Michael Pacholok
Director
Purchasing & Materials Management

Stephen Buckley
General Manager, Transportation Services

Appendix A - FGG Expenditure Yr-by-Yr Cash Flow Financial Summary

F.G. Gardiner Expressway Revised
 Rehabilitation Project
 Financial Summary (\$M inflated 2.5%
 annum)

F.G. Gardiner Expressway Strategic Plan 2013
 to 2038

Conventional Construction

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	10-year	2023	2024	2025	13-year total	20-year total	25-year total
Program Management Sub-Project Total	2.30	5.20	5.70	6.57	6.73	6.90	7.10	7.20	7.40	7.60	62.70	6.90	7.10	7.20	83.90	96.03	128.94
Elevated Portion Sub-Project Total	8.76	16.50	30.00	20.00	31.30	35.00	33.00	33.00	61.00	28.00	296.56	32.00	33.00	45.00	406.56	833.66	1,442.46
At-Grade Section - Sub Project Total (427 to Dufferin)	0	28.99	0	3.9	4	5.8	13.2	4.3	17.1	17.5	94.79	18.9	19.3	19.8	152.79	176.22	176.22
Pavement Resurfacing Program		1.9		2.4	2.1	2.1		2.6	4.6		15.70				15.70	15.70	15.70
TOTAL PROJECT	11.06	52.59	35.70	32.87	44.13	49.80	53.30	47.10	90.10	53.10	469.75	57.80	59.40	72.00	658.95	1,121.61	1,763.32

F.G. Gardiner Expressway Strategic Plan 2013 to
 2038

Accelerated Construction With West Deck Conventional

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	10-year	2023	2024	2025	13-year total	20-year total	25-year total
Program Management Sub-Project Total	2.3	5.2	5.7	6.568	6.732	6.9	7.1	7.2	7.4	7.6	62.700	6.9	7.1	7.2	83.9	96.03	128.94
Elevated Portion (Including Engineering Services and Bent Repairs) Sub-Project Total	8.76	16.50	30.00	20.00	94.00	98.00	98.00	117.00	119.00	122.00	723.260	42.00	43.00	44.00	852.26	1,113.26	1,558.26
At-Grade Section - Sub Project Total (427 to Dufferin)	0	28.99	0	3.9	4	5.8	13.2	4.3	17.1	17.5	94.790	18.90	19.30	19.80	152.79	176.22	176.22
Pavement Resurfacing Program		1.9		2.4	2.1	2.1		2.6	4.6		15.700				15.7	15.70	15.70
Misc Work - Sub Project Total	0	1.9	0	2.4	2.1	2.1	0	2.6	4.6	0	15.700	0	0	0	15.7	15.70	15.70
TOTAL PROJECT	11.06	52.59	35.7	32.868	106.83	112.8	118.3	131.1	148.1	147.1	896.450	67.8	69.4	71	1,104.65	1,320.88	1,879.12

Appendix B: Summary of Recent and Current Projects on the F.G. Gardiner Expressway

F.G.Gardiner Expressway Projects Recently Completed or Currently Under Construction

Contract 12SE-01S Rehabilitation, York to Jarvis;

Work includes removal and installation of seven (7) precast concrete box girders, new concrete distribution slab, curbs and parapets, concrete removals on the bents and girder soffits, concrete patching on the bents and girder soffits, drainage modification, supply and installation of Changeable Message Signs (5 Pole Mounted and 1 Bent Mounted) (including all system network infrastructure and sign poles/supports), waterproofing, paving and coating of concrete surfaces.

Contractor: Grascan/Torbridge
Value: \$11.2 million (excluding HST)
Start Date: July, 2012
Anticipated Completion Date: April 2014

Contract 13SE-17S Bent Repairs and Temporary Shoring at 15 Locations

Work includes rehabilitation of bents 11, 12, 31, 33 and 35 of the F. G. Gardiner Expressway as well as the design of a hoarding system to be installed at some 15 areas, around bents 11 and 12 and around York St. and around Dan Lackie Way where removal of deteriorated concrete cover exposed rusted reinforcement and/or further deteriorating concrete.

Contractor: Grascan/Torbridge
Value: \$2.00 million (excluding HST)
Start Date: November, 2013
Anticipated Completion Date: March 2014

Contract 13SE-18S Interim Repairs, Jarvis to Don

Work includes removal of concrete and concrete repairs on the bents and deck soffit, removal of concrete parapet wall, remove salvage and reinstate railing on parapet, concrete in new parapet wall and light pole bases, localized deck replacement, dowels into concrete and new street lighting poles, conduit and wiring. The work is to hold the structure in a safe and serviceable condition until the EA study of the Gardiner East end is completed (approximately 7 years).

Contractor: Grascan/Torbridge
Value: \$7.0 million (excluding HST)
Start Date: July, 2013
Anticipated Completion Date: December 2014

Contract 13SE-19S (PENDING) Deck Replacement, west deck – Bent 35 to 91

Work includes replacement of the main deck of the F.G. Gardiner Expressway between the CNE and Grand Magazine Street and the demolition of the Garrison Road Bridge under the F.G. Gardiner Expressway east of Strachan Avenue.

Low bidder: Grasca/Torbridge
Value: \$66.5 million (excluding HST)
Anticipated Start Date: April 2014
Anticipated Completion Date: December 2016

Contract 13SE-21S (PENDING) Bridge Rehabilitation, Three (3) bridges, Main Deck "At Grade" over TTC Humber Loop, Lake Shore WB off-ramp, CN

Work includes structural rehabilitation of three bridges along the main line of the FG Gardiner Expressway between the Humber river and Park Lawn (FGG Gardiner main line over ; TTC Humber Loop, Lake Shore WB off-ramp, CN railway). Work also includes median replacement and retaining wall repair between bridges.

Low bidder: Soncin
Est .Value: \$27.0 million (excluding HST)
Anticipated Start Date: April 2014
Anticipated Completion Date: December 2014

Contract 13SE-20S Median Replacement, Ellis to Dufferin

Work includes the replacement of the median steel beam guiderail on the at-grade portion of the Gardiner from Ellis to Dufferin (approximately 4.5km)

Contractor: Dufferin
Value: \$5.13 million (excluding HST)
Start Date: February, 2014 (Ongoing)
Anticipated Completion Date: June 2014

Appendix C: Summary of the At-Grade Needs of the F.G. Gardiner Expressway

At-Grade Pavement

Based on the previous field investigations, it is recommended that the composite pavement section west of the Humber River, flexible pavement east of the Humber River to the west abutment of the elevated section and pavement on the ramps to be completely reconstructed, including mainline and collector shoulders.

At-Grade Roadside Safety

The precast barrier in median from Wickman Road to Grand Avenue is in good condition, but the steel beam guide rail is in poor condition with numerous rotted posts and needs to be replaced.

Steel beam guide rail from Grand Avenue to Humber River and east of Ellis Avenue to Dufferin Street is in poor condition and needs to be replaced.

The concrete barriers on the structures are generally in fair to poor condition, and do not meet current standards. All of these parapet walls will need to be replaced with barriers meeting current standards when rehabilitated.

At-Grade Drainage

Storm sewers on the at-grade section are at or near the end of their useful service life and should be replaced when the pavement is reconstructed.

At-Grade Structures

- The East Mall Overpass, and Wickman and CPR Overhead:
 - Replacement of the existing concrete overlay, waterproofing, asphalt wearing surface, barriers and median
 - Patching of the soffit, fascia, and walls
- Kipling Avenue, Islington Avenue, Royal York Road, and Grand Avenue, and the Eastbound Off-Ramp to Lake Shore Underpasses:
 - Convert to semi-integral structures
 - Construction of a new concrete overlay on the decks, waterproofing and paving, and new barrier walls
 - Replacement of the bearings
 - Patching of the soffit, fascia, and substructure
 - Eliminate longitudinal joint between the northbound and southbound structures at Kipling and Islington the ed by joining the twin structures together
- Park Lawn Overpass and Mimico Creek Bridges (and ramps):
 - Replacement of the deck with a semi-integral structure to eliminate the expansion joints at the abutments.
 - Patching of the substructures
 - Bearing replacement

- Replacement of waterproofing and paving and barriers on the structures and approaches
- The CNR Overhead, TTC Humber Loop (to be rehabilitated in 2014):
 - Strengthening the corners to increase the shear capacity
 - partial deck replacement
 - expansion joint elimination
 - concrete patching
 - new barriers, waterproofing and paving, and associated approach works
- Westbound Off-Ramp to Lakeshore Boulevard (to be rehabilitated in 2014):
 - partial deck replacement
 - expansion joint elimination
 - concrete patching
 - new barriers, waterproofing and paving, and associated approach works
- The Humber River Bridges:
 - minor rehabilitation (replacement of the waterproofing and asphalt system and repairs to the concrete barriers)
- Windermere Avenue, Ellis Avenue, Colborne Lodge Drive, and Parkside Drive:
 - Concrete overlays and waterproofing and paving system
 - Elimination of the longitudinal joint by connecting the eastbound and westbound structures at the median.
 - New concrete barrier
- Dowling Street Underpass:
 - Replacement of the structure
- Dufferin Street Underpass:
 - Replacement of the structure

Other interim repairs are required early in the Plan to address safety deficiencies comprising primarily of falling concrete and the very poor condition of some of the bridge barriers. Therefore, a concrete patching program and placement of temporary concrete barrier at selected locations is included early in the Plan.

Appendix D: Assumptions for Traffic User Impact Cost Development

An assessment of the user costs was carried out for each of the construction methodologies for the Expressway. The road user costs associated with each phase of rehabilitation was estimated based on the following assumptions:

Workzone Lane Capacity: All sections of the Gardiner Expressway will require a reduction of 1 lane in each direction in order to facilitate the rehabilitation stages. A lane capacity of 1,500 vehicles per hour per lane (vphpl) for lanes was assumed for the lanes remaining open through the workzone. Most of the workzones will have 2 lanes open, in each direction during construction, resulting in a typical workzone capacity of 3,000 vphpl;

The average peak hour volumes vary by section, by direction and by peak period (AM vs PM).

The following are some sample volumes:

<i>Gardiner</i>	<i>AM</i>		<i>PM</i>	
<i>Count Location</i>	<i>WB</i>	<i>EB</i>	<i>WB</i>	<i>EB</i>
<i>West of Royal York</i>	4365	3670	4540	4115
<i>West of Spadina</i>	3865	4080	4330	4015

Traffic Demand: A 24 hour profile of traffic demand was developed for each work zone based on peak hour traffic counts at the workzone location and based on measured 24 hour traffic volumes;

Delay Analysis Methodology: The delay analysis was carried out using the QUEWZ queuing methodology which was developed by the Texas Transportation Institute. The Ministry of Transportation Road User Costs software utilizes the QUEWZ queuing methodology in the development of their user costs;

Delay Calculations: The approach used involved:

- a) calculating the average delay and queued traffic for each hour of the day;
- b) when traffic demand is less than the available capacity then all demand can be serviced during that hour which means that no traffic is delayed and no queue is present;
- c) when hourly traffic demands exceed capacity, which has been forecast to be most of the day on a typical Gardiner workzone, a queue will form, and in a given hour the average queue length is calculated based on the length of the queue at the beginning and end of that hour and the average delay is calculated based on the delay at the start and end of the particular hour;
- d) vehicle hours of delay are calculated for each hour by multiplying the average delay for that hour by the estimated total of ALL traffic that travelled through the workzone;
- e) this calculation is carried out for each hour of the day;

- f) the queue length will continue to increase as long as demand exceeds capacity and conversely the queue will start to decrease when demand is less than capacity; and
- g) the total vehicle hours of delay is calculated as the sum of all vehicle hours delayed, for each hour that a queue is present.

Diversion Assumptions and 30 Minute Average Delay Concept: Since the rehabilitation of the Gardiner is expected to result in significant delays and queuing (which will vary by workzone), an assumption was made that existing users of the Gardiner will put up with an additional 30 minutes delay to their commute before they start diverting away from the Gardiner to other arterial routes, to transit, or to other time periods. The amount of diverted traffic was established based on this assumption, which represents very low rate of diversion requirement in the east sections of the Gardiner, to diversion rates in the order of 20 to 50% in the west sections of the Gardiner. Each direction was assessed independently and the diversion was assigned as required to achieve an average delay of 30 minutes. It is also assumed that traffic that is forced to divert off of the Gardiner in order to establish the 30 minute additional delay will also experience an average additional 30 minute delay in their commute, irrespective of their choice of an alternative mode of transport. The 30 minute delay is based on past studies and research conducted in the field by Texas Transportation Institute who developed the QUEWZ Delay Model. The additional delay of diverted traffic is also used to establish the total road user costs.

Road User Cost Calculation: Road User Costs (RUC) were calculated for a 24 hour period by multiplying the daily vehicle hours of delay by a value of \$20 per hour. The value placed on this delay time is considered to be conservative based on recent work undertaken by Metrolinx, which used a value around \$30.00/hr. Weekly road user costs were estimated using the average daily road user cost using the following formula:

Weekly RUC = ((Average Daily RUC) X 5) + ((Average Daily RUC) X 80%) X 2
This calculation assumes that an average weekend day will experience approximately 80% of the traffic demand and delays of an average weekday.

Appendix E: User Cost Summary for the Rehabilitation of the Elevated Expressway

User Cost Comparison (Present Value)		
Year	User Cost (\$M)	
	Conventional Approach	Accelerated Approach
2014	\$550	\$550
2015	\$460	\$460
2016	\$460	\$460
2017	\$386	-
2018	\$395	-
2019	\$395	\$460
2020	\$457	-
2021	\$457	-
2022	\$391	\$620
2023	\$617	\$460
2024	\$617	\$460
2025	\$128	\$460
2026	\$128	-
2027	\$457	-
2028	\$457	-
2029	\$457	-
2030-34	-	-
2035	\$240	\$240
2036	\$240	\$240
2037	\$40	\$40
2038	\$40	\$40
Total	\$7,372	\$4,490
User Cost Reduction using Accelerated Approach	\$2,882	

Appendix F: Accelerated Bridge Construction Approach

In developing the Strategic Plan, the feasibility of using an Accelerated Bridge Construction approach to reduce the construction schedule and mitigating traffic impacts from construction was explored. Through this option, shown schematically in Figure 11, new girders and deck segments would be prefabricated in advance, at a remote facility and then transported to the site and placed in their final locations, using crane hoisting equipment. The existing deck would be saw cut in sections and each deck section, together with the supporting girders, would be hoisted and removed utilizing the same equipment used to handle the prefabricated components.

The advantages and disadvantages of this accelerated construction method have been summarized below:

Advantages

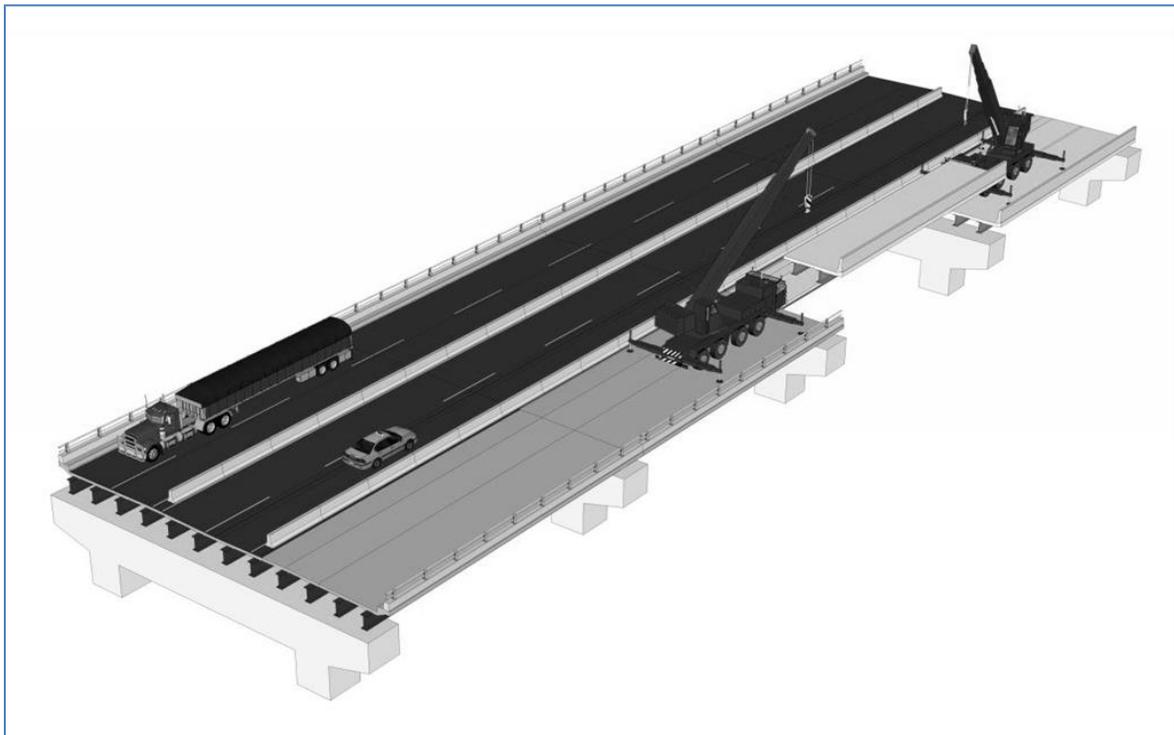
- Construction duration is greatly reduced;
- Traffic delays and public disruption on the Expressway is minimized by reducing the duration of reduced lanes thereby mitigating the user cost;
- Noise and dust from the removal work is mitigated;
- Construction quality is improved since the replacement components are fabricated in a more controlled environment;
- A minimum of a fifteen year increase in service life, and
- Construction with prefabricated components is less weather dependent.

Disadvantages

- More capital construction cost is required due to the cost of the new girders and the cost premium of the accelerated construction method;
- Tight tolerance is required during fabrication and construction to avoid possible installation problems;
- Precise survey data and detailed design is required; and
- Unforeseen risks inherent with unconventional methods exist.

This method has an additional advantage, over conventional construction rehabilitation, with respect to cost savings associated with not having to recoat the steel girders in future years. However, it also means that girders which have not reached the end of their service life, would be replaced and hence represents some loss in residual value.

Figure 11: Schematic of the Accelerated Construction Method



While this operation would require lane restrictions similar to the conventional method, it would significantly reduce the construction schedule. It has been estimated that a typical bent to bent span of 22 metres could be replaced within a few days; and it has been estimated that the accelerated construction approach, would reduce the overall construction impact time by about a 40% over the conventional approach. The net effect is that the rehabilitation of the “elevated” Expressway could be reduced from an estimated 20 year construction period to 12 years or less, if the rehabilitation was undertaken as one continuous project. This represents a significant reduction in impact on users of the Expressway.

The schedule for rehabilitation of the “elevated” and “at-grade” sections within the Strategic Plan using the accelerated construction approach is presented in Figures 12 and 13, respectively, if separate contracts were issued for each component of the rehabilitation.

Figure 12: Accelerated Rehabilitation Phasing- Elevated

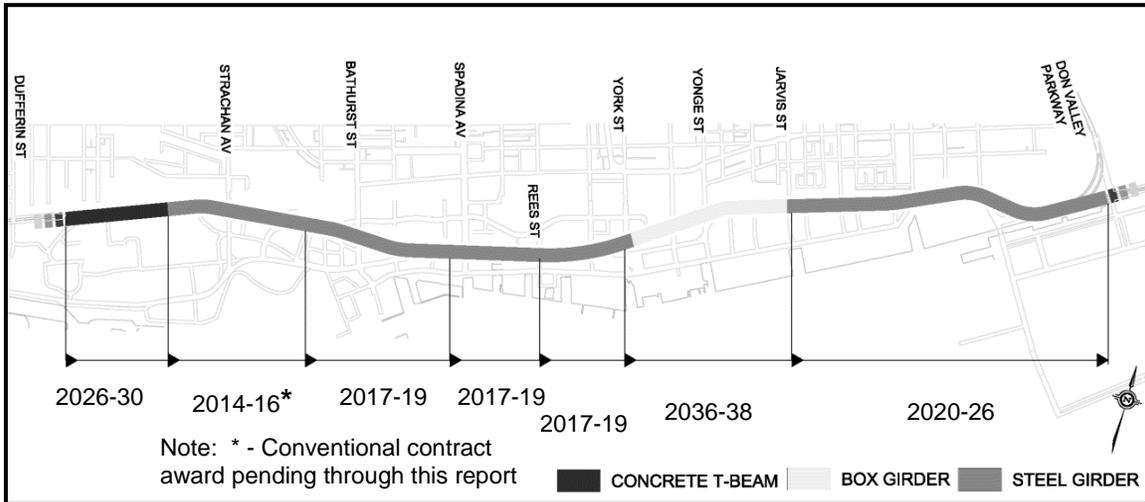
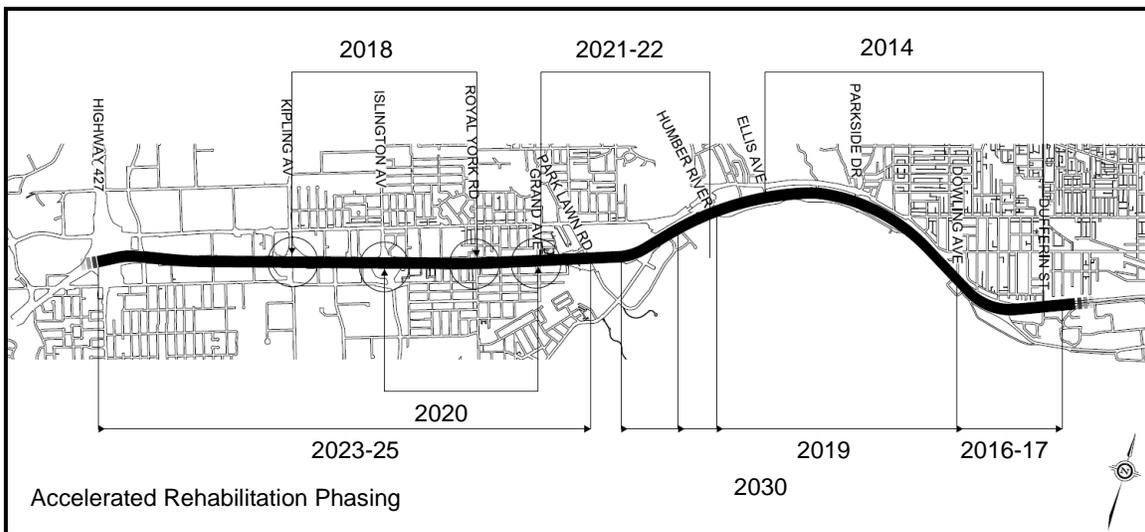
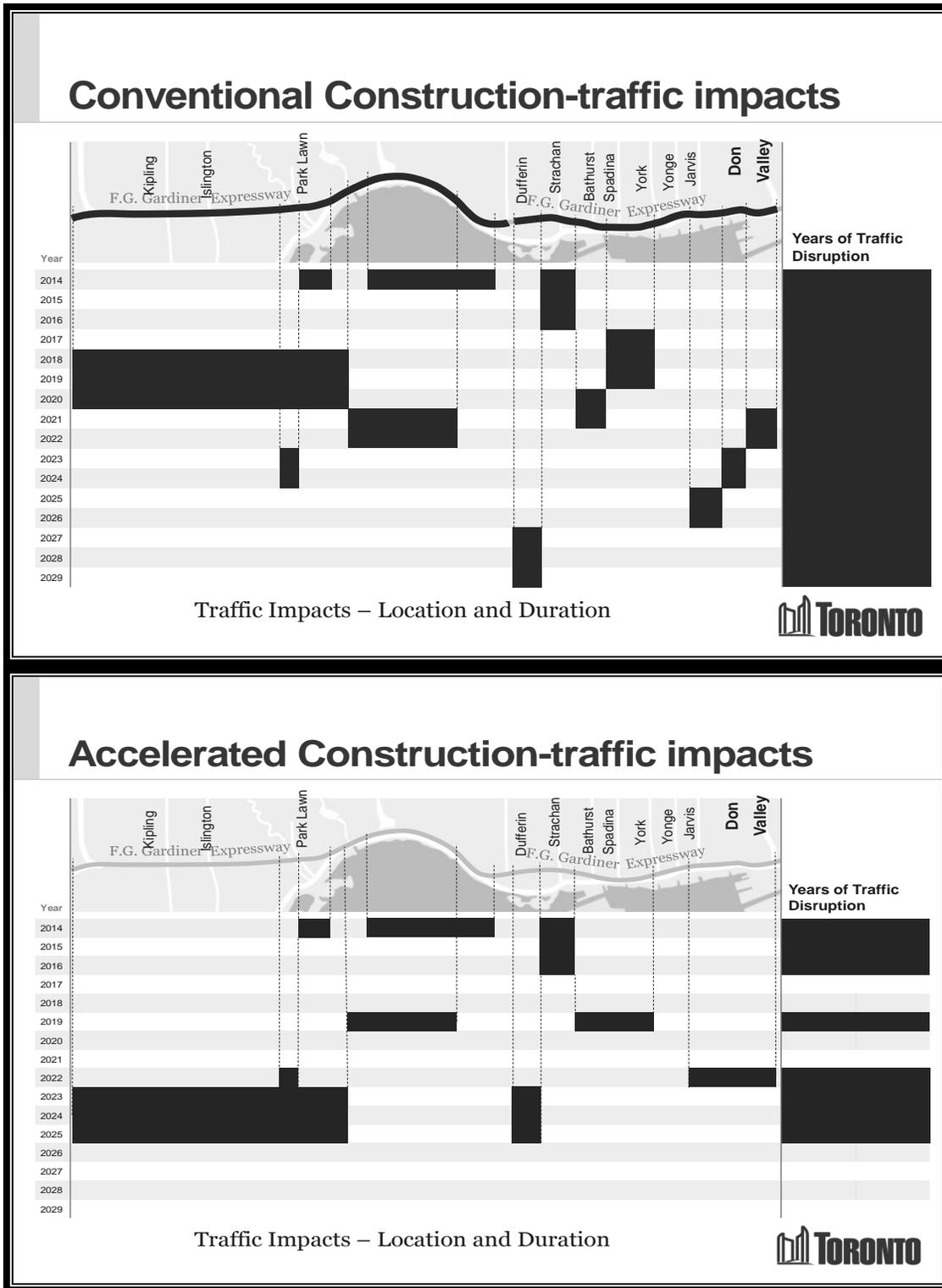


Figure 13: Accelerated Rehabilitation Phasing- At-Grade



The alternative, Accelerated Bridge Construction approach, significantly reduces the construction scheduled for the elevated Expressway and thereby significantly reduces the total duration of construction related traffic restrictions, as shown in Figure 14 by sequencing the rehabilitation works for the “at-grade” section in conjunction with the rehabilitation of the “elevated” section. The traffic restrictions created for the “at-grade” section would impose one set of restrictions, rather than two, if the work on these two sections were undertaken out of sequence eg. undertaken in separate years.

Figure 14: Construction Schedule & Related Traffic Impacts for Conventional and Accelerated Construction



The capital construction cost (net present value) and user impact costs during the period of construction for the conventional and accelerated construction approaches have been summarized in Table 2. It should be noted that traffic impacts are assessed based on traffic restrictions associated with construction along the “at-grade” section and deck replacement work for the “elevated” section. The complete rehabilitation work includes bent repairs and recoating of the steel girder members through to 2034; and the replacement of the deck and concrete box girder for the elevated section of the Expressway from York Street to Jarvis Street planned for 2035 to 2038.

Table 2: Cost Comparison Summary for the Accelerated and Conventional Approaches for Rehabilitation Works Planned for 2014 to 2038

Evaluation Criteria	ACCELERATED	CONVENTIONAL	DIFFERENTIAL
Total Cost (NPV)	\$ 1,310 M	\$ 1,210 M *	\$ 100 M
Years of Traffic Impact	12 years	20 years	8 years
User Cost	\$ 4.5 B	\$ 7.4 B	\$2.9 B

Note: * - Includes steel coating cost planned before 2038 of approximately \$80 million (net present value)

As shown in Table 2, the differential in the capital construction cost in present value between the two options represents a \$100 million cost premium for the accelerated construction approach

The total years of traffic impact and user cost comparison presented in Table 2, shows that the accelerated construction approach reduces the construction related traffic congestion by 8 years, at an estimated reduction in user cost of almost \$3 billion. Additional benefits of the accelerated approach over the conventional deck replacement include the following:

- mitigation of noise, vibration, and dust
- less weather dependent;
- highest quality achievable by fabricating the structural elements in a more controlled environment;
- 15 year longer service life;
- reduction in ‘interim’ repair requirements;
- new steel girders will be incorporated instead of salvaging the existing girders; and
- reduction of costs for future steel coating requirements.