



# Appendix 8C

## Incremental Operations and Maintenance Cost Estimates

December 2010



**METROLINX**

An agency of the Government of Ontario

APPENDIX 8C

Incremental Operations and Maintenance Cost Estimates

December 2010

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**APPENDIX 8C  
INCREMENTAL OPERATIONS AND MAINTENANCE COST ESTIMATES  
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## 1. OPERATIONS AND MAINTENANCE COST ESTIMATES – DEVELOPMENT AND ASSUMPTIONS

There are three categories of costs included in the annual Operations and Maintenance estimates:

- Rolling Stock Maintenance
- Wayside Maintenance
- Energy Costs

In all three cases, the calculations are based upon annual costs in 2010 Canadian dollars. Estimates for each of the three categories in 2010 CAD dollars are provided in Table 1 below. The costs shown are incremental, meaning only costs or savings attributed to a corridor relative to the reference case are determined. Absolute costs are not included. The analysis is based upon the assumption that several annual maintenance costs are the same across technologies and therefore, do not need to be included in the overall annual calculations. For example, it is assumed that the track maintenance for corridors is the same regardless of the technology so this annual cost is not included in wayside maintenance. It is also assumed that the number of staff operating a vehicle is the same regardless of technology and that the contract administration costs required for the operation of the reference case service is also the same regardless of technology.

**Table 1 – Electrification Options Incremental Maintenance Cost Estimates per Option**

\$ Millions CDN	Reference Case	Option 1	Option 2	Option 3	Option 11	Option 15	Option 18
Rolling Stock Maintenance	\$ 87,300,000	\$ 86,600,000	\$ 86,200,000	\$ 85,000,000	\$ 84,700,000	\$ 84,200,000	\$ 82,700,000
Wayside Maintenance	\$ -	\$ 2,839,122	\$ 4,503,235	\$ 7,229,832	\$ 7,990,356	\$ 9,577,695	\$ 11,216,800
Energy	\$ 64,786,815	\$ 60,053,005	\$ 46,736,729	\$ 42,002,918	\$ 37,913,048	\$ 33,365,499	\$ 29,184,538
Total	\$ 152,086,815	\$ 149,492,127	\$ 137,439,964	\$ 134,232,750	\$ 130,603,404	\$ 127,143,194	\$ 123,101,338
Incremental Difference		-\$ 2,594,689	-\$ 14,646,852	-\$ 17,854,065	-\$ 21,483,411	-\$ 24,943,622	-\$ 28,985,477

A description of the items included in each cost category and the method used to determine the annual incremental cost is outlined below.

### 1.1. Rolling Stock Maintenance

#### Unit Costs

The Metrolinx fleet will require a mixture of inspection and maintenance to keep it ready for service. Detailed maintenance models were developed for each proposed type of rolling stock.

The maintenance concept recommended for Metrolinx is a comprehensive Life Cycle Maintenance (LCM) program designed to maintain an optimal level of reliability through prescribed maintenance. The commuter rail fleet will require several levels of maintenance. The maintenance operation may be broken down into the following categories:

- Daily Maintenance and Inspection
- Vehicle Cleaning
- Scheduled Maintenance Program (also called, Programmed LCM), which incorporates:
  - Running Repair and Corrective Maintenance
  - Heavy Repair
  - Mid-Life Overhaul
  - Unscheduled Maintenance

Each maintenance category can be briefly detailed as follows:

- **Daily Maintenance and Inspection:** This activity combines the FRA-required Class I brake test, a safety appliance inspection/test, general servicing, and incidental repairs.
- **Vehicle Cleaning:** This activity describes several levels of cleaning, including daily interior light custodial services, weekly vehicle exterior washing, and periodic thorough system work.
- **Programmed LCM:** The intent of the LCM is to proactively perform maintenance activities on a pre-defined schedule to maximize component life while minimizing the chance of unexpected component failure, keeping the vehicle in an overall state of good repair.
- **Running Repair and Corrective Maintenance:** These activities arise through unexpected defects or failures that are identified during the inspection/testing process. These activities typically require the vehicle to be pulled from service for a day or two for repairs to be made.
- **Heavy Repair:** This involves a long-term effort to repair damaged major components. Heavy repairs may be made in-house or possibly outsourced. This will entail more than a few days of lost revenue service.
- **Mid-Life Overhaul:** To optimize the reliability of components through prescribed maintenance schedule, this work involves thoroughly reconditioning systems through a process of selective upgrades, overhaul, or re-qualifications designed to ensure that the vehicle will perform with the same level of maintenance applied during the first half of service life.
- **Unscheduled Maintenance:** This activity catches all light and medium repairs of the vehicle's safety- or operations-critical components due to random failure or accident. The LCM program should minimize the occurrence of and magnitude of many unscheduled failures.

LCM activities are typically scheduled to coincide with the FRA-required inspection intervals. However, in some cases, there are system maintenance requirements that call for a unique interval for maintenance. Coincident maintenance tasks are planned to compliment each other rather than create repeated, unnecessary activities. The following Table 1 compares the typical vehicle maintenance cycles by type.

**Table 1 – Typical Vehicle Maintenance Cycles by Rolling Stock Type**

Maintenance Interval		30-Year Occurrences	Diesel and Electric Locomotive	Cab/Coach Car	EMU	DMU
Daily Inspection		10949	X	X	X	X
Daily Cleaning		10949				
45-day	(1/8 Year)	239	X	X	X	X
92-day	(1/4 Year)	119	X	X	X	X
184-day	(1/2 Year)	59				X
368-day	(1 Year)	29	X	X	X	X
736-day	(2 Year)	29				X
1472-day	(4 Year)	14		X	X	X
1840-day	(5 Year)	6	X	X	X	X
3680-day	(10 Year)	5	X	X	X	X
5520-day	(15 Year)	2	X	X		X
Mid-Life	(15 Year)	1	X	X	X	X

Rolling stock maintenance schedules and activity descriptions were used to estimate labour and material costs for each task. Electric Locomotive and EMU maintenance program costs were derived from several transit agencies currently maintaining large fleets of similar vehicles. Dual-Mode and DMU maintenance program costs were estimated by blending historical EMU and locomotive maintenance activity costs with predicted costs of technology-specific maintenance.

The maintenance program tasks were assumed to require three distinct employee skill levels, consistent with current practices and job descriptions at several agencies. Each task was analyzed for labour hours required by skill level. Labour rates were calculated from industry averages and adjusted for the Toronto Area cost of living. Base staff pay was burdened for overtime, benefits, indirect administration, materials and supplies, and adjusted for productivity per the following Table 2:

**Table 2 – Fully Burdened Labour Rates**

Job Title	Base Labour Rate (\$/hr)	Overtime Rate	Fringe Rate	Admin Labour Rate	Other Materials & Supplies	Productivity	Fully Burdened Labour Rate (\$/hr Scheduled Work)
Service Worker	\$18.00	5%	30%	40%	15%	91%	\$43.31
General Repair Mechanic	\$27.00	5%	30%	40%	15%	84%	\$70.53
Electro Mechanic	\$32.00	5%	30%	40%	15%	77%	\$91.42

Material costs from historical calculations were updated to 2010 dollars by 3.0% annual inflation. The labour and materials costs for each maintenance interval were thus compiled and multiplied by the number of occurrences expected in a 30-year service life. This yielded the average annual maintenance costs by rolling stock type shown in Table 3.

**Table 3 – Average Annual Maintenance Costs by Rolling Stock Type**

Vehicle Type	Annual Maintenance Costs per Vehicle (\$CAN, 2010)
Diesel Locomotive, Tier 4	287,740
Electric Locomotive	247,038
BL Coach Car	139,964
BL Cab Car	170,608
Single-Level DMU	285,695
Single-Level EMU	254,811

## 1.2. Fleet Rolling Stock Maintenance Costs

In the simplest sense, the fleet maintenance costs were calculated by multiplying the required fleet size by the estimated rolling stock unit costs. However, this study is concerned with the cost to maintain the reference case fleet required to meet the future service demands. In addition, the study considers the rolling stock technology, and thus the future fleet size and make-up, which is varied with each electrification Option. Costs are further tracked by corridor.



Fleet maintenance costs were thus calculated as the average annual value to maintain all rolling stock, including spares, required to meet the future service demands and rolling stock technology selection, by corridor, in \$2010 CAD. This value was calculated from the corridor fleet composition and estimates of a 30-year life cycle maintenance program to maintain vehicles in service-ready condition and in compliance with regulated and recommended maintenance cycles. The maintenance of existing equipment and spares was assumed to be a continuing expense and thus not an additional burden to the electrification project. The cost to maintain new equipment was calculated and distributed across all corridors of compatible technology in proportion to the number of revenue trainsets required.

### **1.3. Allocation of Rolling Stock Maintenance Costs**

As described for the rolling stock capital costs, the number of new vehicles was calculated by corridor for each electrification Option, assuming that some or all of the existing 2020 fleet would remain in service.

The rolling stock maintenance costs by corridor were assumed to be the average annual cost to maintain all new vehicles assigned to that corridor. Existing vehicles were assumed to be maintained under the existing Metrolinx maintenance program at 2020 budget levels and thus do not add costs to the electrification Options.

As noted for rolling stock capital costs, some Options resulted in excess diesel locomotives. The maintenance costs for these units were credited to individual corridors of similar technology, in proportion to the revenue trainsets, as described for capital costs.

Rolling stock maintenance cost estimation process can be summarized as:

- It was assumed that the cost to maintain the 2020 fleet of 52 T4 MP40s, 468 coach cars, and 52 cab cars had already been budgeted
- Maintenance costs reflect only new vehicles purchased beyond the 2020 fleet
- All costs include spare rolling stock, assumed as a communal "pool" and distributed across all corridors of common technology in proportion to the number of required revenue service locomotives
- Options 11, 15, and 18 created surplus diesel locomotives; the maintenance costs for these units were applied as a credit
- For Options 11 and 15, the maintenance cost credit was applied to the remaining diesel corridors
- For Option 18, the maintenance cost credit was applied to all corridors

Appendix 8C-1 provides the backup details for the annual rolling stock maintenance cost estimates.

### **1.4. Wayside Maintenance**

Items included in the wayside maintenance category are:

- Overhead Catenary
- Power Supply Equipment ( such as sub-stations)

As noted above, items such as track and signals are not included within this estimate as these items are considered to have the same annual maintenance cost regardless of technology. Annual maintenance costs for each of the two items were determined on a segment basis so that double counting could be avoided. For example, the cost to maintain the catenary and power supply equipment for Union Station

is only counted once for each scenario regardless of the fact that multiple corridors may use Union Station for that option.

To determine the maintenance of Catenary and Power Supply installations, the requirement of maintenance staff and facilities was estimated for the entire GO network assuming that all corridors are electrified. It is estimated that the 300+ mile network would require three maintenance offices or zones each with a self-propelled catenary inspection vehicle and maintenance staff. Thirty linemen and 5 supervisors for the catenary maintenance and 20 electricians plus 3 supervisors for the power supply maintenance for the entire network. The crew could be split in three bases or two bases, if so decided. The staff should be able to travel to the farthest point in the territory within reasonable time. It was assumed that Lakeshore East, Lakeshore West and Georgetown lines will have one maintenance base each.

The annual cost by corridor is a sum of these costs according to the applicable segments for that corridor. With all options, the wayside maintenance cost is an incremental cost for those corridors that are electrified. For example, Option One wayside maintenance costs are the sum of estimated annual wayside maintenance costs for the ARL and Georgetown corridors.

Appendix 8C-2 provides the backup details for the annual wayside maintenance cost estimates.

## **1.5. Energy Costs**

Two types of energy are used in the analysis to power the different technologies:

- Diesel fuel
- Electricity

## **1.6. Diesel Fuel Consumption**

Calculations of annual diesel fuel costs by corridor are based upon the number of estimated litres consumed determined by the reference case operating plan. The operating model determines the number of imperial gallons of fuel consumed by corridor for weekday revenue and non revenue service. To determine the amount of weekend and holiday revenue and non-revenue imperial gallons of fuel, it is assumed that it is the same percentage as that for train miles. For the purposes of the analysis, annual weekend and holiday revenue and non-revenue train miles as a percentage of annual weekday revenue and non-revenue miles was determined for each corridor based upon the reference case operating plan. The percentage by corridor was applied to the annual weekday revenue and non-revenue fuel consumption to determine the total annual fuel consumption by corridor.

The total annual fuel consumption by corridor factor was also increased by 20% to account for non-revenue hotelling. Twenty percent was chosen to account for potentially high demand in summer and winter months during extreme temperatures. For the purposes of this analysis non-revenue hotelling is defined as the fuel consumed when a train is parked during the mid day and overnight in order to maintain minimum power to the engines and cabs for purposes of temperature control of the equipment and to provide for start up. The total annual fuel consumption for each corridor in imperial gallons was then determined and this figure was converted to litres by using a conversion factor of 4.546. Total annual fuel consumption by corridor was multiplied by the estimated cost per litre of fuel paid currently by Metrolinx for a litre of diesel fuel (\$0.75 CND). This calculation determined the estimated annual diesel fuel costs by corridor.

## 1.7. Electricity Consumption

Annual cost of electricity for the entire network was estimated by a two-step process.

- Annual electric energy consumption (in kWh) and demand (in kVA) was estimated by computer modeling of the proposed train operating plan.
- Energy cost (per kWh) and demand charges (per kVA) were obtained from Hydro One website, which lists 8.55 cents per kWh for the energy charge and \$5.41 per kVA for the demand charge.

Together, these two charges provided the estimated average annual cost of electricity at 10.8 cents/kWh (or 0.108 \$/kWh) for the entire network.

Calculations for the annual electricity costs by corridor were based upon ton.miles.

- The reference case operating plan was used to determine the weekday revenue and non-revenue ton.miles by corridor based upon a 2 car train consist for the ARL and a 10 car train locomotive hauled consist for the Tier 4 Diesel and electric locomotive scenarios. Ton.miles were used for these calculations since the distance and weight of the vehicle more accurately reflect the energy requirements rather than straight train miles.
- As with the diesel fuel consumption calculations, annual weekend and holiday revenue and non-revenue train miles as a percentage of annual weekday revenue and non-revenue miles was determined for each corridor based upon the reference case operating plan. This percentage by corridor was applied to determine the total annual weekend and holiday revenue and non-revenue ton.miles and added to the annual weekday revenue and non-revenue ton.miles and aggregated to determine the total estimated annual ton.miles by corridor.
- A non-revenue hotelling factor was not included in this calculation as it was already captured in the model of total system electricity costs. Total annual electricity cost divided by total annual ton.miles provided the intermediate index of cost of electricity per ton.mile at \$0.00756 per ton.mile. The total annual estimated ton.miles by corridor was then multiplied by the estimated cost of electricity per ton.mile of \$0.00756 to determine the total annual cost of electricity for that corridor.
- It was also assumed that there would be energy savings during operations due to the regenerative braking capabilities of the electric locomotives which is not captured by the computer model. Studies for Amtrak on portions of the North East corridor where there were minimal station stops indicate energy savings in the order of 10%. Similar European studies in corridors with a larger number of stations and stations stops indicate 20% plus savings. As a result, a 15% savings due to regenerative braking was applied to this analysis in order to be conservative but also to account for a higher number of station stops than the Amtrak tests.
- For each option, the total incremental cost of energy was calculated as a sum of the individual energy costs by corridor and technology. For example, the total cost of energy for Option One was the sum of the cost of the annual cost of electricity for the ARL and Georgetown corridors together with the sum of the annual total diesel fuel costs for each of the other five corridors.

Appendix 8C-3 provides the backup details for the annual energy consumption cost estimates.



## **APPENDIX 8C-1 – ROLLING STOCK MAINTENANCE COST ESTIMATES**

**Table 8C-1-A – Estimated Incremental Maintenance Costs by Option**

**Table 8C-1-B – Cost Summary of Rolling Stock Maintenance Costs**

**Table 8C-1-C – Labour Rates Used for Rolling Stock Maintenance Costs**

**Table 8C-1-D – Calculation of Vehicle Maintenance Costs over 30 Year Life by Vehicle Type**

**Table 8C-1-A – Estimated Incremental Maintenance Costs by Option**

**Option 1 –Electrification of Georgetown and ARL Corridors (Total \$86.6 M)**

Corridor	Incremental Annual Rolling Stock Maintenance Cost of Metrolinx Fleet (\$MCAN, 2010)		
	LHC	DMJ	EMJ
Lakeshore	\$32.8	\$0.0	\$0.0
Lakeshore	\$0.0	\$0.0	\$0.0
Milton	\$9.8	\$0.0	\$0.0
Georgetown	\$14.6	\$0.0	\$2.8
Barrie	\$9.8	\$0.0	\$0.0
Richmond Hill	\$6.2	\$0.0	\$0.0
Stouffville	\$10.6	\$0.0	\$0.0

**Notes:**

**Cost to maintain only newly purchased expansion fleet rolling stock**

**Maintenance costs reflect credit for excess diesel locos removed from service during sale residual value recovery**

**Costs are for corridor fleets**

**LHC = locomotive-hauled coaches (diesel or electric)**

**Option 2 – Electrification of Lakeshore East and West (Up to Hamilton James) Corridor (Total \$86.2 M)**

Corridor	Incremental Annual Rolling Stock Maintenance Cost of Metrolinx Fleet (\$M CAN, 2010)		
	LHC	DMU	EMU
Lakeshore	\$36.7	\$0.0	\$0.0
Lakeshore East	\$0.0	\$0.0	\$0.0
Milton	\$9.3	\$0.0	\$0.0
Georgetown	\$11.8	\$3.1	\$0.0
Barrie	\$9.3	\$0.0	\$0.0
Richmond Hill	\$5.9	\$0.0	\$0.0
Stouffville	\$10.1	\$0.0	\$0.0

**Notes:**

**Cost to maintain only newly purchased expansion fleet rolling stock**

**Maintenance costs reflect credit for excess diesel locos removed from service during sale residual value recovery**

**Costs are for corridor fleets**

**LHC = locomotive-hauled coaches (diesel or electric)**

**Option 3- Electrification of Georgetown, ARL, Lakeshore East and West (Up to Hamilton James) Corridors (Total \$85.0)**

Corridor	Incremental Annual Rolling Stock Maintenance Cost of Metrolinx Fleet (\$M CAN, 2010)		
	LHC	DMU	EMU
Lakeshore	\$36.0	\$0.0	\$0.0
Lakeshore	\$0.0	\$0.0	\$0.0
Milton	\$8.5	\$0.0	\$0.0
Georgetown	\$14.4	\$0.0	\$2.8
Barrie	\$8.5	\$0.0	\$0.0
Richmond Hill	\$5.4	\$0.0	\$0.0
Stouffville	\$9.3	\$0.0	\$0.0

**Notes:**

**Cost to maintain only newly purchased expansion fleet rolling stock**

**Maintenance costs reflect credit for excess diesel locos removed from service during sale residual value recovery**

**Costs are for corridor fleets**

**LHC = locomotive-hauled coaches (diesel or electric)**



**Option 11 – Electrification of - Electrification of Georgetown, ARL, Lakeshore East and West (Up to Hamilton James) and Milton Corridors (Total \$84.7 M)**

Corridor	Incremental Annual Rolling Stock Maintenance Cost of Metrolinx Fleet (\$M CAN, 2010)		
	LHC	DMU	EMU
Lakeshore	\$35.4	\$0.0	\$0.0
Lakeshore	\$0.0	\$0.0	\$0.0
Milton	\$11.3	\$0.0	\$0.0
Georgetown	\$14.4	\$0.0	\$2.8
Barrie	\$7.6	\$0.0	\$0.0
Richmond Hill	\$4.9	\$0.0	\$0.0
Stouffville	\$8.3	\$0.0	\$0.0

**Notes:**

**Cost to maintain only newly purchased expansion fleet rolling stock**

**Maintenance costs reflect credit for excess diesel locos removed from service during sale residual value recovery**

**Costs are for corridor fleets**

**LHC = locomotive-hauled coaches (diesel or electric)**

**Option 15 – Electrification of- Georgetown, ARL, Lakeshore East and West (Up to Hamilton James), Milton and Barrie Corridors (Total \$84.2M)**

Corridor	Incremental Annual Rolling Stock Maintenance Cost of Metrolinx Fleet (\$M CAN, 2010)		
	LHC	DMU	EMU
Lakeshore	\$34.2	\$0.0	\$0.0
Lakeshore	\$0.0	\$0.0	\$0.0
Milton	\$11.3	\$0.0	\$0.0
Georgetown	\$14.4	\$0.0	\$2.8
Barrie	\$11.3	\$0.0	\$0.0
Richmond Hill	\$3.7	\$0.0	\$0.0
Stouffville	\$6.4	\$0.0	\$0.0

**Notes:**

**Cost to maintain only newly purchased expansion fleet rolling stock**

**Maintenance costs reflect credit for excess diesel locos removed from service during sale residual value recovery**

**Costs are for corridor fleets**

**LHC = locomotive-hauled coaches (diesel or electric)**

**Option 18 – Electrification of All Corridors (Total \$82.7M)**

Corridor	Incremental Annual Rolling Stock Maintenance Cost of Metrolinx Fleet (\$M CAN, 2010)		
	LHC	DMU	EMU
Lakeshore	\$32.1	\$0.0	\$0.0
Lakeshore	\$0.0	\$0.0	\$0.0
Milton	\$9.6	\$0.0	\$0.0
Georgetown	\$12.2	\$0.0	\$2.8
Barrie	\$9.6	\$0.0	\$0.0
Richmond Hill	\$6.1	\$0.0	\$0.0
Stouffville	\$10.4	\$0.0	\$0.0

Notes:

Cost to maintain only newly purchased expansion fleet rolling stock  
 Maintenance costs reflect credit for excess diesel locos removed from service during sale for residual value recovery  
 Costs are for corridor fleets  
 LHC = locomotive-hauled coaches (diesel or electric)

**Notes:**

**Cost to maintain only newly purchased expansion fleet rolling stock**

**Maintenance costs reflect credit for excess diesel locos removed from service during sale residual value recovery**

**Costs are for corridor fleets**

**LHC = locomotive-hauled coaches (diesel or electric)**

**Table 8C-1-B- Cost Summary of Rolling Stock Maintenance Cost**

	Annual Maintenance Costs per Vehicle (\$CAN, 2010)				
	Total	Light	Heavy	Corrective	Rehab
Diesel Locomotive, Tier 4	283,679	91,368	192,311	133,599	58,712
Electric Locomotive	243,775	92,611	151,165	87,108	64,057
BL Coach Car	139,064	105,416	33,647	5,907	27,740
BL Cab Car	169,353	118,893	50,460	18,120	32,340
Single-Level DMU	259,462	163,306	96,156	52,306	43,850

**Capital and Maintenance Calculation Parameters**

Residual Value as Fraction of New Value	17%
Cab Car Upgrade for Electric Loco Compatibility	15,000 \$CAN, 2010
Spares Ratio for Diesel Locomotives	16.0%
Spares Ratio for Electric Locomotives	16.0%
Spares Ratio for Combined Coach and Cab Cars	8.6%
Spares Ratio for Cab Cars	21.0%
Minimum Spares for Locomotives and Cabs	3
Spares Ratio for DMUs and EMUs	20.0%
Minimum Spares for DMUs and EMUs	4
Currency Conversion, \$US => \$CAN	1.02 As of 12-1-10
Inflation Escalation, 2006 - 2010	10.4% Applied to cost of maintenance materials

**Definition of Assumed Fleet**

	Diesel Locos	Electric Locos	Coaches	Cabs	DMUs	EMUs
Vehicles per Diesel Train	1		9	1		
Vehicles per Electric Train		1	9	1		
Vehicles per DMU Train					2	
Vehicles per EMU Train						2
Metrolinx 2020 Fleet	52		468	52		

**Table 8C-1-C –Labour Costs Used for Rolling Stock Maintenance Costs**

Job Title	Base Labor Rate (\$/hr)	Overtime Rate	Fringe Rate	Labor Rate w/ Fringe (\$/hr)	Admin Labor Rate	Labor Rate w/ Fringe + Admin (\$/hr)	Other Materials & Supplies	Fully Burdened Labor Rate (\$/hr Pay)	Productivity	Fully Burdened Labor Rate (\$/hr Scheduled Work)
Service Worker	\$18.00	5%	30%	\$24.57	40%	\$34.40	15%	\$39.56	91%	\$43.31
General Repair Mechanic	\$27.00	5%	30%	\$36.86	40%	\$51.60	15%	\$59.34	84%	\$70.53
Electro Mechanic	\$32.00	5%	30%	\$43.68	40%	\$61.15	15%	\$70.32	77%	\$91.42
Operator	\$35.00	5%	30%	\$47.78	40%	\$66.89	15%	\$76.92	77%	\$99.99
Conductor	\$32.00	5%	30%	\$43.68	40%	\$61.15	15%	\$70.32	77%	\$91.42
Fair Inspector	\$22.00	5%	30%	\$30.03	40%	\$42.04	15%	\$48.35	89%	\$54.36

**Table 8C-1-D - Calculation of Vehicle Maintenance Costs over 30 Year Life**
**Tier 4 Diesel Locomotive**

Activity	Frequency	Intervals Over 30 Year Life	Labor Hours per Event			Activity Materials (\$US, 2006)	Total Activity Labor (\$CAN, 2010)	Activity Materials (\$CAN, 2010)	Total Life Cycle Labor Hours			Total Life Cycle Labor Hours	Total Life Cycle Labor Cost (\$CAN, 2010)	Total Life Cycle Materials (\$CAN, 2010)
			Service Worker	General Repair Mechanic	Electro Mechanic				Service Worker	General Repair Mechanic	Electro Mechanic			
Inspection and Maintenance	Daily	10949		1.00		1.10	70.53	1.24	0.00	10,949.00	0.00	10,949.00	772,186.20	13,560.10
Cleaning and Servicing	Daily	10949	0.65			1.10	28.15	1.24	7,116.85	0.00	0.00	7,116.85	308,197.12	13,560.10
Inspection and Maintenance	45 Day	239		21.40		800.00	1,509.25	900.71	0.00	5,114.60	0.00	5,114.60	360,710.89	215,270.01
Inspection and Maintenance	92 Day	119			41.50	2,950.00	3,794.02	3,321.37	0.00	0.00	4,938.50	4,938.50	451,488.73	395,243.39
Inspection and Maintenance	184 Day	59				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inspection and Maintenance	1 Year	29			45.00	800.00	4,114.00	900.71	0.00	0.00	1,305.00	1,305.00	119,306.02	26,120.63
Non-Scheduled Repairs	1 Year	29		20.00		750.00	1,410.51	844.42	0.00	580.00	0.00	580.00	40,904.92	24,488.09
Inspection and Maintenance	2 Year	14				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inspection and Maintenance	4 Year	6				10,000.00	0.00	11,258.89	0.00	0.00	0.00	0.00	0.00	67,553.35
Inspection and Maintenance	5 Year	5			369.00	670,000.00	33,734.81	754,345.73	0.00	0.00	1,845.00	1,845.00	168,674.03	3,771,728.65
Inspection and Maintenance	10 Year	2			156.00	401,000.00	14,261.87	451,481.55	0.00	0.00	312.00	312.00	28,523.74	902,963.10
Inspection and Maintenance	15 Year	1			506.00	596,000.00	46,259.65	671,029.93	0.00	0.00	506.00	506.00	46,259.65	671,029.93
Mid-Life Overhaul	15 Year	1				100,000.00	0.00	112,588.91	0.00	0.00	0.00	0.00	0.00	112,588.91

Average Annual Labor (yrs 1-30) per vehicle:	237.23	554.79	269.62		74,048.93
Average Annual Recurring (yrs 1-3) per vehicle:				1,000.13	22,941.41
Average Annual Recurring (yrs 4-30) per vehicle:				1,068.47	165,137.04
Capitalized (10, 15, Mid-Life) per vehicle:	0.00	0.00	818.00	818.00	74,783.39

Light Maintenance (<= 1 yr Frequency)	91,367.87
Heavy Maintenance (> 1 yr Frequency)	192,310.71
Corrective Maintenance (Scheduled, Annualized)	133,598.53
Rehabilitation Maintenance (Scheduled, Capitalized)	58,712.18

Calendar Year	Service Year	Annualized Labor	Annualized Materials	Capitalized Labor	Capitalized Materials	Total Annual Maint Cost per Vehicle (\$CAN, 2010)
2020	1	74,049	22,941			96,990
2021	2	74,049	22,941			96,990
2022	3	74,049	22,941			96,990
2023	4	74,049	165,137			239,186
2024	5	74,049	165,137			239,186
2025	6	74,049	165,137			239,186
2026	7	74,049	165,137			239,186
2027	8	74,049	165,137			239,186
2028	9	74,049	165,137			239,186
2029	10	74,049	165,137	14,262	451,482	704,929
2030	11	74,049	165,137			239,186
2031	12	74,049	165,137			239,186
2032	13	74,049	165,137			239,186
2033	14	74,049	165,137			239,186
2034	15	74,049	165,137	46,260	783,619	1,069,064
2035	16	74,049	165,137			239,186
2036	17	74,049	165,137			239,186
2037	18	74,049	165,137			239,186
2038	19	74,049	165,137			239,186
2039	20	74,049	165,137			239,186
2040	21	74,049	165,137			239,186
2041	22	74,049	165,137			239,186
2042	23	74,049	165,137			239,186
2043	24	74,049	165,137			239,186
2044	25	74,049	165,137	14,262	451,482	704,929
2045	26	74,049	165,137			239,186
2046	27	74,049	165,137			239,186
2047	28	74,049	165,137			239,186
2048	29	74,049	165,137			239,186
2049	30	74,049	165,137			239,186
<b>Total</b>						<b>8,510,358</b>
<b>Average</b>						<b>283,679</b>

**Electric Locomotive**

Frequency	Intervals Over 30 Year Life	Labor Hours per Event					Total Life Cycle Labor Hours						
		Service Worker	General Repair Mechanic	Electro Mechanic	Activity Materials (\$US, 2006)	Total Activity Labor (\$CAN, 2010)	Activity Materials (\$CAN, 2010)	Service Worker	General Repair Mechanic	Electro Mechanic	Total Life Cycle Labor Hours	Total Life Cycle Labor Cost (\$CAN, 2010)	Total Life Cycle Materials (\$CAN, 2010)
Daily	10949		1.00		1.10	70.53	1.24	0.00	10,949.00	0.00	10,949.00	772,186.20	13,560.10
Daily	10949	0.65			1.10	28.15	1.24	7,116.85	0.00	0.00	7,116.85	308,197.12	13,560.10
45 Day	239		20.00		800.00	1,410.51	900.71	0.00	4,780.00	0.00	4,780.00	337,112.98	215,270.01
92 Day	119			40.00	2,000.00	3,656.89	2,251.78	0.00	0.00	4,760.00	4,760.00	435,169.86	267,961.62
184 Day	59			20.00	250.00	1,828.44	281.47	0.00	0.00	1,180.00	1,180.00	107,878.24	16,606.86
1 Year	29			45.00	3,250.00	4,114.00	3,659.14	0.00	0.00	1,305.00	1,305.00	119,306.02	106,115.05
1 Year	29		20.00		750.00	1,410.51	844.42	0.00	580.00	0.00	580.00	40,904.92	24,488.09
2 Year	14				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Year	6		160.00		75,000.00	11,284.12	84,441.69	0.00	960.00	0.00	960.00	67,704.70	506,650.12
5 Year	5			150.00	350,000.00	13,713.34	394,061.20	0.00	0.00	750.00	750.00	68,566.68	1,970,306.01
10 Year	2			175.00	150,000.00	15,998.89	168,883.37	0.00	0.00	350.00	350.00	31,997.78	337,766.74
15 Year	1			350.00	550,000.00	31,997.78	619,239.03	0.00	0.00	350.00	350.00	31,997.78	619,239.03
15 Year	1				800,000.00	0.00	900,711.32	0.00	0.00	0.00	0.00	0.00	900,711.32

Average Annual Labor (yrs 1-30) per vehicle:	237.23	575.63	266.50		75,234.22	
Average Annual Recurring (yrs 1-3) per vehicle:				1,022.36	21,918.73	
Average Annual Recurring (yrs 4-30) per vehicle:				1,085.70	113,657.84	
Capitalized (10, 15, Mid-Life) per vehicle:	0.00	0.00	700.00	700.00	63,995.57	1,857,717.09

Light Maintenance (<= 1 yr Frequency)	92,610.57
Heavy Maintenance (> 1 yr Frequency)	151,164.67
Corrective Maintenance (Scheduled, Annualized)	87,107.58
Rehabilitation Maintenance (Scheduled, Capitalized)	64,057.09

Calendar Year	Service Year	Annualized Labor	Annualized Materials	Capitalized Labor	Capitalized Materials	Total Annual Maint Cost per Vehicle (\$CAN, 2010)
2020	1	75,234	21,919			97,153
2021	2	75,234	21,919			97,153
2022	3	75,234	21,919			97,153
2023	4	75,234	113,658			188,892
2024	5	75,234	113,658			188,892
2025	6	75,234	113,658			188,892
2026	7	75,234	113,658			188,892
2027	8	75,234	113,658			188,892
2028	9	75,234	113,658			188,892
2029	10	75,234	113,658	15,999	168,883	373,774
2030	11	75,234	113,658			188,892
2031	12	75,234	113,658			188,892
2032	13	75,234	113,658			188,892
2033	14	75,234	113,658			188,892
2034	15	75,234	113,658	31,998	1,519,950	1,740,840
2035	16	75,234	113,658			188,892
2036	17	75,234	113,658			188,892
2037	18	75,234	113,658			188,892
2038	19	75,234	113,658			188,892
2039	20	75,234	113,658			188,892
2040	21	75,234	113,658			188,892
2041	22	75,234	113,658			188,892
2042	23	75,234	113,658			188,892
2043	24	75,234	113,658			188,892
2044	25	75,234	113,658	15,999	168,883	373,774
2045	26	75,234	113,658			188,892
2046	27	75,234	113,658			188,892
2047	28	75,234	113,658			188,892
2048	29	75,234	113,658			188,892
2049	30	75,234	113,658			188,892
Total						7,313,257
Average						243,775

**Coach Car**

Activity	Frequency	Intervals Over 30 Year Life	Labor Hours per Event			Activity Materials			Total Life Cycle Labor Hours			Total Life Cycle Labor Hours	Total Life Cycle Labor Cost (\$CAN, 2010)	Total Life Cycle Materials (\$CAN, 2010)
			Service Worker	General Repair Mechanic	Electro Mechanic	Activity Materials (\$US, 2006)	Total Activity Labor (\$CAN, 2010)	Activity Materials (\$CAN, 2010)	Service Worker	General Repair Mechanic	Electro Mechanic			
Inspection and Maintenance	Daily	10949		0.55		0.88	38.79	0.99	0.00	6,021.95	0.00	6,021.95	424,702.41	10,848.08
Cleaning and Servicing	Daily	10949	3.23			2.03	139.66	2.28	35,310.53	0.00	0.00	35,310.53	1,529,131.87	24,962.90
Inspection and Maintenance	45 Day	239		3.20		0.00	225.68	0.00	0.00	764.80	0.00	764.80	53,938.08	0.00
Inspection and Maintenance	92 Day	119			34.30	860.00	3,135.78	968.26	0.00	0.00	4,081.70	4,081.70	373,158.16	115,223.50
Inspection and Maintenance	184 Day	59				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inspection and Maintenance	1 Year	29		26.70		3,800.00	2,440.97	4,278.38	0.00	0.00	774.30	774.30	70,788.24	124,072.98
Non-Scheduled Repairs	1 Year	29		130.00		5,200.00	9,168.34	5,854.62	0.00	3,770.00	0.00	3,770.00	265,881.99	169,784.08
Inspection and Maintenance	2 Year	14				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inspection and Maintenance	4 Year	6		68.70		20,000.00	4,845.12	22,517.78	0.00	412.20	0.00	412.20	29,070.71	135,106.70
Inspection and Maintenance	5 Year	5			8.00	1,666.00	731.38	1,875.73	0.00	0.00	40.00	40.00	3,656.89	9,378.66
Inspection and Maintenance	10 Year	2			50.50	12,300.00	4,616.82	13,848.44	0.00	0.00	101.00	101.00	9,233.65	27,696.87
Inspection and Maintenance	15 Year	1			380.00	25,500.00	34,740.45	28,710.17	0.00	0.00	380.00	380.00	34,740.45	28,710.17
Mid-Life Overhaul	15 Year	1				650,000.00	0.00	731,827.95	0.00	0.00	0.00	0.00	0.00	731,827.95

Average Annual Labor (yrs 1-30) per vehicle:	1,177.02	365.63	163.20		91,677.61
Average Annual Recurring (yrs 1-3) per vehicle:				1,690.78	14,829.72
Average Annual Recurring (yrs 4-30) per vehicle:				1,707.52	20,181.03
Capitalized (10, 15, Mid-Life) per vehicle:	0.00	0.00	481.00	481.00	43,974.10

Light Maintenance (<= 1 yr Frequency)	105,416.41
Heavy Maintenance (> 1 yr Frequency)	33,647.40
Corrective Maintenance (Scheduled, Annualized)	5,907.10
Rehabilitation Maintenance (Scheduled, Capitalized)	27,740.30

Calendar Year	Service Year	Annualized Labor	Annualized Materials	Capitalized Labor	Capitalized Materials	Total Annual Maint Cost per Vehicle (\$CAN, 2010)
2020	1	91,678	14,830			106,507
2021	2	91,678	14,830			106,507
2022	3	91,678	14,830			106,507
2023	4	91,678	20,181			111,859
2024	5	91,678	20,181			111,859
2025	6	91,678	20,181			111,859
2026	7	91,678	20,181			111,859
2027	8	91,678	20,181			111,859
2028	9	91,678	20,181			111,859
2029	10	91,678	20,181	4,617	13,848	130,324
2030	11	91,678	20,181			111,859
2031	12	91,678	20,181			111,859
2032	13	91,678	20,181			111,859
2033	14	91,678	20,181			111,859
2034	15	91,678	20,181	34,740	760,538	907,137
2035	16	91,678	20,181			111,859
2036	17	91,678	20,181			111,859
2037	18	91,678	20,181			111,859
2038	19	91,678	20,181			111,859
2039	20	91,678	20,181			111,859
2040	21	91,678	20,181			111,859
2041	22	91,678	20,181			111,859
2042	23	91,678	20,181			111,859
2043	24	91,678	20,181			111,859
2044	25	91,678	20,181	4,617	13,848	130,324
2045	26	91,678	20,181			111,859
2046	27	91,678	20,181			111,859
2047	28	91,678	20,181			111,859
2048	29	91,678	20,181			111,859
2049	30	91,678	20,181			111,859
Total						4,171,914
Average						139,064



**Cab Car**

Activity	Frequency	Intervals Over 30 Year Life	Labor Hours per Event			Activity Materials (\$US, 2006)	Total Activity Labor (\$CAN, 2010)	Activity Materials (\$CAN, 2010)	Total Life Cycle Labor Hours			Total Life Cycle Labor Hours	Total Life Cycle Labor Cost (\$CAN, 2010)	Total Life Cycle Materials (\$CAN, 2010)
			Service Worker	General Repair Mechanic	Electro Mechanic				Service Worker	General Repair Mechanic	Electro Mechanic			
Inspection and Maintenance	Daily	10949		0.83		0.98	58.18	1.10	0.00	9,032.93	0.00	9,032.93	637,053.61	12,068.49
Cleaning and Servicing	Daily	10949	3.23			1.95	139.66	2.20	35,310.53	0.00	0.00	35,310.53	1,529,131.87	24,038.35
Inspection and Maintenance	45 Day	239		3.70		0.00	260.95	0.00	0.00	884.30	0.00	884.30	62,365.90	0.00
Inspection and Maintenance	92 Day	119			41.80	860.00	3,821.45	968.26	0.00	0.00	4,974.20	4,974.20	454,752.51	115,223.50
Inspection and Maintenance	184 Day	59				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inspection and Maintenance	1 Year	29			26.50	3,350.00	2,422.69	3,771.73	0.00	0.00	768.50	768.50	70,257.99	109,380.13
Non-Scheduled Repairs	1 Year	29		156.00		7,150.00	11,002.01	8,050.11	0.00	4,524.00	0.00	4,524.00	319,058.39	233,453.11
Inspection and Maintenance	2 Year	14		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inspection and Maintenance	4 Year	6		160.60		64,000.00	11,326.43	72,056.91	0.00	963.60	0.00	963.60	67,958.59	432,341.43
Inspection and Maintenance	5 Year	5			8.20	7,025.00	749.66	7,909.37	0.00	0.00	41.00	41.00	3,748.31	39,546.86
Inspection and Maintenance	10 Year	2			83.60	34,075.00	7,642.90	38,364.67	0.00	0.00	167.20	167.20	15,285.80	76,729.35
Inspection and Maintenance	15 Year	1				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mid-Life Overhaul	15 Year	1				780,000.00	0.00	878,193.54	0.00	0.00	0.00	0.00	0.00	878,193.54

Average Annual Labor (yrs 1-30) per vehicle:	1,177.02	513.49	192.79		104,810.91
Average Annual Recurring (yrs 1-3) per vehicle:				1,849.82	16,472.12
Average Annual Recurring (yrs 4-30) per vehicle:				1,887.02	33,949.46
Capitalized (10, 15, Mid-Life) per vehicle:	0.00	0.00	167.20	167.20	15,285.80

Light Maintenance (<= 1 yr Frequency)	118,892.80
Heavy Maintenance (> 1 yr Frequency)	50,460.13
Corrective Maintenance (Scheduled, Annualized)	18,119.84
Rehabilitation Maintenance (Scheduled, Capitalized)	32,340.29

Calendar Year	Service Year	Annualized Labor	Annualized Materials	Capitalized Labor	Capitalized Materials	Total Annual Maint Cost per Vehicle (\$CAN, 2010)
2020	1	104,811	16,472			121,283
2021	2	104,811	16,472			121,283
2022	3	104,811	16,472			121,283
2023	4	104,811	33,949			138,760
2024	5	104,811	33,949			138,760
2025	6	104,811	33,949			138,760
2026	7	104,811	33,949			138,760
2027	8	104,811	33,949			138,760
2028	9	104,811	33,949			138,760
2029	10	104,811	33,949	7,643	38,365	184,768
2030	11	104,811	33,949			138,760
2031	12	104,811	33,949			138,760
2032	13	104,811	33,949			138,760
2033	14	104,811	33,949			138,760
2034	15	104,811	33,949	0	878,194	1,016,954
2035	16	104,811	33,949			138,760
2036	17	104,811	33,949			138,760
2037	18	104,811	33,949			138,760
2038	19	104,811	33,949			138,760
2039	20	104,811	33,949			138,760
2040	21	104,811	33,949			138,760
2041	22	104,811	33,949			138,760
2042	23	104,811	33,949			138,760
2043	24	104,811	33,949			138,760
2044	25	104,811	33,949	7,643	38,365	184,768
2045	26	104,811	33,949			138,760
2046	27	104,811	33,949			138,760
2047	28	104,811	33,949			138,760
2048	29	104,811	33,949			138,760
2049	30	104,811	33,949			138,760
Total						5,080,588
Average						169,353

**Single Level EMU**

Activity	Frequency	Intervals Over 30 Year Life	Labor Hours per Event			Activity Materials (\$US, 2006)	Total Activity Labor (\$CAN, 2010)	Activity Materials (\$CAN, 2010)	Total Life Cycle Labor Hours			Total Life Cycle Labor Hours	Total Life Cycle Labor Cost (\$CAN, 2010)	Total Life Cycle Materials (\$CAN, 2010)
			Service Worker	General Repair Mechanic	Electro Mechanic				Service Worker	General Repair Mechanic	Electro Mechanic			
Inspection and Maintenance	Daily	10949		1.50		1.74	105.79	1.96	0.00	16,423.50	0.00	16,423.50	1,158,279.29	21,449.61
Cleaning and Servicing	Daily	10949	2.75			0.40	119.09	0.45	30,109.75	0.00	0.00	30,109.75	1,303,910.90	4,930.94
Inspection and Maintenance	45 Day	239		9.05		560.00	638.26	630.50	0.00	2,162.95	0.00	2,162.95	152,543.62	150,689.00
Inspection and Maintenance	92 Day	119			52.18	1,597.50	4,769.96	1,798.61	0.00	0.00	6,208.83	6,208.83	567,624.69	214,034.34
Inspection and Maintenance	184 Day	59			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inspection and Maintenance	1 Year	29			37.75	3,550.00	3,451.19	3,996.91	0.00	0.00	1,094.75	1,094.75	100,084.50	115,910.29
Non-Scheduled Repairs	1 Year	29		125.00		5,687.50	8,815.72	6,403.49	0.00	3,625.00	0.00	3,625.00	255,655.76	185,701.34
Inspection and Maintenance	2 Year	14		0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inspection and Maintenance	4 Year	6		160.60		66,950.00	11,326.43	75,378.28	0.00	963.60	0.00	963.60	67,958.59	452,269.67
Inspection and Maintenance	5 Year	5			100.45	174,525.00	9,183.36	196,495.80	0.00	0.00	502.25	502.25	45,916.82	982,479.02
Inspection and Maintenance	10 Year	2			122.60	134,325.00	11,208.37	151,235.06	0.00	0.00	245.20	245.20	22,416.73	302,470.12
Inspection and Maintenance	15 Year	1				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mid-Life Overhaul	15 Year	1				1,300,000.00	0.00	1,463,655.89	0.00	0.00	0.00	0.00	0.00	1,463,655.89

Average Annual Labor (yrs 1-30) per vehicle:	1,003.66	772.50	260.19		121,732.47	
Average Annual Recurring (yrs 1-3) per vehicle:				1,987.49		23,090.52
Average Annual Recurring (yrs 4-30) per vehicle:				2,041.78		76,229.36
Capitalized (10, 15, Mid-Life) per vehicle:	0.00	0.00	245.20	245.20	22,416.73	1,766,126.01

Light Maintenance (<= 1 yr Frequency)	141,027.14
Heavy Maintenance (> 1 yr Frequency)	111,238.89
Corrective Maintenance (Scheduled, Annualized)	51,620.80
Rehabilitation Maintenance (Scheduled, Capitalized)	59,618.09

Calendar Year	Service Year	Annualized Labor	Annualized Materials	Capitalized Labor	Capitalized Materials	Total Annual Maint Cost per Vehicle (\$CAN, 2010)
2020	1	121,732	23,091			144,823
2021	2	121,732	23,091			144,823
2022	3	121,732	23,091			144,823
2023	4	121,732	76,229			197,962
2024	5	121,732	76,229			197,962
2025	6	121,732	76,229			197,962
2026	7	121,732	76,229			197,962
2027	8	121,732	76,229			197,962
2028	9	121,732	76,229			197,962
2029	10	121,732	76,229	11,208	151,235	360,405
2030	11	121,732	76,229			197,962
2031	12	121,732	76,229			197,962
2032	13	121,732	76,229			197,962
2033	14	121,732	76,229			197,962
2034	15	121,732	76,229	0	1,463,656	1,661,618
2035	16	121,732	76,229			197,962
2036	17	121,732	76,229			197,962
2037	18	121,732	76,229			197,962
2038	19	121,732	76,229			197,962
2039	20	121,732	76,229			197,962
2040	21	121,732	76,229			197,962
2041	22	121,732	76,229			197,962
2042	23	121,732	76,229			197,962
2043	24	121,732	76,229			197,962
2044	25	121,732	76,229	11,208	151,235	360,405
2045	26	121,732	76,229			197,962
2046	27	121,732	76,229			197,962
2047	28	121,732	76,229			197,962
2048	29	121,732	76,229			197,962
2049	30	121,732	76,229			197,962
Total						7,567,981
Average						252,266

**Single Level DMU**

Activity	Frequency	Intervals Over 30 Year Life	Labor Hours per Event			Activity Materials (\$US, 2006)	Total Activity Labor (\$CAN, 2010)	Activity Materials (\$CAN, 2010)	Total Life Cycle Labor Hours			Total Life Cycle Labor Hours	Total Life Cycle Labor Cost (\$CAN, 2010)	Total Life Cycle Materials (\$CAN, 2010)
			Service Worker	General Repair Mechanic	Electro Mechanic				Service Worker	General Repair Mechanic	Electro Mechanic			
Inspection and Maintenance	Daily	10949		1.80		1.74	126.95	1.96	0.00	19,708.20	0.00	19,708.20	1,389,935.15	21,449.61
Cleaning and Servicing	Daily	10949	2.75			1.70	119.09	1.91	30,109.75	0.00	0.00	30,109.75	1,303,910.90	20,956.51
Inspection and Maintenance	45 Day	239		18.00		794.40	1,269.46	894.41	0.00	4,302.00	0.00	4,302.00	303,401.68	213,763.12
Inspection and Maintenance	92 Day	119			54.44	1,126.00	4,977.03	1,267.75	0.00	0.00	6,478.36	6,478.36	592,266.18	150,862.39
Inspection and Maintenance	184 Day	59			4.50	114.00	411.40	128.35	0.00	0.00	265.50	265.50	24,272.60	7,572.73
Inspection and Maintenance	1 Year	29			47.50	9,351.00	4,342.56	10,528.19	0.00	0.00	1,377.50	1,377.50	125,934.14	305,317.49
Non-Scheduled Repairs	1 Year	29		198.90		14,643.10	14,027.57	16,486.51	0.00	5,768.10	0.00	5,768.10	406,799.45	478,108.71
Inspection and Maintenance	2 Year	14		82.70		40,142.00	5,832.48	45,195.44	0.00	1,157.80	0.00	1,157.80	81,654.69	632,736.19
Inspection and Maintenance	4 Year	6		65.00		47,812.50	4,584.17	53,831.57	0.00	390.00	0.00	390.00	27,505.03	322,989.45
Inspection and Maintenance	5 Year	5			359.90	85,700.00	32,902.86	96,488.70	0.00	0.00	1,799.50	1,799.50	164,514.32	482,443.50
Inspection and Maintenance	10 Year	2			99.60	77,275.00	9,105.66	87,003.08	0.00	0.00	199.20	199.20	18,211.31	174,006.17
Inspection and Maintenance	15 Year	1			48.00	200,000.00	4,388.27	225,177.83	0.00	0.00	48.00	48.00	4,388.27	225,177.83
Mid-Life Overhaul	15 Year	1				900,000.00	0.00	1,013,300.23	0.00	0.00	0.00	0.00	0.00	1,013,300.23

Average Annual Labor (yrs 1-30) per vehicle:	1,003.66	1,044.20	330.70		147,339.81
Average Annual Recurring (yrs 1-3) per vehicle:				2,305.57	61,025.56
Average Annual Recurring (yrs 4-30) per vehicle:				2,386.67	90,856.41
Capitalized (10, 15, Mid-Life) per vehicle:	0.00	0.00	247.20	247.20	22,599.58

Light Maintenance (<= 1 yr Frequency)	178,151.69
Heavy Maintenance (> 1 yr Frequency)	104,897.57
Corrective Maintenance (Scheduled, Annualized)	57,061.44
Rehabilitation Maintenance (Scheduled, Capitalized)	47,836.13

Calendar Year	Service Year	Annualized Labor	Annualized Materials	Capitalized Labor	Capitalized Materials	Total Annual Maint Cost per Vehicle (\$CAN, 2010)
2020	1	147,340	61,026			208,365
2021	2	147,340	61,026			208,365
2022	3	147,340	61,026			208,365
2023	4	147,340	90,856			238,196
2024	5	147,340	90,856			238,196
2025	6	147,340	90,856			238,196
2026	7	147,340	90,856			238,196
2027	8	147,340	90,856			238,196
2028	9	147,340	90,856			238,196
2029	10	147,340	90,856	9,106	87,003	334,305
2030	11	147,340	90,856			238,196
2031	12	147,340	90,856			238,196
2032	13	147,340	90,856			238,196
2033	14	147,340	90,856			238,196
2034	15	147,340	90,856	4,388	1,238,478	1,481,063
2035	16	147,340	90,856			238,196
2036	17	147,340	90,856			238,196
2037	18	147,340	90,856			238,196
2038	19	147,340	90,856			238,196
2039	20	147,340	90,856			238,196
2040	21	147,340	90,856			238,196
2041	22	147,340	90,856			238,196
2042	23	147,340	90,856			238,196
2043	24	147,340	90,856			238,196
2044	25	147,340	90,856	9,106	87,003	334,305
2045	26	147,340	90,856			238,196
2046	27	147,340	90,856			238,196
2047	28	147,340	90,856			238,196
2048	29	147,340	90,856			238,196
2049	30	147,340	90,856			238,196
Total						8,491,478
Average						283,049

## **APPENDIX 8C-2 – WAYSIDE MAINTENANCE ESTIMATES**

**Table 8C-2-A - Wayside Maintenance Estimates by Segmen**

**Table 8C-2-B - Wayside Estimates by Option**

**Figure 8C-2-B (con't) - Union Station Segment Graphics**

**Table 8C-2-C - Fuel Consumption Estimates**

**Table 8C-2-D - Electricity Consumption Estimates**

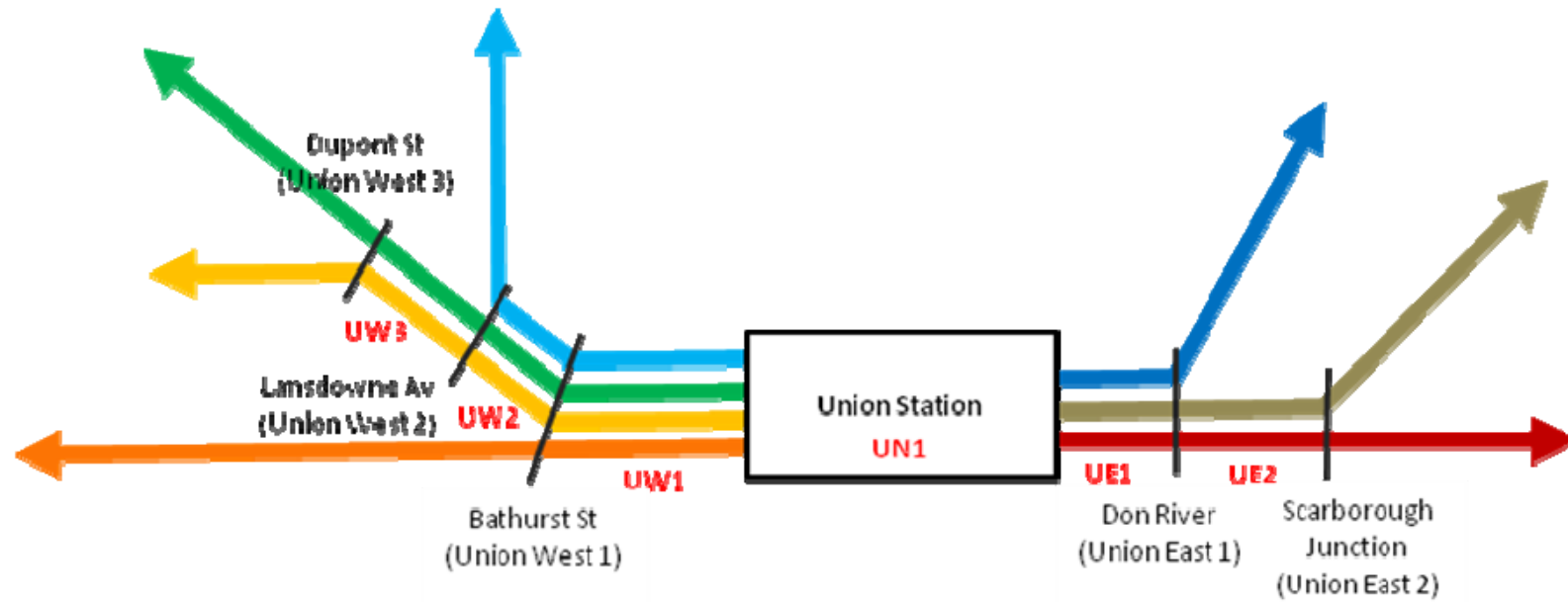
**Table 8C-2-A- Wayside Maintenance Estimates by Segment**

Infrastructure Maintenance Costs (\$ per section in 2010 prices)				
All Corridors (Incl. Hamilton TH&B) Maintenance Costs				
	Corridor	Corridor Sections	Infrastructure Maintenance Costs (\$ per section in 2010 prices)	
			Catenary System Maintenance	Power Supply Maintenance
UN1	Union	Union Station	\$29,173	\$0
UE1	Union East	Union to Don River (Union E1)	\$81,268	\$140,267
UE2	Union East	Don River to Scarborough Jctn (Union E2)	\$283,397	\$350,667
UW1	Union West	Union to Bathurst St (Union W1)	\$83,352	\$0
UW2	Union West	Bathurst St to Lansdowne Av (Union W2)	\$158,369	\$210,400
UW3	Union West	Lansdowne Av to Dupont St (Union W3)	\$112,525	\$140,267
LE1	Lakeshore East	Union E2 to Pickering	\$385,503	\$0
LE2	Lakeshore East	Pickering to Oshawa 2	\$318,822	\$140,267
LE3	Lakeshore East	Oshawa 2 to Bowmanville	\$69,807	\$350,667
LW1	Lakeshore West	Union W1 to Oakville	\$855,400	\$350,667
LW2	Lakeshore West	Oakville to Hamilton-James	\$573,045	\$490,933
LW3	Lakeshore West	Hamilton Jctn to Hamilton TH+B	\$30,215	\$70,133
LW4	Lakeshore West	Hamilton-James to St Catherine's	\$293,816	\$140,267
MI1	Milton	Union W3 to Meadowvale	\$275,062	\$140,267
MI2	Milton	Meadowvale to Milton	\$275,062	\$70,133
GT1A	Georgetown	Union W3 to Pearson Airport (ARL)	\$527,202	\$420,800
GT1B	Georgetown	Union W3 to Brampton (excluding ARL)	\$81,268	\$0
GT2	Georgetown	Brampton to Georgetown	\$168,788	\$140,267
GT3	Georgetown	Georgetown to Kitchener	\$345,911	\$420,800
BA1	Barrie	Union W2 To Bradford	\$802,263	\$420,800
BA2	Barrie	Bradford to Allandale	\$224,009	\$140,267
RH1	Richmond Hill	Union E1 to Richmond Hill	\$408,425	\$70,133
RH2	Richmond Hill	Richmond Hill to Bloomington	\$78,143	\$70,133
ST1	Stouffville	Union E2 to Mt Joy	\$265,685	\$70,133
ST2	Stouffville	Mt Joy to Lincolnville	\$71,891	\$70,133
	<b>All Corridors (Incl. Hamilton TH&amp;B) Maintenance Costs</b>		<b>\$6,798,400</b>	<b>\$4,418,400</b>

**Table 8C-2-B- Wayside Estimates by Option**

<b>Option One</b>	
UN1	\$29,173
UW1	\$83,352
UW2	\$368,769
UW3	\$252,792
GT1A	\$948,002
GT1B	\$81,268
GT2	\$309,055
GT3	\$766,711
<b>TOTAL</b>	<b>\$2,839,122</b>
<b>Option 2</b>	
UN1	\$29,173
UW1	\$83,352
LW1	\$1,206,067
LW2	\$1,063,978
UE1	\$221,535
UE2	\$634,064
LE1	\$385,503
LE2	\$459,089
LE3	\$420,474
<b>TOTAL</b>	<b>\$4,503,235</b>
<b>Option 3</b>	
Option 1	\$2,839,122
Option 2	\$4,503,235
Less Option 2 UN1 & UW1	\$112,525
<b>TOTAL</b>	<b>\$7,229,832</b>
<b>Option 11</b>	
Option 3	\$7,229,832
MI1	\$415,329
MI2	\$345,195
<b>TOTAL</b>	<b>\$7,990,356</b>
<b>Option 15</b>	
Option 11	\$7,990,356
BA1	\$1,223,063
BA2	\$364,276
<b>TOTAL</b>	<b>\$9,577,695</b>
<b>Option 18</b>	
	\$11,216,800

Figure 8C-2-B (con't) Union Station Segment Graphics



**Table 8C-2-C - Fuel Consumption Estimates**

Corridor	Weekday Revenue Gallons of Fuel	Weekday Non-Revenue Gallons of Fuel	TOTAL Annual Gallons of Fuel (250 days)	%Weekend (Revenue and Non)	Total Annual Weekend and Holiday	TOTAL Annual Gallons of Fuel	Conversion to Litres (4.546)	Non-Revenue Hoteling Factor (20%)	TOTAL Annual Litres of Fuel	Cost
Barrie	5608	1037	1,661,250	29%	483,594	2,144,844	9,750,459	1,950,092	11,700,551	\$ 8,775,413.50
Georgetown	5116	112	1,307,000	19%	248,501	1,555,501	7,071,306	1,414,261	8,485,567	\$ 6,364,175.39
Lakeshore East	9182	994	2,544,000	36%	918,475	3,462,475	15,740,412	3,148,082	18,888,495	\$ 14,166,371.11
Lakeshore West	10809	878	2,921,750	33%	958,948	3,880,698	17,641,655	3,528,331	21,169,986	\$ 15,877,489.31
Milton	3914	1881	1,448,750	25%	359,632	1,808,382	8,220,904	1,644,181	9,865,085	\$ 7,398,813.83
Richmond Hill	2259	353	653,000	31%	200,253	853,253	3,878,890	775,778	4,654,668	\$ 3,491,000.69
Stouffville	3489	1305	1,198,500	27%	320,944	1,519,444	6,907,391	1,381,478	8,288,869	\$ 6,216,652.06
ARL	1636	36	610,280			610,280	2,774,333	554,867	3,329,199	\$ 2,496,899.59
									86,382,421	\$ 64,786,815.48
Hamilton TH&B with St.Catherines	635	0	158750			158,750	721,678	72,168	793,845	\$ 595,383.94



**Table 8C-2-D - Electricity Consumption Estimates**

Corridor	Ton-Miles (Weekday Revenue and Non-Revenue)	Weekend and Holiday Assumption	Weekend and Holiday (revenue and non-revenue) as a percentage of Weekday	Ton-Miles (Weekend Revenue and Non Revenue)	Estimated Annual Ton Miles	Electricity Cost	15% Reduction Due to Regenerative Breaking
Barrie	2,320,934	Assume same percentage as train miles	29%	675,629	657,930,861	\$ 4,973,957	\$ 4,227,864
Georgetown	1,836,782	Assume same percentage as train miles	19%	349,228	499,356,767	\$ 3,775,137	\$ 3,208,867
Lakeshore East	3,104,250	Assume same percentage as train miles	36%	1,120,746	904,948,239	\$ 6,841,409	\$ 5,815,197
Lakeshore West	3,635,574	Assume same percentage as train miles	33%	1,193,233	1,046,115,265	\$ 7,908,631	\$ 6,722,337
Milton	1,848,630	Assume same percentage as train miles	25%	458,897	514,930,603	\$ 3,892,875	\$ 3,308,944
Richmond Hill	1,102,291	Assume same percentage as train miles	31%	338,036	314,446,879	\$ 2,377,218	\$ 2,020,636
Stouffville	1,641,714	Assume same percentage as train miles	27%	439,631	460,986,070	\$ 3,485,055	\$ 2,962,296
ARL	391,559	Assume 365 days a year same service			142,919,035	\$ 1,080,468	\$ 918,398
Hamilton TH&B and St. Catharines		Assume total tons is the same percentage of Lakeshore West as total train miles			177,271,131	\$ 1,340,170	\$ 1,139,144
Estimated Lakeshore West to Hamilton James Only		Assume total tons is the difference between estimate for Lakeshore total minus estimate for St. Catharines with TH&B			868,844,135	\$ 6,568,462	\$ 5,583,192