

# GARDINER EXPRESSWAY AND LAKE SHORE BOULEVARD EAST RECONFIGURATION ENVIRONMENTAL ASSESSMENT

## Appendix O - Capital Cost Estimate and Life Cycle Analysis Report

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WATERFRONToronto



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## 1. Background

A high level cost estimate exercise was completed in two phases of the Gardiner Expressway and Lake Shore Boulevard East Environmental Assessment (Gardiner East EA) work: for the evaluation of Alternative Solutions and for the evaluation of Alternative Designs, with the same estimate approach used in both phases. There were two components in each of these phases: determination of comparative capital costs and a Life Cycle Analysis (LCA).

Capital costs accounted for the required initial major capital expenditures, including the costs associated with establishing new bridges, replacement of existing bridges/bridge decks with new decks and new road segments in the corridor from west of Lower Jarvis Street easterly to approximately Logan Avenue. The LCA work involved adopting and applying the LCA costing methodology developed by the City for assessing costs associated with the maintenance and repair works for the entire elevated section of the Gardiner. This approach was applied to the segment of the corridor assessed under the Gardiner East EA integrating the expected ongoing maintenance and repair work costs and the capital costs events into a 100-year timeline starting in 2013. Year 2013 was used as the base year for the initial costing exercise in the evaluation of the Alternative Solutions work that was undertaken in 2013. This year was adopted as the base year for all subsequent costing to be consistent throughout the EA.

Independent peer reviews of the costs were completed at various stages in the EA. The results of these reviews are summarized in Section 4.

The following provides specific details of the comparative capital cost estimate and Life Cycle Cost Analysis.

## 2. Capital Cost Estimate

### 2.1 Overview

Concept plans of the alternatives were developed that provided the basis for the costing exercise. These illustrated the proposed extent of the new facilities at the Gardiner level and the Lake Shore Boulevard level and included sideroad intersections and new ramp configurations.

The capital cost estimate included cost determination for the following Major Costs Items:

1. Roadworks
  - New construction of Lakeshore Boulevard (Don River to approximately Cherry Street, Don Roadway to Logan))
  - Other Roadworks
    - New construction of Don Roadway (Metrolinx Rail Bridge to Lake Shore Boulevard)

- Intersection Reconstruction (at major Lake Shore Boulevard intersections at Lower Jarvis Street, Lower Sherbourne Street, Parliament Street, Cherry Street and at Don Roadway)
  - Lake Shore Boulevard Resurfacing (Cherry Street to Lower Jarvis Street)
  - Traffic signals at intersections including Gardiner Ramp/sideroads
2. Structures
- Bridge and Ramp Demolition (Gardiner deck from just west of Cherry Street at Bent #294 to approximately Logan Avenue, connecting ramps between the Gardiner and the Don Valley Parkway)
  - Bridge Deck Replacement of the Gardiner (from west of Cherry Street at Bent #294 easterly to where the new DVP connecting ramps start/finish)
  - Other Bridges
    - New Lake Shore Boulevard crossing of the Don River
    - New ramp structures connecting the Don Valley Parkway and the new Gardiner deck east of Cherry Street
    - New ramp structures connecting the new Gardiner deck and relocated Lake Shore Boulevard, east of Cherry Street
    - New Metrolinx Rail Bridge over the Don Valley Parkway/Don Roadway ramps
3. Utility Relocations
4. Traffic Maintenance During Construction
- Major Detours, Temporary Roadworks and any outside corridor works
5. Landscaping and Urban Design
- a general allowance for hard and soft landscaping
6. Contaminated Material Disposal
- Contaminated soil disposal for excavation along the new Lake Shore Boulevard footprint with an additional allowance for new footing construction.

Additional information on the costing of the above six Major Cost Items is provided in Section 2.2 through Section 2.7 below.

Quantities were estimated from the conceptual design layout plans of each alternative and included the following:

- Deck areas to be demolished (m<sup>2</sup>)
- New Gardiner bridge deck areas (m<sup>2</sup>)
- New ramp deck areas (m<sup>2</sup>)
- Miscellaneous new bridge deck areas (m<sup>2</sup> - e.g. new Metrolinx Rail Bridge, new Lake Shore Boulevard Bridge over the Don River)
- Bent relocations (number of bents requiring relocation)
- Lump sum allowances for the other roadworks (e.g. Don Roadway between Lake Shore Boulevard and the Metrolinx Rail Bridge and intersections/traffic signals etc.)

Totals for the Major Cost Items outlined above (Items 1 to 6) were developed and, in addition to these costs, percentages were added to determine the total capital costs. For the Hybrid alternatives this involved the following additional costs:

- Contingencies – 15% for the new work east of Cherry Street; 13% for the work associated with the City's original maintain scheme (for works mainly located west of Cherry Street).
- Engineering and design costs – 10% for the new work east of Cherry Street; 7% for the work associated with the City's original maintain scheme (for works mainly west of Cherry Street).

## **2.2 Roadwork Capital Cost Components**

Roadwork capital costs were determined for the section from Cherry Street to Don Roadway and included allowances for the following:

- New eastbound and westbound lanes for Lake Shore Boulevard
- New Queens Quay Extension from Cherry Street to Munition Street
- Don Roadway reconstruction from the Metrolinx Rail bridge south to Lake Shore Boulevard
- A lump sum allowance for each new, major intersection including traffic signals

## **2.3 Structure Capital Cost Components**

Structure capital costs included the cost of the following specific structural elements:

- Demolition of the Gardiner superstructure (Cherry Street to the Don Valley Parkway (DVP))
- Demolition of the existing Gardiner-DVP connecting ramps
- Bridge Gardiner Deck Replacement from Yonge Street to Cherry
- Jarvis Street and Sherbourne Street ramps deck replacement
- New Gardiner-DVP connecting ramps plus deck reconnection works at Cherry Street
- New Gardiner-Lake Shore Boulevard connecting ramps at Cherry Street
- Metrolinx Bridge Replacement at the DVP
- New Lake Shore Boulevard Bridge over the Don River (includes an allowance for new rail spur structure)

## **2.4 Utility Relocations**

The determination of utility relocation costs involved developing a detailed inventory of the existing buried utilities in the Lake Shore Boulevard corridor between Yonge Street and Cherry Street from available Digital Map Owners Group (DMOG) composite underground utility mapping. This inventory was provided to the affected utility companies for the costing exercise. For utility relocation costs associated with the Tunnel Alternative, it was assumed that their complete removal and relocation. This was used to represent the cost for utility relocation with the Tunnel Alternative. For the other alternatives, that involved considerably less utility relocation, 15% of the Tunnel Alternative utility relocation cost was assigned to each of the three Hybrid Alternatives to represent the reduced costs of utility relocation with these alternatives. Of note is that the

majority of the lands through which the new sections of the Hybrid options are located are outside of the existing Gardiner/Lake Shore Boulevard corridor and have minimal existing underground utilities.

Any costs associated with relocating existing utilities from the old Lake Shore Boulevard corridor to the new one through the Keating Precinct area were not included in establishing utility costs for the Hybrid Alternatives. Municipal servicing and utility work requirements and issues in this area were assessed as part of the Keating Channel Precinct Plan (May 2010) that concluded the following relative to municipal servicing infrastructure:

- The current potable water infrastructure in the Keating Channel Precinct is very limited and over 80 years old, nearing the end of its lifespan. It needs to be replaced to adequately prepare for new development in this Precinct and the rest of the Lower Don Lands.
- The sewers in this area were part of the East Harbour Development, and were constructed and installed in the late 1920's and early 1930's. Like the water infrastructure, the wastewater infrastructure is nearing the end of its lifespan. In addition to the age of the infrastructure, the configuration of the existing system is not conducive to supporting the proposed development.
- The majority of storm outlets are found along the Keating Channel. They serve the study area north of the Keating Channel. Most of the active storm system was constructed in the late 1920s and 1930s as a part of the Eastern Harbour Development, with the most recent storm sewers constructed in the late 1940s.
- Much of the servicing infrastructure is old and needs replacing.

Utility/servicing, relocation and de-commissioning issues and costs associated with existing utilities in the bypassed portion of Lake Shore Boulevard were considered to be part of the cost of development of the Keating Precinct lands and as a separate initiative to this EA.

## **2.5 Traffic Maintenance During Construction**

Traffic maintenance costs during construction were determined as a percentage allowance of 5% of the total Major Cost Items 1, 2, and 3 as outlined above. This would include an allowance for the construction of any required traffic detours. For the three Hybrid alternatives this amount varied from approximately \$6.0 million (Hybrid 1) to approximately \$13.5 million (Hybrid 3).

## **2.6 Landscaping and Urban Design**

Comprehensive landscaping and urban design costs were assumed to be part of separate, follow-up work and not included in the Gardiner capital costs. A general allowance only (i.e. \$6.0 million) was included for basic treatments (e.g. multi-lane path, ground cover) in the area between Lower Jarvis Street and Logan Avenue.

## **2.7 Contaminated Materials**

Contaminated material disposal costs were established by estimating the volume of contaminated soil that may be encountered with disposal to an appropriate Ministry of the Environment and Climate Change (MOECC) licensed site using unit rates from recent, relevant project experience. The estimation of the required volume of contaminated soil removal and disposal along the project limits was based on a new curb to new curb width plus 4 m excavation width into native soils along the new Lake Shore Boulevard footprint between Cherry Street and the Don River to a depth of 2 m and an additional allowance for the excavation associated with new footings for the new bridge and ramp structures. Of note is that the future grade of Lake Shore Boulevard in this area will be entirely in fill.

Any de-commissioning costs related to the disposal of contaminated materials in the old road corridor were considered to be part of the development of the Keating Precinct lands and were not part of this EA.

## **2.8 Unit Costs and Cost Assumptions**

Quantities for costing (e.g. bridge deck areas, new LSB lane pavement areas etc.) were taken from concept plans for each of the alternatives as outlined above. Unit costs were then applied to these quantities to determine the capital cost. The unit costs were estimated based on the following principles:

- The major reference for prices was the Ontario Ministry of Transportation (MTO)'s Parametric Estimating Guide (PEG), 2011.
- For items not directly addressed in the MTO PEG document (e.g. bridge demolition, and bent relocation) the work was quantified and priced based on MTO's Highway Costing (HiCo) 2013 data base with adjustment based on similar and local project experience.
- Other items that were not covered or not directly related to PEG or HiCo were estimated and included based on recent, similar project experience. These included the following:
  - Rail structure replacement (Metrolinx Rail Bridge replacement with reconfiguration);
  - Intersection costs (drainage, curb, pavement marking etc.);
  - Soil contamination
  - Basic landscaping in the road corridor

While the majority of unit prices were based on the MTO PEG methodology, price adjustments were made. Prices from recent City of Toronto projects (e.g. bridge removal, and deck replacement) were reviewed and some of the unit prices were adjusted to account for complexity of the Gardiner project, the increased durability required to provide for the extended service life of 100 years, use of premium durable materials and the work in downtown core. Unit prices used in the analysis were converted to 2013 year values. Additional adjustments were made as follows;

- Available MTO PEG 2011 prices were updated with inflation rate of 5% per year for two years in order to represent 2013 prices.

- In agreement with a peer review that was completed for the initial project capital cost estimate (Delcan, 2014), a complexity factor of 2.6 was applied for the new bridge construction item – New Bridge Gardiner and Ramps. This was to account for the difficult urban city construction environment for bridge work. This factor was not considered applicable to demolition, road, signal, and other structural items.
- All deck replacement unit costs were adjusted to be consistent with the City’s original Gardiner Rehabilitation Life Cycle Analysis.

The deck area in square metres was determined for each section of the Gardiner and ramps. To systemically evaluate the costs, the section of the Gardiner Expressway east of Yonge Street was divided into twelve (12) zones based on similar condition and approximate dates of construction or rehabilitation for the existing deck. This was based on the zones developed by the City for their original Gardiner LCA analysis. The capital and Operations and Maintenance (O&M) costs for these zones were developed for each of the alternatives according to the zones indicated below. O&M costs were taken from the City’s original LCA costing in those zones where deck replacement/basic rehabilitation works are required (essentially west of Cherry Street).

- Zone 1: Jarvis Street to Small Street
- Zone 2: Small Street to Cherry Street
- Zone 3: Cherry Street to Don River (Existing structures to be maintained)
- Zone 3a: Cherry Street to Don River (New Structures under Hybrid Scheme)
- Zone 4: Gardiner to LSB Ramps at east
- Zone 5: Jarvis on-ramp
- Zone 6: Sherbourne off-ramp
- Zone 7: Gardiner off ramp to DVP
- Zone 8: DVP on-ramp to Gardiner
- Zone 9: Yonge Street to west of Jarvis Street
- Zone 10: West of Jarvis Street to Jarvis Street
- Zone 0: LSB Bridge over the Don River

**Figures 1A and 1B** at the back of this report illustrate the zones that were used in this assessment.

The following superstructure renewal cost elements were included in the Life Cycle Analysis (LCA) calculations:

- Deck Replacement
- Superstructure Repairs OWP (Overlay Waterproof and Pave)
- Superstructure Repairs PWP (Patch Waterproof and Pave)
- Steel Painting for Steel Plate Girder Sections
- Substructure Concrete Repairs



The following additional cost assumptions are of note:

- A \$35 million cost was assigned to the replacement of the Metrolinx rail bridge over the Don Valley Parkway/Don roadway based on experience with similar rail structures. This represents the total estimated cost to replace the existing spans of the Metrolinx bridge over the Don Valley, the Don Roadway ramps and currently unused east-most span, all of which are on the east side of the Don River (leaving the existing 2 spans over the river as is). Note that the existing road to rail bridge soffit clearances will be maintained with the new spans and therefore the existing rail elevations will be unchanged.
- A general allowance of \$5 million was included in the cost estimate for utility relocation work in the vicinity of Cherry Street. During the Gardiner EA, for the Tunnel Alternative, the cost of the complete removal and relocation of the existing utilities under LSB/Gardiner from Yonge Street to Cherry Street was estimated by the affected utility companies. It was assumed that 15% of this cost (i.e. \$5.0 million) would be used for miscellaneous utility relocation costs associated with the Hybrid Option. Any utility and municipal servicing works in the area between Cherry Street and the Don River, including those associated with the bypassed section of old Lake Shore Boulevard, was assessed as part of the Keating Channel Precinct Plan, May 2010. The cost of utility relocations or new municipal servicing works in the Keating Precinct was considered part of the development of the Keating Precinct.
- In the Gardiner EA cost estimate it was assumed that Cherry Street was in its ultimate location (as per the Keating Precinct plan) and the cost for its realignment were not included in the estimate
- For the Lake Shore Boulevard crossing of the Don River, a new 5-span bridge cost of \$23.9 million was determined. A unit cost of \$5,400/m<sup>2</sup> was used for this bridge in the cost estimate. The approximate length of the future 5-span bridge is 114.2 m (source AECOM General Arrangement drawing from Keating Channel Precinct Plan, February 10, 2010). The deck area used for costing of this bridge was 4,417.5 m<sup>2</sup>. The width of the road component of this bridge is approximately 31.0 m. Total width used in costing is approximately 38.5 m with the additional width being an allowance for the adjacent rail spur. Therefore a cost of approximately \$4.5 million can be assigned to the rail spur bridge. A demolition cost of \$2.806 million was included in addition to the above.
- Note that the above costs do not include allowances for contingency and engineering/design.

### **3. Life Cycle Cost Analysis and Operations and Maintenance Considerations**

A life cycle cost analysis was conducted for the alternatives for a 100-year cycle starting in 2013. The capital costs and costs associated with projected remedial treatment occurrences were assigned throughout the 100 year time line using year 2013 construction unit rates without adjustment for inflation. The maintenance methodology followed the City of Toronto's model proposed for Major and Minor Arterial Roads. A 4% discount rate was applied to convert all costs to 2013 present value and summed together to arrive at the total LCCA cost for each

individual alternative. The following are some key comments and assumptions related to this analysis:

- All capital cost work items carried forward from the original Maintain (west of Cherry Street) were used in accordance with the original “Maintain Alternative” time line.
- The majority of the capital costs for new bridge works (demolition of Logan Ramps and construction of new ramp structures in the vicinity of Cherry Street) would start in 2020 and be carried out over a period of 4 years, followed by designated and specific life-cycle repairs required over the 100 years period of evaluation.
- The new structures supporting the new ramps and new road works would follow a similar model once their remaining life-spans expired. All new bridges would be designed for 75 years life according the CHBDC unless otherwise noted.
- Operations and maintenance (O&M) costs include allowances for the following:
  - Structural work
    - Superstructure Repairs - overlay, waterproof and pave (OWP);
    - Superstructure Repairs - patch, waterproof and pave (PWP);
    - Bent Repairs; and
    - Steel Painting.
  - Road work
    - Road Resurfacing;
    - Road Reconstruction; and
    - Intersection Signal Replacement.
- O&M unit costs were based on ongoing and recent City costs for these types of remediation works.
- It was assumed that the new decks will have a life span of 100 years, having been replaced with reinforcing materials inert to chlorides such as Stainless Steel and/or Glass Fibre Reinforced Polymer (GFRP) in conjunction with high performance concrete, waterproofing membrane and asphalt protection layer

Life cycle costs were determined and documented in two ways:

- All 2013 capital and maintenance costs were assigned over the 2013 – 2113 timeline at the appropriate years and discounted to a 2013 net present worth.
- The initial construction capital costs (essentially in the period of 2020 to 2028) were classified as 2013 capital costs and the remaining costs in the 100 year period were discounted to 2013 and added to the 2013 capital costs.

In the LCA the following structural demolition areas were assumed:

- Zone 4 - Logan Ramps (6236 m<sup>2</sup>)
- Zone 3 - Bent 328 to Bent 340 (6842 m<sup>2</sup>)
- Zone 3 -Gardiner from Cherry Street to DVP (16,558 m<sup>2</sup>)
- Zone 7 & 8 -/DVP Ramps (6905 m<sup>2</sup>)

Any costs associated with purchasing private property to accommodate the new facilities are not included in the capital cost estimates. It should be noted that for the LCA analysis the years assigned for the construction of the new road and bridge elements may vary which would affect the bottom line cost numbers presented in this assessment.

## **4. Peer Reviews**

A number of peer reviews of the project's capital and LCA costing were completed during the EA. The EA's detailed costing files were made available for these reviews and meetings were held to discuss the methodology, assumptions and findings with the peer review firms. The final costing was adjusted based on comments and suggestions that were received.

### **4.1 Alternative Solutions Costing Peer Review (December 2013)**

Parsons (then Delcan) undertook the first of the peer reviews in December 2013 after the initial costing of the Alternative Solutions had been completed. This work reviewed the costing of the following alternatives:

- Remove Option
- Maintain Option
- Improve Option
- Replace Option – Elevated

The following aspects of the costing were reviewed:

- The methodology used to establish unit prices
- Unit prices for new bridge works
- Unit prices for bridge superstructure only
- Unit prices for removal of existing structures
- Life cycle costing methodology
- Discount rate used in the LCA
- Lake Shore Boulevard capital costing assumptions
- Contingencies, engineering and miscellaneous cost percentages

The EA costing team and the Parson's review team worked together to finalize the costing at this stage of the EA. The conclusions of this peer review were the following:

- Unit prices have been updated and they are appropriate for this project;
- All major items were taken into account for Capital Cost and Life Cycle Cost Analysis;
- Consider separating Capital Cost and life cycle cost in future summaries;
- Consider presenting final costs with a price range of +/- 5%.

Note that when presenting the final project costs a cost range of +/- 20% was used (refer to Section 5).

## **4.2 Alternative Design Costing Peer Review (April 2015)**

Parson undertook a second round of peer reviews of the EA team's costing during the evaluation of design alternatives. This work reviewed the Hybrid Options. As before, the EA costing was adjusted, where necessary based on the review comments. It was noted that the costing methodology used at this phase of the EA work was consistent with the methodology used in the previous phase (Alternative Solutions).

Main review comments included:

- The Capital Cost and Life Cycle Cost Analysis are high level cost estimation. This level of estimation is appropriate for EA Study stage of the project.
- The year 2013 present value of blended capital costs and maintenance costs spread out over the 100 year period used a net discount rate of 4%.
- The capital costs do not start to be expended until 2020 and construction is expected to take from 4 to 7 years to complete. As a result, capital costs are discounted from between 7 and 14 years in the future.

The basic conclusion was that the cost analysis included all important structural, roadway and maintenance

items; the methodology used was consistent with the approach used in the previous phase and; no revisions were required and that the assumptions for the time frame in completion of the proposed improvement works were appropriate. Of note is that in the final costing an allowance for the handling and disposal of contaminated materials was included.

## **4.3 Final Costing Peer Review (February 2016)**

A final peer review was undertaken by the Altus Group just prior to the identification of the preferred undertaking. Overall no significant concerns with the total estimated values or the approach and methodology used in the EA costing were identified. Specifically, the following work was undertaken in this review:

- Review of available documentation
- Review/assess the comparative cost analysis completed by the EA team
- Summarize the methodology for the 100-year life cycle cost projections and analysis prepared and its strengths and weaknesses
- Identify and recommend any revisions to the life cycle cost methodology that would improve reliability and accuracy
- Identify, review, assess for validity the infrastructure/construction and financial assumptions included in the life cycle analysis and make recommendations for any missing assumptions or revisions
- Provide comments on the level of reliability/accuracy of the cost projections and analysis including the depth of the analysis, additional elements to consider and the range/contingency that the EA team has recommended

It was noted in the review that all costs generated by the EA team have been in 2013 dollars and, recognizing that the works will be constructed over a multi-year period starting in approximately 2020, escalation costs should be considered.

The review concluded that, in general, the costing approach taken was both reasonable and prudent considering the nature of the proposed project and the limited level of design completion and that the current estimates included all suggested amendments from the previous consultant peer reviews.

Specific comments included the following:

- The lifecycle cost approach used a 100 year life span for what is essentially a large bridge structure. Normally bridge projects would use a 75 year design life.
- Overall the estimate of roadwork costs is in-line with bench-mark projects
- Overall the estimate of structure costs is in-line with bench-mark costs
- The identified cost for utility relocation appears reasonable. However this cost is considered to be of high risk.
- The amounts included for traffic maintenance (5%) could be optimistic
- The unit rate used for the handling of contaminated materials (\$99 per m<sup>3</sup>) may be low and a \$105 per m<sup>3</sup> value may be more appropriate.
- A contingency value of 20% for all work is more appropriate than the values used (13% for maintain works, 15% for new works) recognizing the risks associated with this project [note that the EA Team recommends that a +/- 20% range be shown in summarizing the project's estimated costs].
- Engineering cost allowances (7% for maintain works, 10% for new works) are adequate (excluding any project management costs by the City/Waterfront Toronto).
- The use of a 4% for the discount rate in the LCA costing appears reasonable.

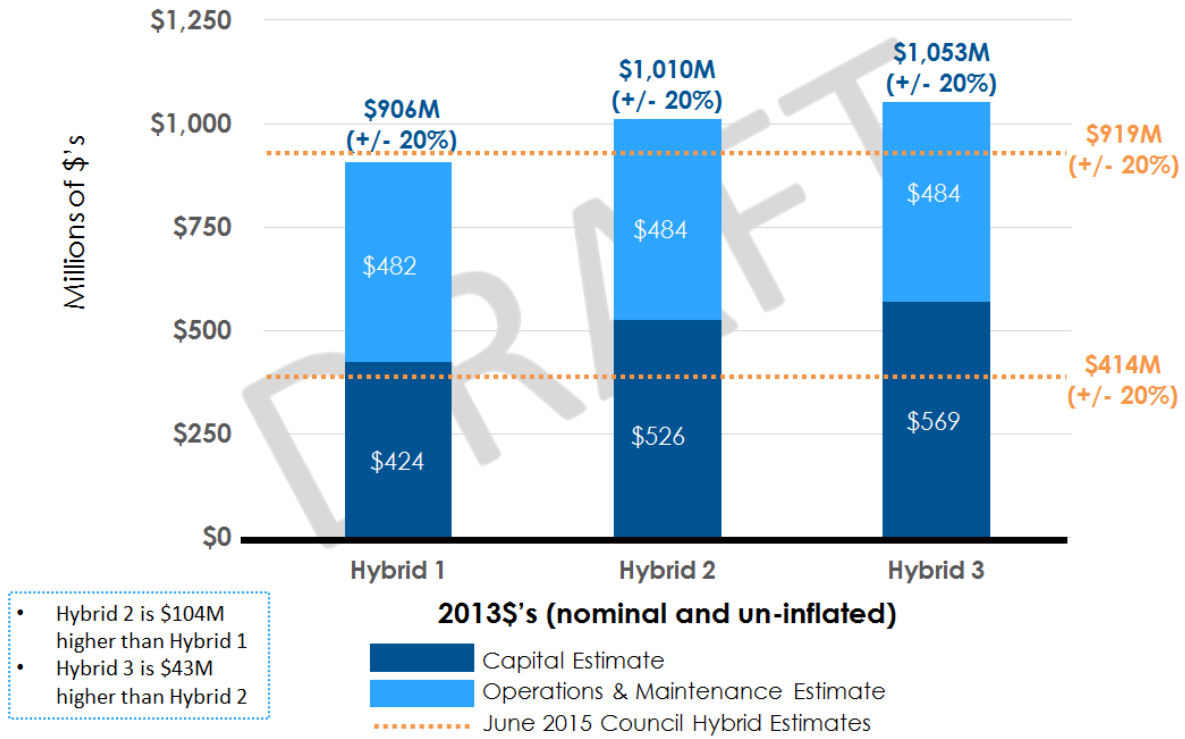
The EA Team provides the following clarifications/responses:

- Utility relocation costs of \$5.0 million were carried against each of the three Hybrid Alternatives. The majority of these alternatives involve work outside of existing road corridors where utilities are located. For example, the total length of new road/bridge works associated with Alternative 2A is approximately 1000 m of which 840 m is in land where the City's DMOG utility plans indicated there are no existing utilities. Refer to a further discussion in Section 2.4.
- Recent (2012 and 2013) tipping fees for disposal of contaminated materials at the east end of Toronto's waterfront varied but for PortsToronto's pedestrian tunnel project these costs were as high as \$45/ metric tonne (1000 kg). The future elevation of Lake Shore Boulevard through the Keating area is essentially in fill throughout the area between the Don Roadway and Cherry Street. Refer to a further discussion in Section 2.7.
- As indicated previously, it was assumed that the new decks will have a life span of 100 years, having been replaced with reinforcing materials inert to chlorides such as Stainless Steel and/or Glass Fibre Reinforced Polymer (GFRP) in conjunction with high performance concrete, waterproofing membrane and asphalt protection layer. Use of the 100-year LCA assessment

period is considered appropriate. Using the more traditional 75-year period would not noticeably alter the costs.

## 5. Summary Costing

The following exhibit summarizes the capital and life cycle costs determined for the three Hybrid alternatives.



<sup>1</sup> All costs are high level order of magnitude prepared for comparative purposes only.

Figure 1A – Zones of Gardiner Expressway Established for Cost Evaluation

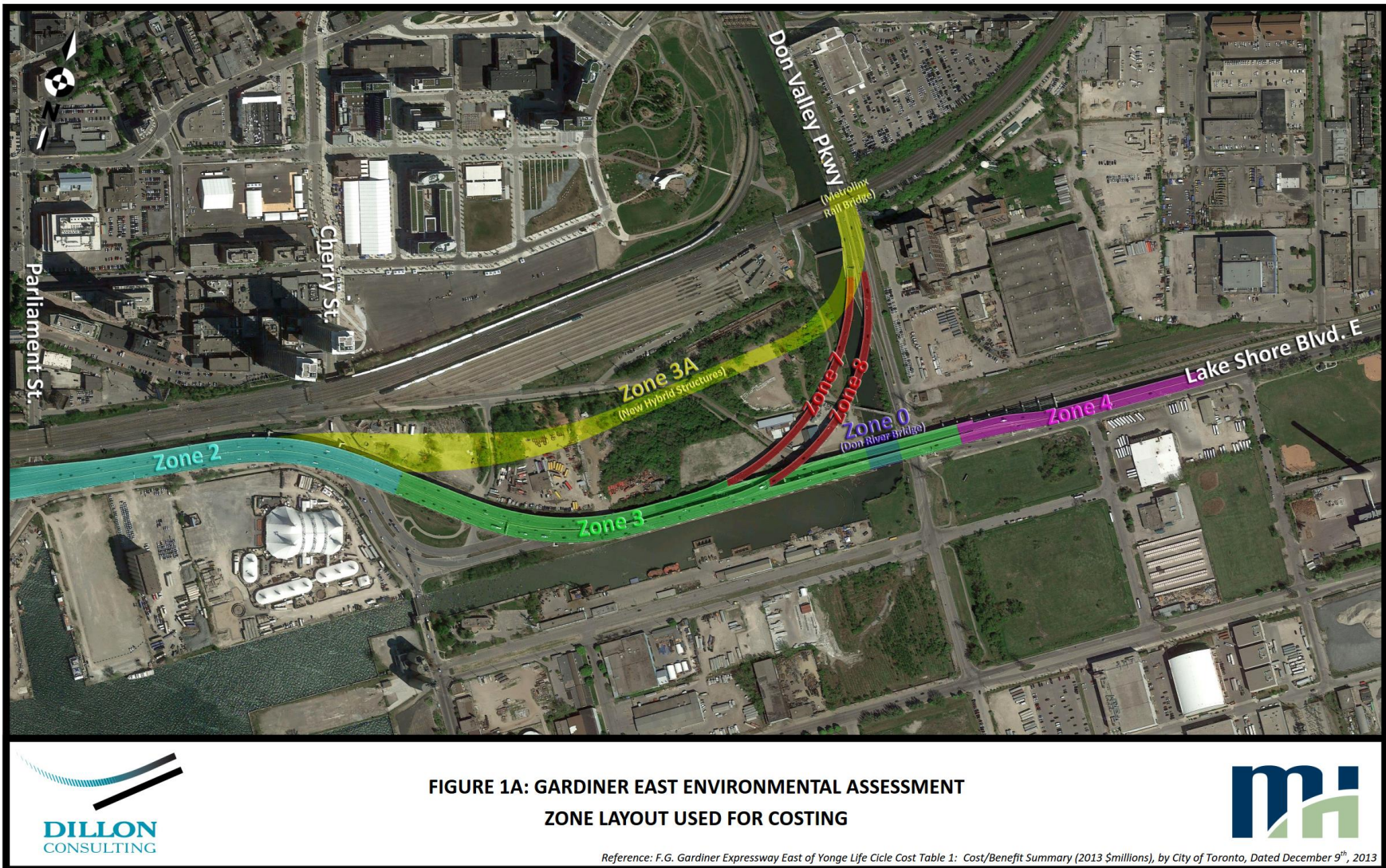


Figure 1B – Zones of Gardiner Expressway Established for Cost Evaluation

