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Date: February 17, 2009

Subject: Windsor Highway 401 Extension - Modified GreenLink

This memorandum provides a summary description for the Modified GreenLink, including the construction cost estimate, life cycle cost and a comparison to the DRIC/MTO proposed Windsor-Essex Parkway. It additionally provides a comparative evaluation of the greenspace area (accessible and inaccessible), and length of trails for both options.

Introduction

As you are aware, my team at Parsons Brinckerhoff based in New York City has been involved from the outset in the conceptual planning and engineering issues and requirements for GreenLink Windsor. The original GreenLink alternative for providing an extension of Highway 401 as an access road to a proposed new bridge crossing of the Detroit River (October 2007) considered an alignment extending from the current end of Highway 401 to the EC Row Expressway. It proposed six tunnels or covered highway segments ranging in length from 120 metres to 1,220 metres, with three tunnels longer than one kilometre each. The originally presented GreenLink had tunnels covering about 65% of the new access road, with landscaping on tunnel roofs and adjacent areas. Although the City of Windsor advocated a full tunnel solution for the access road, it submitted GreenLink based on MTO's decision to not consider any full tunnel solution. DRIC first introduced the "Parkway" alternative in August 2007 and in May, 2008 chose it as its preferred access road alternative (the Windsor-Essex Parkway or W-E Parkway) with only minor variations from the 2007 concept. Neither the August, 2007 Parkway concept nor the May, 2008 W-E Parkway accepted the essential feature provided by GreenLink, which proposed long tunnelled sections in residential areas.

Modified GreenLink

In July 2008 City of Windsor staff working with PB developed a Modified GreenLink solution in order to work with DRIC and reach a potentially acceptable solution that will break the impasse. The Modified GreenLink would also assist DRIC appreciating that the Parkway could include long tunnelled sections which would provide significant vehicle noise and emission shielding for communities and protected greenspaces, all for a construction cost that was not substantially higher than the DRIC W-E Parkway construction cost.

The Modified GreenLink solution was presented by City staff and PB to DRIC and MTO staff in two meetings, one in July 08 in Windsor and the second in August 19, 2008 in New York. The Modified GreenLink maintains the original GreenLink principles and benefits, has the same length as the W-E Parkway (from the current Talbot Road termination of Highway 401 to the new bridge plaza), has construction features similar to the Parkway, including full shoulders, and can be constructed at substantially less costs than the original GreenLink even when costed in future dollars.

The Modified GreenLink respected the City's firm view that the access road design must protect and connect the communities it is traversing and present a considerate approach for those residents impacted by the new facility.

The Modified GreenLink provides for five tunnels covering 2,830 metres and consisting of three longer tunnels (1020m, 750m, and 700m) and two short tunnels (240m and 120m). The tunnels (see attached Figure No.1) are as follows:

- Howard Tunnel is moved and lengthened to 240m as per W-E Parkway (Oliver Estates) and a new bridge at Howard was added as shown in the W-E Parkway (DRIC change).

- Mt.Carmel/Villa Paradiso Tunnel is reduced in length by 250 metres to 750m long.

- St.Clair Tunnel is modified to a 24 metre wide bridge crossing to accommodate four lanes, sidewalks, and planting areas along the sidewalks.

- Oakwood Tunnel is shortened to 700 metres.

- Oakwood Full Connection 120 m long is maintained as per W-E Parkway.

- Pulford Tunnel is eliminated but the buffer distance to the nearest residents was increased.

- Bellewood Tunnel is moved easterly to accommodate a modified depressed roadway over the Grand Marais Drain and it includes the W-E Parkway Spring Garden tunnel. The tunnel length is made 1020m

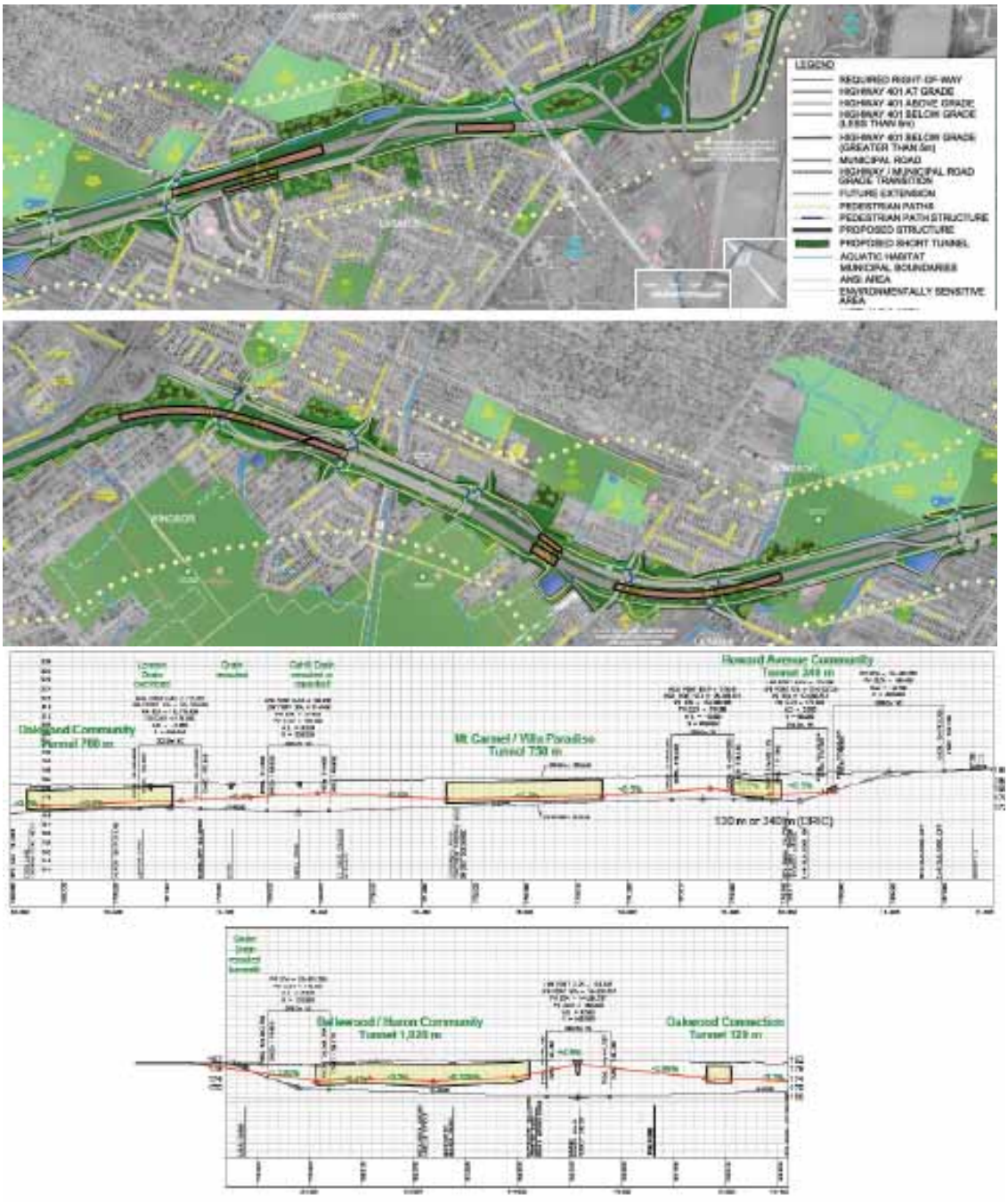
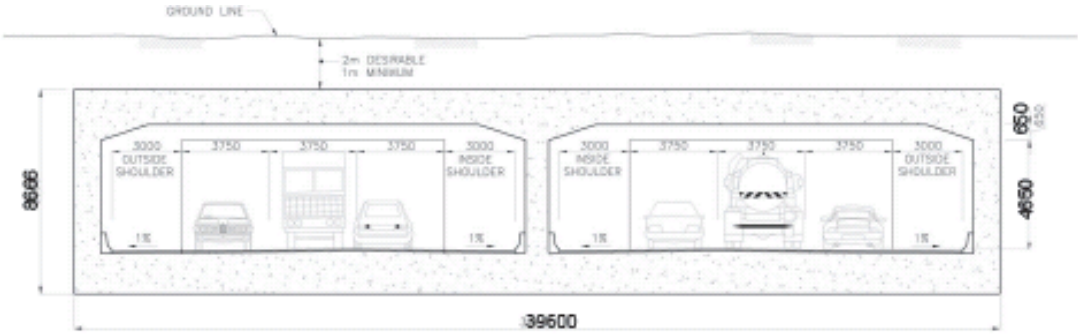


Figure 1 – Modified GreenLink Plan and Profile

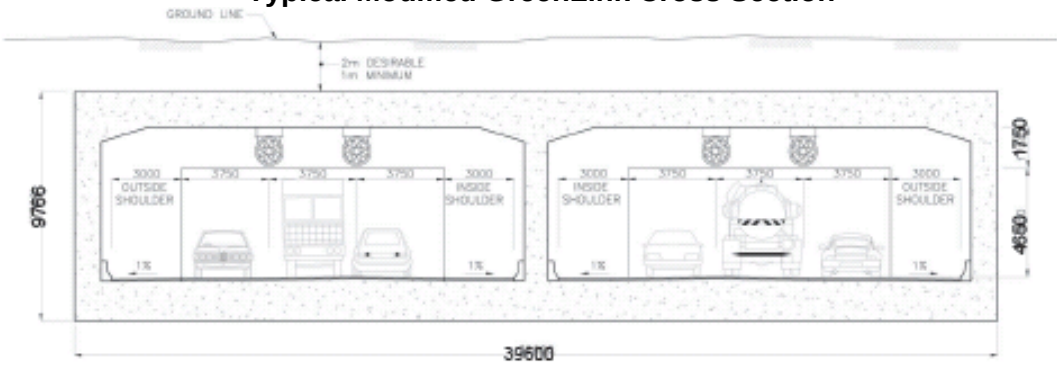
The Modified GreenLink achieves significant connections and functional land use. It allows for pedestrian path consolidation, and shields communities from the exposed highway better than the W-E Parkway, and better meets the City of Windsor Official Plan and Ontario Provincial Policy Statement objectives. The 700 to 1020 m tunnels provided by the Modified GreenLink create useable land, limit the impact of vehicle noise and vehicle emissions on the adjoining residents, create healthier greenspace above the tunnels than an open roadway, increase connectivity of the communities, enhance cohesion of the neighbourhoods, and provide more possibilities for use of the land.

The Modified GreenLink cross section provides three lanes in each direction at 3.75 m each, and two full shoulders at 3 m each. This cross section is equivalent to the DRIC/MTO cross section.

The tunnel width is 39.6 m while its overall height is 8.67 m typically and 9.77 m at the locations of the jet fans. See Figure 2.



Typical Modified GreenLink Cross Section



Section at Ventilation Fans, Modified GreenLink
Figure 2 – Tunnel Cross Sections

Capital Cost

The estimated capital cost of the Modified GreenLink is $1.757 billion. The cost covers the alignment from the end of Highway 401 at North Talbot to Plaza B, or 11.4 km, equivalent to the W-E Parkway. The $1.757 billion Modified GreenLink cost estimate is based on cost escalated to 2011 (mid point of construction), the same time frame used by DRIC in its cost estimate. This cost estimate accounts for full shoulders and barriers, all mechanical and electrical equipment, fire life safety elements, CCTV, ITS, communication, traffic control, etc. It also includes the cost of landscaping the park above the tunnels, and along the alignment, and the engineering, project management, and construction management and administrative costs related to the project similar to the W-E Parkway.

The capital cost of the W-E Parkway was reported to be $1.59 billion. While it provides for 1,860 metres of coverage, this is achieve by 11 short (120 to 240 m) landscaped highway overpasses.

DRIC's proposed W-E Parkway does not actually propose any "tunnels", as understood by a tunnel engineer. Rather it proposes to provide widened traditional highway overpasses with planting and green spaces on them. The difference between an overpass and a tunnel, in engineering terms, is as follows:

- An overpass bridge is typically composed of two abutments, a center pier and a bridge deck. The bridge deck is usually composed of precast concrete or steel beams and a thin deck usually in the range of 20 to 25 cm deep. The bridge beams and deck are simply supported on the abutments and the center pier with flexible connections. Overpass bridges do not have structural bottom slab at the road level; rather the road is simply a pavement over compacted gravel and soil. The center pier is typically composed of cast in place concrete columns while the abutments are either inclined or vertical cast in place retaining walls. The structural elements (abutments, pier, and deck) are not rigidly connected to each other, rather they are independent from each other and each behaves independently. Generally overpass bridges are flexible structures and have limited or no redundancy in their design. They are more susceptible to the elements and therefore have less life expectancy than tunnels.

- On the other hand tunnels constructed by the cut and cover method are rigid structures. They are built by constructing a cast-in-place reinforced concrete bottom slab in the order of 1.75 to 2.0 m thick heavily reinforced with steel bars. The cast-in-place reinforced concrete walls are rigidly connected to the bottom slab with reinforcing bars passing between the walls and the slab. A center wall is provided (rather than pier columns) and fully anchored with the bottom slab. The outer walls and the center wall are usually heavily reinforced and are in the order of 1 to 1.25 m thick. The top

slab is also constructed of reinforced concrete and is rigidly connected to the outer and center walls with reinforcing bars resulting in the entire structure to be a single unit box with all its components acting together to support the loads. The top slab is usually in the range of 1.5 to 1.75 m thick and is heavily reinforced with steel bars. The tunnels are fully encapsulated with waterproofing membranes and are designed to resist all possible loads including thermal variations. Tunnels are therefore less susceptible to the elements. Their rigidity and their design and construction enable them to last for long time. It is generally accepted practice to consider the life expectancy of tunnels to be in the order of 125 years while bridge overpasses are typically designed for 75 years life.

It should be noted that PB's review of DRIC's cost estimate of the W-E Parkway revealed that certain required cost elements were not included in the DRIC cost estimates. These omissions include tunnel lighting, power distribution, ITS, communication systems, traffic control, intrusion alarms, and fire-life safety elements.

After PB raised these issues, DRIC agreed that the tunnel lighting estimate was low and subsequently admitted that the W-E Parkway costs should have been increased, just for lighting and ITS alone by $62 million before contingencies and inflation, as set out in the September 3, 2008 letter from URS to PB attached as Appendix A.

However DRIC's Team reduced the civil cost by $67 million, offsetting the added lighting cost, by adopting the method of construction that we had proposed with the original GreenLink ("slurry wall" construction). It should be noted that DRIC originally criticised this method of construction as inappropriate for Windsor.

Adding the cost of the items omitted by DRIC, we estimate that the W-E Parkway cost will be $1.613 billion instead of the published estimate of $1.59 billion.

It can be concluded that based on a minor difference in construction costs (about $140 million), 2.8 km of tunnels can be provided through the Modified GreenLink solution, along with improvement to the parkland and the pedestrian/cyclist trails. This will result in three long tunnels: 700, 750 and 1020 m, in addition to two short tunnels. In contrast, the W-E Parkway provides only short landscaped overpasses, ranging in length between 120 to240 m.

In total, the Modified GreenLink provides 1 km more covered roadway than the W-E Parkway.

Operation and Maintenance Cost

DRIC/MTO have taken the position they will not consider tunnels with mechanical ventilation because of the increased construction, operation, and maintenance costs that those facilities impose on the roadway throughout its operating lifespan.

Although longer tunnels do require mechanical ventilation such as jet fans, DRIC/MTO have also refused to acknowledge that the operating and maintenance costs are not necessarily more for longer tunnels than for shorter tunnels. Short tunnels have increased lighting requirements and power requirements to offset the 'black hole effect' on the motorists (going from bright daylight to dark underpasses quickly requires much more lighting than does a long tunnel that allows the eye time to adjust.) Overall long tunnels require less lighting than short tunnels, as the human eye has time to adjust to darker conditions within the longer tunnel. At the entrance of longer tunnels additional lighting is provided to overcome the black hole effect.

We have conducted a comparative operation and maintenance cost analysis for the W-E Parkway and the Modified GreenLink and determined that the annual operating and maintenance cost of the Modified GreenLink is $24.6 million, compared to the cost for the W-E Parkway of $29.5 million. Comparatively speaking, the Modified GreenLink would achieve an annual saving of $4.9 million, notwithstanding the added jet fans requirements for longer tunnels in the Modified GreenLink.

As is the case here, the capital cost of additional lighting and power requirements for short tunnels often offset or exceed the added cost of the jet fans.

Life Cycle Cost

Considering that the annual operation and maintenance cost of the Modified GreenLink is less than that of the W-E Parkway, while the capital cost of the W-E Parkway is less than that of the Modified GreenLink, it became important to compare the two options on the basis of life cycle cost. The life cycle cost (LCC) was determined as a need during the DRIC/City/PB meeting that took place in July 2008 in Windsor.

PB performed a comparative LCC analysis and presented preliminary findings to DRIC in August 19, 2008 meeting in New York. During that meeting DRIC objected to PB's methodology in performing the LCC for both the Modified GreenLink and the W-E Parkway. In order to accommodate DRIC's preferred approach, PB performed the LCC analysis again, using two different methodologies as described below.

For Life Cycle Cost Evaluations, the following categories were taken into account: Capital costs; civil works; electrical; mechanical; staffing/miscellaneous; and parks.

The Life Cycle Cost analyses were performed using:

1. A Net Present Value methodology based on a straight line distribution
2. A 125 year horizon due to the life expectancy of the tunnel structures
3. A discount rate of 5 percent

4. An escalation rate of 3 percent/year
5. Replacement costs accounting for working on an active roadway.
6. The electrical cost of $0.05 per KW-hr
7. Power demand cost of 30% of the annual power cost.

The following life expectancies of various components and elements of the project were used:

	Work Element	**Life**
1.	Tunnel Structures	125 years
2.	Bridges (land bridges, overpasses; etc…);	75 Years
3.	Depressed Structures (U shape); and ramp structures	75 years
4.	Buildings, superstructures, etc	75 years
5.	Pavement	15 years
6.	Drainage system	30 years
7.	Ventilation system (fans, and control)	30 years
8.	Lighting	20 years
9.	Power system (transformers, distribution, etc..)	30 years
10.	Traffic Control and communication systems (CCTV, VMS, ITS, etc…)	20years
11.	Fire detection and protection systems	20 years
12.	Communication system	20 years
13.	Park facilities	75 years

These life expectancies are based on normal practice and reflect the industry standards for an area such as Windsor. These values were agreed to by DRIC in a teleconference in July 08.

In addition, the following maintenance and operating cost assumptions were used:

	Work Element	**O&M Intervals**
1.	Visual inspection, cleaning, snow removal, etc.	Annually
2.	Power consumption	Annually
3.	Testing and inspection of M&E components	Annually
4.	Finishes, bridge painting, etc…	25 years
5.	Complete re-lamping (average)	3 years

6.	Bridge deck repair	15 years
7.	Structural repair – Bridges,	15 years
8.	Depressed structures, ramps, etc…	15 years
9.	Pavement patching/topping	15 years
10.	Structural repair – Tunnels	30 years

Using the standard practice for calculating Net Present Value, the following Life Cycle cost comparison resulted:

- Modified GreenLink $2,248,661,000
- W-E Parkway $2,473,427,000

The comparative Life Cycle cost using present value method reveals that the Modified GreenLink has lower overall Life Cycle cost than the W-E Parkway. The main reason for the cost-savings associated with the Modified GreenLink is that the life span of tunnels far exceeds the life span of the short Parkway overpasses (125 years versus 75 years). In addition, as noted above, the annual operating and maintenance cost of the Modified GreenLink is less than that of the W-E Parkway.

During the presentation by the City and PB of the comparative Life Cycle costs at the August 19th 2008 meeting with the DRIC team, DRIC indicated for the first time that DRIC's life cycle costing approach adopted the MTO methodology which uses un-escalated future costs.

In order to provide a further comparison between the Modified GreenLink and the W-E Parkway, PB used the MTO methodology in which the replacement cost in the future is calculated using present dollars (un-escalated), and the following comparative Life Cycle costing using Net Present Value resulted:

- Modified GreenLink $1,756,259,000
- W-E Parkway $1,725,964,000

The comparative Life Cycle cost of the two alternatives using the MTO methodology (without escalation cost of future expenditures) is practically the same (within the margin of error of the analysis.)

Using the standard methodology used by PB, which allows for the escalation of the value of money, the Modified GreenLink had a lower life cycle cost. Even using the MTO methodology, which does not allow for the value of money to be escalated over

time, the life cycle cost of the two alternatives are within the margin of tolerance – meaning that there is no difference in long-term cost.

Life Cycle Cost Assumptions

Intrinsic to a LCC estimate are assumptions regarding the life of an item and the annual maintenance costs. The following table identifies the assumptions made during the LCC estimate:

Item #	Element		Life/Maintenance Assumption (years)
Capital Costs			
1	Construction Cost		4
Staffing/Miscellaneous			
1	Staffing Costs 20 staff @ 2.38 million		Annual
Civil			
1	Tunnel Structures	replace every	125
1a	Annual inspections		Annually
1b	Finishes/Painting/Fascia		Every 30 years
2	Bridges/Depressed Highway	replace every	75
2a	Annual maintenance/repair	varies by concept	Annually
2b	Basic Bridge Maintenance		Every 10 years
2c	Deck Replacement		Every 35 years
2d	Non-Bridge Maintenance		Every 15 years
3	Drainage	replace every	30
3a	Electrical Operating Costs		Annually
3b	Motor Refurbishment		Every 15 years
Electrical			
1	Lighting	replace every	25
1a	Power Consumption		Annually
1b	Inspections/Minor Maintenance		Annually
1c	Lamp Replacement		Every 3 years
2	Power Distribution	replace every	30
2a	Parts, inspection, troubleshooting		Annually
2b	Replace UPS Batteries		Every 10 years

3	CCTV	replace every	20
3a	Inspection and replacement parts		Annually
4	Fire Detection	replace every	20
4a	No annual costs above staffing		
5	Intrusion	replace every	20
5a	No annual costs above staffing		
6	Radio Re-Broadcast	replace every	20
6a	No annual costs above staffing		
7	SCADA	replace every	25
7a	Parts, inspection, troubleshooting		Annually
8	Telephone	replace every	25
8a	No annual costs above staffing		
9	VMS/ITS	replace every	25
9a	Parts, inspection, minor repair		Annually

Mechanical

1	Tunnel Ventilation - Jet Fans	replace every	30
1a	Power Consumption		Annually
2	Standpipe	replace every	30
2a	No annual costs above staffing		
3	Air Quality Monitoring	replace every	20
3a	Parts, inspection, troubleshooting		Annually

Parks

1	General	75
1a	General maintenance activity	Annually
1b	Periodic upgrades/Capital Costs	Every 25 years

Parkland Space

We have estimated the greenspace and accessible recreational area associated with the W-E Parkway, based on DRIC plans presented in the December 2008 Environmental Assessment Report.

First, we estimated the total greenspace associated with the W-E Parkway, including all green areas identified by DRIC on the plans. Greenspace included parks and green space adjacent to highways in the sloped sides and along the roadway ramps and in median of the roadway. Useable and non-useable green spaces are both included in this category. Next we calculated the area of greenspace that would be inaccessible due to its location on embankments, ramps, access roads, medians etc.

To determine these estimates, the EA report was downloaded in Adobe Acrobat Format. The images were scaled in AutoCad, the green space areas were bounded and then the green space areas were determined. The following table itemizes the spaces determined through this analysis:

Available Green Spaces

Highway 401 to Malden

Total green spaces	383 acres
Minus inaccessible (slopes, ramps, etc.)	148 acres
Accessible green space	235 acres

Malden to Plaza

Total green spaces	108 acres
Minus inaccessible areas	15 acres
Accessible green space	93 acres

As these figures indicate, 39% of the W-E Parkway greenspace in the Highway 401 to Malden Road component of the W-E Parkway is inaccessible, leaving 235 acres for potential use by people seeking to engage in passive or active recreation. In the Malden Road to Plaza component, 93 acres are accessible. In total the W-E Parkway provides about 328 accessible acres of potential recreational area. In comparison, the Modified GreenLink provides approximately 350 acres.

The major difference between the potential recreational areas provided by the W-E Parkway in comparison to the Modified GreenLink is not the total area but rather the quality of the greenspace. The majority of the accessible green space provided by the W-E Parkway is subject to high levels of air pollution and traffic noise while the majority of the 350 acres of useable greenspace provided by the Modified GreenLink

will provide healthy recreational areas, since the longer GreenLink tunnels protect people adjacent to and on top of the tunnels from air contaminant impacts.

Park Path Lengths

Many of the paths or trails provided by the W-E Parkway plan are adjacent to the highway and the service roads. An estimate of the Parkway path lengths was made according to the same DRIC plans presented in the December 2008 Environmental Assessment Report. These path lengths are divided into the following categories:

1. Total path length provided by the W-E Parkway.
2. Path length provided by the W-E Parkway which is within 25 m of the highway alignment.
3. Path length provided by the W-E Parkway which is within 50 m of the highway alignment.
4. Path length provided by the W-E Parkway which is within 100 m of the highway alignment.

The Parkway path lengths determined are:

Total path length:	18,200m
Path length within 25 m:	2,500 m
Path length within 50 m:	8,200 m
Path length within 100 m:	15,800 m

These lengths were determined by scaling the images from the EA report in AutoCad and then measuring the length of the path.

These calculations indicate that about 87% of the Parkway paths are within 100 metres of the travelled Parkway roads making them essentially unusable because of their direct exposure to high levels of air pollution and traffic noise.

By comparison, the Modified GreenLink provides for over 14 km of paths, the majority of which would be located on top of or adjacent to protective tunnels, again resulting in cleaner, healthier recreational space than the W-E Parkway.

Protection of Community, Neighbourhood, and the Environment

In its EA evaluation DRIC stated that "*Potential changes to community cohesion and character for specific neighbourhood communities due to the displacement and disruption of residents and social features are similar for all alternatives".* However, protection of communities is not just about displacement and disruption. Displacement of some residents is unavoidable and disruption during the construction phase is time-limited. The real focus should be on the community that remains after construction. The focus should be on the protection of the quality of life for those communities and the residents who remain when the roadway is completed and in operation. The Modified GreenLink provides for functional parkland, with increased opportunity for recreational features and increased connectivity, representing an overall improvement in the quality of life for those residents remaining after construction.

Longer tunnels create usable land and limit exposure to the roadway. Increased coverage will limit the impact of traffic noise for users; will increase connectivity; and will enhance cohesion; and will provide more possibilities for use of the land. Land created must be functional. The Modified GreenLink creates functional land that can be enjoyed by the community and is capable of future development. The W-E Parkway bisects communities north and south and does little to connect communities east and west.

The Modified GreenLink provides a greater opportunity for ecological connections. Longer tunnels allow for more flexibility and the creation of buffers on the tunnel decks themselves. Limited space on the W-E Parkway land bridges, which will also contain paths and function as roadway overpasses, may compromise the effectiveness of the ecological connection.

Conclusions

The Modified GreenLink meets or exceeds DRIC's seven evaluation factors summarized in the Environmental Assessment Report.

The Modified GreenLink provides substantially more benefits than the W-E Parkway for minor additional capital investment, including better air quality, more useable park space and trails, better connectivity and protection of communities and neighbourhoods.

Moreover, the Modified GreenLink is expected to have less operating and maintenance cost than the W-E Parkway and the Modified GreenLink is either equivalent or more advantageous than the W-E Parkway in term of Life Cycle cost.

Referring to the Environmental Assessment methodology, overall the Modified GreenLink should receive a score that is at least equivalent to the W-E Parkway on

the basis of cost ("low negative impact"). There is no rationale basis to conclude otherwise on this factor. Overall, the Modified GreenLink is better than and preferred over the W-E Parkway.

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