

# Transit Vehicle (Trolley) Technology Review

## CFBT or ETC Remarks/Comments



Recommendation:

1. That the trolley system be phased out in 2009 and 2010.
2. That the purchase of 47 new hybrid buses to be received in 2010 be approved with funding identified in the 2009 -2011 Capital budget process.
3. That the decommissioning of the remaining trolley infrastructure in 2010 be approved.

### Report Summary

In 2004 City Council directed that Edmonton Transit continue to operate its fleet of trolley buses. Council also authorized the Administration to test new hybrid bus and trolley bus technology and to report back in 2008. This report summarizes the results of our tests and includes recommendations dealing with the existing trolley bus fleet.

### Previous Council/Committee Action

On July 27, 2004, City Council passed the following motions:

- That Edmonton Transit continue to operate trolleys until 2008.
- That Administration arrange to have a demonstration of low-floor trolley and hybrid buses to be utilized within the system for information gathering.
- That expansion of the trolley fleet to Northgate be considered in the 2006 budget.
- That a report be provided to Council in 2008 regarding continuation of trolleys based on:

The manner in which the demonstration was carried out provided a poor basis for fair comparison. ~\$4.5 million was spent to purchase six hybrids, which were heavily promoted at public events and featured prominent interior and exterior signage. By contrast, one trolley was leased from Vancouver, was used in service for less than 8 full months out of the 12 month lease, and was devoid of any interior or exterior signage to inform the public. Public opinions on the new trolley were never gathered at any point during lease period, nor was it ever taken to public venues such as Earth Day or the ETS Community Conference to ensure equal public exposure. In contrast to the hybrids, the new trolley was essentially operated on only one route, the 5/135, so patrons who use other trolley routes were never exposed to it. It would be a fair assessment to say that many more Edmontonians are aware that hybrid buses are being tested than realize a new low floor trolley bus has been operating in our city.

1. service levels

2. environmental concerns in light of the demonstration of low-floor trolley and hybrid buses, and other options.

- That Administration continue to look at ways to maximize the costbenefit of trolleys.

**Report**

*Current Situation*

As per City Council direction Administration has purchased a total of six hybrid buses from two different manufacturers, involving three different types of technology. These vehicles were received in 2006 and 2007 and have been in service since their arrival. A new trolley bus was leased from Coast Mountain Bus Company in Vancouver (Trans-Link) and has been in service in Edmonton since the summer of 2007.

*Vehicle Technology Reviewed*

In undertaking this assessment Administration focused upon three types of transit vehicle technology; trolley, clean diesel and hybrid.

Trolley buses use an electric propulsion system with the electric power being carried to the vehicles through the overhead trolley line infrastructure. In Alberta most of the power that is utilized is generated at one of the coal fired generating plants located throughout the province. Including Edmonton, there are seven transit systems in North America that currently operate trolley bus systems. Vancouver has received 228 new trolley buses since 2006, and plan to order 34 additional trolley buses in 2008.

The effect of service levels on costs was not given proper consideration in any of the studies, nor is the point addressed in this administrative report. Trolleys become more economical as service levels are increased. An examination of the impact of different service levels, therefore, ought to be paramount in any trolley analysis. This would entail not only looking at future service requirements on the existing system, but at potential areas for expansion as well. All of the studies assume that the City would never expand the trolley system or utilize/require more trolley buses to provide transit service than presently. The *2008 Strategic Ridership Study* document envisions 10 minute service on main line (base) routes. This change alone would increase service levels on trolley routes on the existing trolley system, reducing per unit costs accordingly.

There is no indication that administration has attempted to comply with this directive. The cost-benefit of operating trolley buses improves as trolley utilization increases. On the basis of the kms of travel per trolley bus cited in both the Booz Allen and Checkel reports, the utilization of the trolley fleet has not improved. The old Booz Allen report of 2004 states that annually 1.18 million kms of trolley service were being run (p.41), but data in the 2008 report suggest that now only 860,000 to 970,000 km are being operated. The 2007-08 bus schedules contain almost 2.3 million kms of trolley bus service. (Attachment I) The practice of leaving trolleys standing idle in the barn while diesel buses are used to provide the service would not be considered 'best practice' by other municipalities that use trolley buses. It should come as no surprise that per unit trolley costs are higher in the 2008 Booz Allen report than they were in 2004.

There are *eight* other trolley systems in North America, *excluding* Edmonton. *All* of these systems have recently purchased new trolleybus fleets, despite the higher purchase price of such vehicles compared to diesel buses. Several of them either have extended overhead wire in recent years (Dayton, Vancouver, Seattle) or have plans to build extensions (Vancouver, Seattle, San Francisco, see links below).

[http://www.translink.bc.ca/Plans/Public\\_Consultation/MarineDr\\_Trolley\\_Extension.asp](http://www.translink.bc.ca/Plans/Public_Consultation/MarineDr_Trolley_Extension.asp)

<http://transit.metrokc.gov/up/archives/2007/trolley3-07.html>

[http://www.sftfep.com/files/3\\_17\\_08\\_TEP%20summary.pdf](http://www.sftfep.com/files/3_17_08_TEP%20summary.pdf) (p. 7)

Clean diesel is the most recent version of diesel engine technology. It is the standard type of technology that is used in the Edmonton Transit fleet, as well as transit fleets across North America. These engines comply with 2007 Transport Canada and the United States Environmental Protection Act standards for diesel emissions. Contributing to lower emissions is the use of ultra-low sulphur fuel, and post-combustion converter technology to capture some of the emissions before they leave the tailpipe.

Hybrid buses combine electric and diesel technology. The vehicle carries its own set of batteries which provide power to an electric motor for some of the propulsion needs, while the diesel responds to the rest. While this technology is relatively new for the public industry, a large number of systems across North America are ordering these types of vehicles as part of their own environmental initiatives. According to the American Public Transit Association, over 4,000 of these buses have been delivered or are on order for 2008. Translink (Vancouver) have an order in for 141 hybrids and Toronto Transit Commission has ordered 400 hybrids.

*Project Process*

Consultant specialists were hired to undertake the assessment of the technologies.

The issue was assessed from a micro vehicle level as well as a macro system perspective. Dr. David Checkel, of the University of Alberta, who is a recognized authority in the field of vehicle fuel and emission technologies,

The hybrids now in service or on order are largely being used to replace diesel, or in some cases, CNG (Compressed Natural Gas) buses. The industry trend in North America is to replace trolley buses with new trolley buses, regardless of the source of power generation in the municipality and despite the higher purchase cost of trolley buses. In Vancouver, hybrid buses will displace aging diesel buses. Seattle's hybrids replaced dual-mode buses that operated 95% of their travel as diesel buses and were incompatible with the 1000 Volt LRT system being installed in their transit tunnel.

Toronto Transit Commission (TTC) recently reported extensive problems with its new hybrid buses ranging from premature failure of the battery packs to poor fuel economy and reliability. These problems have received much media attention. TTC bought the hybrids to replace costly and trouble-prone CNG buses that they had been convinced were a suitable replacement for trolley buses in 1993. On May 16, 2008, TTC Chair Adam Giambrone told the *Globe and Mail* that hybrids are a 'transitional technology' to electric vehicles and that the TTC may return to using trolley buses. (Attachment I) In an interview with *Diesel Fuel News*, August 7, 2000, former TTC Chair Howard Moscoe characterized the abandonment of Toronto's trolley bus system as a mistake.

It is clear from reading his report, that Dr. Checkel's expertise lies in the area of internal combustion technologies and hybrid vehicles. His literature review, for instance, references only materials on hybrid buses; there are no references to studies on trolley buses or other grid-connected vehicles. The planning and operation of trolley buses and other grid-connected systems is paradigmatically different from internal combustion vehicles. An examination of issues specific to grid-connected technologies is lacking in his report. While the report may provide a comparison between diesel and hybrid buses, it cannot be considered a proper assessment of the viability of Edmonton's trolley bus system.

was hired to conduct the micro vehicle technical evaluation of the options, assess the results of the emissions tests that were carried out independently by Environment Canada and undertake noise testing.

The macro fleet wide analysis was conducted by Booz Allen Hamilton Consultants. Their approach to the analysis was to review data from other transit systems and various published technical references.

Booz Allen Hamilton is one of the world's largest technology and management consulting firms. They are specialists in urban mass transportation with expertise in bus technology.

The macro analysis included an update of the original report from 2004 to reflect the current Edmonton Transit fleet.

Environment Canada was hired to test the three types of vehicles to determine the differences in emission generated in the Edmonton environment.

A comprehensive process was implemented to obtain input from a number of public perspectives. This work is summarized in the section on 'Public Consultation'.

*Assessment Results -Transit Service Levels*

In terms of transit service there would be no impact on what is provided to customers. The service provided by a large bus is not impacted by the type of propulsion technology that is utilized by the vehicle.

Significant problems have been identified with the Checkel report. On the cost side, these concern "loading" of trolley costs by (1) underestimating the km of annual travel per vehicle, (2) using inflated infrastructure cost estimates and (3) including costs for a diesel back-up fleet. A consultant experienced in trolley operations would recognize that maintaining special back-up fleets is not industry standard practice. Checkel ignores factors like the effect of the regenerative features on new trolleys in lowering trolley energy usage/costs, and the effects of expanding the trolley system or increasing trolley service on per unit costs; these items belong in any proper trolley study. Costs involved in dismantling the trolley system are also ignored. The emissions analysis suffers from the same basic flaws as that of Booz Allen Hamilton (see below and subsequent comments).

Since there is much uncertainty about certain cost elements such as the life expectancy of hybrid batteries or fuel/power prices, a report like that of Dr. Checkel (and Booz Allen) ought to include a sensitivity analysis. Such an analysis would test results against a full range of possible future scenarios. At the April 23<sup>rd</sup> Vehicle Technology session, Dr. Checkel told the audience that he had tested some different scenarios, but there is no indication that the full range of possible scenarios was tested—Dr. Checkel's figures represent only a worst case scenario for trolley buses.

Booz Allen Hamilton's 2003-04 trolley study for Edmonton was found to contain major flaws, errors, and omissions. That study was criticized for erroneous or misleading statements as "petroleum prices are forecasted to remain stable", "electricity and petroleum pricing tend to track each other", as well as for its heavy focus on area-wide rather than local emissions. The study buried significant findings, such as the high maintenance cost of relatively new diesel buses, by hiding them in averages, and "loaded" trolley cost figures by distributing them over few service kms. Its comparison of trolley and diesel buses was flawed in that it did not account for the different service environments in which these vehicles operate: trolleys only on busy stop-and-go routes, but diesels often in express and suburban services with few stops and higher average speeds. The study recognized that Edmonton's trolley system is underutilized, but did not investigate this underutilization or propose how it could be rectified. An examination of the Terms of Reference for the 2003-04 study found them suggestive of a particular outcome.

(A two-part analysis of the 2003-04 Booz Allen report by Engineer Irvine Bell is available at <http://www.bettertransit.ab.ca/ib.htm> and <http://www.bettertransit.ab.ca/irvine.htm>)

By the narrowness of its focus – costs and emissions – the new Booz Allen study is even more open to criticism for 'tailoring'; the Terms of Reference beg review. The current study also suffers from similar flaws. For instance, it assumes electricity and diesel prices will increase with general inflation (p. 17). According to StatsCan, general inflation for the period 2003-2008 totals 9.21%. Oil prices have increased 394% over the same period, rack diesel prices have more than doubled, but Alberta Pool electricity costs have only risen by about two cents per kWh. [Sources: Statscan [www.statcan.ca](http://www.statcan.ca); Natural Resources Canada [http://fuelfocus.nrcan.gc.ca/prices\\_bycity\\_e.cfm](http://fuelfocus.nrcan.gc.ca/prices_bycity_e.cfm); Energy Information Administration <http://www.eia.doe.gov/>; Alberta Electric System Operator [www.aeso.ca](http://www.aeso.ca)] (See Attachment III) Booz Allen's costing assumptions are not supported by actual recent trends in Alberta.

After stating local emissions are of greatest relevance, the study goes into a detailed analysis of area-wide emissions, portraying power plants as high polluters and new diesel engines as low emitters. It ignores the fact that proximity to the emissions is the greatest determinant of their health impacts.

The public consultation was anything but comprehensive. 45 of the 46 communities served by trolley buses were not even consulted. (See comments on pages 8 and 9 of this report.)

However, with trolley buses eliminated, the use of hybrids or clean diesels will provide more opportunity to introduce service efficiencies through changes to route designs since the restriction of the overhead infrastructure will be gone.

As well hybrids would likely be assigned to those routes for which they are best suited (i.e. congested routes with a lot of stop and go traffic).

*Assessment Results - Operating Costs*

The assessment of the new hybrid buses indicated that their vehicle maintenance costs are similar to those of the clean diesels that Edmonton Transit is operating. The current vehicle maintenance costs of the trolley fleet are not useful for any comparison as these vehicles are almost 30 years old and at the end of their life cycle. Vehicle maintenance costs on the new trolley bus were marginally higher over the short period in service in Edmonton. It is assumed that maintenance costs are similar for all three types of buses.

Energy costs of the trolley bus are approximately 50% less than the diesel bus. The hybrid used 15% to 20% less fuel than the diesel bus.

Annual overhead system maintenance is \$2.2 million to provide for routine inspections and repairs.

While the energy costs for a trolley bus itself are substantially below those of either the clean diesel or the hybrid, when you add the costs of annually maintaining the overhead system and substations, the cost of running a trolley bus is approximately double those of the other two technologies.

While frequent route changes may be necessary to create 'service efficiencies' in suburban settings, this is not an issue with the main line routes in the city core served by trolleys. Similar to SLRT, trolleys operate on busy corridors with long established, stable travel demand.

Abandoning trolleys is not necessary to create efficiencies. More efficient trolley bus use could be attained on the trolley system with better application of 'interlines' (interconnecting of routes) than is presently the case; trolley expansion would also improve efficiencies.

The greatest reduction in energy use, local air pollution and noise is achieved on such routes with trolley buses, not with diesel buses or hybrids. Note that depending on the distribution of the 47 hybrids, some communities with trolley service may apparently end up with diesels.

New vehicles generally have low maintenance costs; problems are covered by manufacturers' warranties. Major issues with new technologies like hybrids are typically uncovered only after longer periods of service. Experience with hybrid buses in North America to date has been mixed. Issues could arise in the electronic components or with the batteries that would dramatically increase the maintenance costs of hybrids. In the Leger survey of MES employees, respondents (mostly diesel service personnel) found that hybrids were the most complicated vehicles to service. Typically, ease of maintenance is associated with lower costs; but complex maintenance procedures lead to higher costs.

Data in the 2008 Booz Allen report indicates that 14-15 year old low floor diesels are about as expensive to maintain as 30 year old trolleys. The 2004 Booz Allen report showed that ten year-old diesels cost twice as much to maintain as a 23 year-old trolleys. There is no basis to conclude that maintenance costs are *similar* between diesels and trolleys; the data suggest trolleys have been cheaper. While there may be uncertainties in predicting the maintenance costs of new trolleys over the life of the vehicle, just as there are with hybrids, the data shows that new low floor diesel buses are most certainly more expensive to maintain over their lifetimes than previous diesel fleets. One can deduce that as diesel technology becomes more complex to meet tighter emission standards, diesel maintenance costs will increase further. Recent news reports on the Toronto experience suggest the cost of replacing hybrid batteries is underestimated in both the Booz Allen and Checkel analyses.

Reports from Seattle, Victoria and Toronto over the past three years indicate the fuel economy claims made for hybrid buses have not been achieved in real service (Attachment II). Checkel reports that the New Flyer hybrids only achieved a ~10% fuel savings.

The cost of this service appears high. A comparison with practices and costs in other cities is needed, particularly where transit authorities maintain their own trolley and LRT electrical installations. It should be noted that these moneys are paid to Epcor, a City-owned utility that pays an annual dividend to the City in excess of \$100 million. Discontinuing trolleys may impact this dividend. While these 'system maintenance' expenditures are not necessary for diesel or hybrid operation, diesels or hybrids offer no such payback.

A key point is that the energy use of the trolley bus is far below that of the other two. Researchers are predicting an era of energy constraints lies ahead, and advise that we need not only choose products that use the least energy, but that are powered by sources other than petroleum fuels. If Edmonton wants to be seen as a leader, it will follow this advice. The most energy conscious products may not necessarily be the cheapest to purchase. [R.Gilbert/A. Perl: *Transport Revolutions*, Earthscan, Jan. 2008]

According to Checkel's analysis, 62% of the cost of maintaining trolley overhead consists of capital costs. Capital costs can be paid with infrastructure funds. Overall, 60% of the trolley's total lifetime cost is capital related and can be covered by infrastructure funds. Operating costs are typically covered by fare revenue and local tax dollars. Even if trolley buses remain more expensive overall due to their higher capital requirements, high diesel fuel prices could close the small operating cost gap to the extent that trolleys pose less of a local tax burden than diesels or hybrids. Increased use of trolleys would also make them more economical.

*Assessment Results - Capital Costs*

The estimated capital cost to purchase each vehicle type in 2010 is:

Clean Diesel	\$425,000
Hybrid	\$650,000
Trolley Bus	\$950,000

In purchasing 47 buses, hybrid bus purchases would be \$14.1 million less than trolley.

The estimated capital cost to upgrade the overhead system and substations for the life of an 18 year trolley bus is \$66.3 million.

Replacing trolley buses with hybrid buses would avoid costs of \$9.7 million.

(Attachments 1 and 2 Lifecycle Cost Comparison Details) .

*Assessment Results - Emissions*

The analysis of emissions was undertaken from two different perspectives:

- Micro -each of the three vehicles were tested locally. Estimates were added to those measurements to represent emissions generated by the extraction of the base fuel and the manufacture of the fuel.
- Macro -fleet wide estimates were generated through 2027 utilizing industry numbers for the different vehicles under consideration. Emission estimates for electric power generation were provided by EPCOR.
- Booz Allan Hamilton used the Greenhouse Gases Regulated Emissions and Energy use in Transportation (GREET) model to calculate well to wheel emissions.

The findings from the field testing done by Environment Canada and

Because Edmonton buys transit vehicles with provincial/federal infrastructure dollars, the actual purchase does not have a local tax impact regardless of the vehicle chosen. Given future energy uncertainties, it makes more sense to invest in technologies that maintain and increase fleet fuel diversity and rely on locally produced energy (i.e. electricity from a local utility), rather than world commodities like oil/diesel fuel. Hybrid buses do not increase fleet fuel diversity – they consume diesel fuel.

Vancouver quotes a 25-year life expectancy for new trolley buses (17-18 for diesels) despite the effects of corrosion caused by its damp climate. (Attachment IV) It is well known that the United States Federal Transportation Administration (FTA) uses a 1/3 longer life expectancy for trolleys as a basis for funding bus purchases.

The wide variation in figures quoted over the past four years for upgrading the trolley system ought to cast doubt on the reliability of the estimates being made in current reports, or at least require some justification of the figures. (Attachment Va) The estimates to upgrade the overhead system, as quoted on p. 14 of Booz Allen's 2008 report appear inflated. Spreadsheets appended to the Checkel report suggest the estimates are based on the replacement of practically every major component in the trolley system over the next 18-21 years, including all 8 substations, nearly every support pole as well as all the wire and feeder cable in the system. Given that the system has been proactively maintained, that at least 2 substations contain new equipment and numerous poles have been replaced in the last few years, this does not seem reasonable. Feeder cable replacement is costed at \$60.00 per metre. Recent Vancouver reports project the cost of feeder cable at only \$21 per metre (about 1/3 the cost). (See detailed comments, Attachment Vb) <http://vancouver.ca/ctyclerk/cclerk/20070724/documents/a19.pdf> p.10]. If the trolley system would truly be overhauled to this extent, then the investment *MUST* be written off over a longer life cycle than that of one generation of trolley buses given that many major components of the infrastructure have a 30-50 yr life cycle (i.e. the life of the infrastructure is much longer than the life of the vehicles).

One cannot *positively* conclude that elimination of trolley buses will avoid \$66.3 million in costs. If Epcor loses its contract to maintain the trolley system, it will incur a loss in income. It is unlikely that a well-managed, for-profit enterprise like Epcor would not take steps to recover this lost income. Since Epcor has many contracts with the City/ETS, this could potentially lead to higher charges for other services that Epcor provides to the City, resulting in little or no financial benefit to taxpayers. Many trolley costs can be covered by infrastructure funds, but not so if trolleys are abandoned and Epcor seeks to make up losses by increasing service fees. Rising diesel costs compound the problem. Trolley abandonment has the potential to create a greater local tax burden.

None of the reports considers the possibility of renewable or green energy seriously. This is a major shortcoming given the extent to which it is now available to both residential and commercial customers: <http://www.epcor.ca/Customers/Commercial+and+Industrial/EnVest/EnVestRE.htm>

Checkel's dismissive statements about the availability and practicality of green energy appear unfounded in light of Epcor's ENVEST program and other green energy initiatives locally available from private undertakings like Bullfrog Power ([www.bullfrogpower.com](http://www.bullfrogpower.com)).

Booz Allen is a U.S. firm; their statements about oil and electricity pricing tracking each other are based on U.S. national models and do not apply to the same degree in Alberta (see comments on page 4). Similarly, a U.S. based model of the emissions resulting from supplying coal to power plants may yield inaccuracies. The distances between coal mines and power plants in the U.S. are much greater, resulting in high transportation emissions. This is not the case in Alberta where mines and power plants are fairly close. The origins of the default values that GREET uses are unclear. Booz Allen does not provide its calculations using the GREET model in the report, so it is not known what values were used. This information is necessary in order to confirm that conclusions about feedstock emissions for power generation are based on the situation in Alberta.

used by Dr. Checkel are comparable to the results presented by Booz Allan Hamilton.

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Testing by Environment Canada should not be construed to imply that diesel exhaust at the levels found is safe. Health Canada, the Canadian Lung Association and other authorities state categorically that there is “no safe level” of exposure to certain components of diesel exhaust.  
<http://www.pyr.ec.gc.ca/airshed/documents/DOCFinalReport.pdf>[3]

The trolley bus itself does not have any emissions. From a route perspective these vehicles are emission free. However, from a regional perspective the fuel (coal burning) ultimately results in emission levels that, with the exception of PM10, are higher than hybrids or clean diesels. And if the emissions (well to wheel) associated with getting the feedstock out of the ground and to the refinery or generating plant are included, total emissions associated with use of trolley buses is higher in all categories.

According to the Booz Allen report, the route or local perspective is also the most relevant (p.22). That is, numerous studies show that health effects from emissions increase with proximity; ill health in people living or working along major transportation corridors has been attributed to diesel exhaust exposure. Hundreds of people are directly impacted by inhaling the emissions of hybrid or diesel buses operating in the streets; the health impact of the power emissions for that small portion of electricity generated for trolleys is negligible by comparison, as power emissions are released from high stacks and are well diluted by the time they reach populated areas. To compare emissions from power plants with those of diesel or hybrid buses operating in the streets of populated areas is not meaningful.

Given the claims made in these studies about power plant pollution, investments in electric Light Rail Transit—which uses the same coal fired generation—would have to be questioned.

The hybrid bus offers the best overall emission reduction opportunity (Attachment 3).

According to 2006 (most recent) data from Alberta Electric System Operator (AESO, [http://www.aeso.ca/downloads/Trans\(3\)FinalSingleLR\(1\).pdf](http://www.aeso.ca/downloads/Trans(3)FinalSingleLR(1).pdf)), trolley power accounts for 0.006% of electricity demand in Alberta. Growth in demand is occurring at twice the consumption of the City of Red Deer annually. Because of this strong growth, power plants in the Edmonton region would generate similar amounts of electricity with or without trolleys. Switching from trolleys to hybrids most likely results in a net increase in total emissions in the Edmonton region, as the emissions from the hybrid bus are added into the picture. Indisputably, the best opportunities to reduce total emissions are: (1) if green power is purchased for trolleys, with increasing benefits if trolley use is expanded, and (2) if hybrid buses and green trolley buses are used to replace diesel buses.

*Assessment Results - Noise*

All the buses tested fall within the safe limits for exposure. The 2006 diesel buses were at the highest levels. The trolley bus had the lowest noise levels although only marginally less than the hybrid bus.

The difference appears “marginal” because of the way Checkel presents his data, i.e. taking the loudest noise produced by each vehicle. The new trolley is, in fact, substantially quieter than hybrids or diesels at idle or when accelerating from a stop, i.e. in those situations where bus noise is most disruptive to residents and passengers. The instructions to transit operators (“running boards”) for many diesel routes instruct drivers not to layover at certain points because of diesel bus noise concerns.

Checkel’s diesel and hybrid noise tests were conducted in open areas to minimize noise reflection off nearby surfaces. (The only on-street test of diesels and hybrids did not allow the vehicles to accelerate fully.) On city streets, vehicle noise is reflected and magnified by buildings and other structures. What appears to be a small difference in noise in an open area can be much greater on a narrow street lined with tall buildings, as found in our downtown core.

Electric vehicles are intrinsically quieter than internal combustion engines; trolley buses are recognized the world over for their quiet operation. Their operation is also vibration-free. Although new diesel buses are certainly quieter than older vehicles, the replacement of trolleys with new diesel or hybrid buses would still negatively impact communities.

*Policy Environmental*

Edmonton Transit System is governed by the City's Environmental Policy (C512). Edmonton Transit is working towards being ENVISO ISO 14001 certified by year end. The aspect of these include prevention of pollution, continual improvement in emissions reductions, and meeting or exceeding regulatory and voluntary emissions regulations.

The greatest emissions reductions are attainable through the expansion of trolley service combined with the purchase of green electricity for the trolley (and LRT) system. Such a reduction would offset increasing greenhouse emissions due to the growth of the transit fleet between now and 2027 (p. 8 of the Booz Allen 2008 report – the fleet is projected to grow from 907 to 1527 vehicles by 2027). It is astounding that the analyses completely overlook this point, despite the claims of adherence to ENVISO ISO 14001 and awareness of the City’s aim of becoming greenhouse gas neutral by 2050.

The City is a member of the Federation of Canadian Municipalities

(FCM) Partners for Climate Protection (PCP) program. PCP methodology requires that greenhouse gases produced in the generation of electrical power for City use be included in the City's greenhouse gas emissions inventory.

### Focus Area

The report recommendations meet City Council 's 2007 Strategic Direction in the focus areas of:

- Healthy Ecosystem and,
- Balanced Infrastructure

### Public Consultation

A multi-faceted consultation program was developed to obtain input from the general public, transit riders, specific stakeholder groups, Edmonton Transit System Advisory Board, and transit operating staff. Input was obtained from :

- general public via City-wide telephone survey
- transit riders through surveys at transit centres
- internal survey of transit maintenance staff and operators
- one day stakeholder workshop

In addition, all technical reports were shared with stakeholder groups and the Edmonton Transit System Advisory Board. In addition, a workshop was scheduled with representatives of these groups and the consultants who prepared the reports to facilitate a discussion of assumptions, background information, methodologies and conclusions.

The results indicated 62% of the general public and users suggest purchasing hybrid buses. ETS operators (66%) prefer diesel buses

If this is the case, then purchasing green power for trolley operation would allow the City to remove all greenhouse gas emissions associated with trolley operation from its inventory, and thereby reduce greenhouse gases associated with its transit operations considerably (see Attachment VI). The trolley option CLEARLY offers the greatest emissions benefits to the City of Edmonton among the three vehicle choices. Hybrid or diesel buses cannot match this. It would require approx. 240 hybrid buses, at a total capital purchase cost of \$156 million, to achieve the same reduction in the City's emissions inventory as could be achieved with 47 trolleys using green energy. (Attachment VII)

ENVEST green power is available from Epcor for commercial customers like Edmonton Transit. Green power typically adds a nominal 0.02 per kWh to power costs ([www.bullfrogpower.com](http://www.bullfrogpower.com))

The trolley option, if green electricity is purchased, actually meets these Strategic Directions to a much greater degree. It also allows the city to continue to capitalize on recent infrastructure and technology investments. (In 2004, ETS reported that there had been over \$12 million in capital investments in the trolley system during the previous ten years, and further capital upgrades [pole replacement, hardware upgrades] have been made since that time.)

The public consultation process was poorly planned and poorly carried out. Hence, the findings, while interesting to comment on, are not useful for decision-making.

According to J. Bradford-Green, Director of the Office of Public Involvement, "the City is committed to involving people who are affected by a decision, in making that decision." (*City Link*, May 2008). There are 46 communities served by trolleybuses and 9 Business Associations/Revitalization Zones (BRZ) [See Attachment VIII]. Only one of these communities and two of the BRZ's were included in the consultation process.

There was no assessment of opinions of the new trolley; it is evident from responses that respondents were comparing 28-year-old trolley buses to brand new low floor diesels and hybrids. In the questionnaire, diesels were always referred to as "modern diesels", but the other vehicles were simply called trolleys or hybrids. While "hybrid" can only be associated with a new vehicle, a "trolley bus" in the minds of most Edmontonians is the 28 year-old high floor trolley vehicles that they are familiar with. At the April 23<sup>rd</sup> Vehicle Technology Forum, representatives of Leger Marketing indicated that they themselves did not know what a low floor trolley bus was.

Bias was also evident in the questions. Respondents were asked to rate the appearance of "modern diesel buses", "hybrid buses" and "trolley buses and overhead wires". At least two members of the general public who took part in the telephone survey and one individual surveyed aboard transit later contacted *Citizens for Better Transit* or the *Edmonton Trolley Coalition* to complain of bias in the questions.

Staff opinions can be very valuable, but staff surveys in most organizations are done for internal, not *public* information. Including operator and maintenance staff opinions as part of a "public consultation" appears unprecedented. To our knowledge, the City has not previously included operators or maintenance staff as an identifiable group in opinion polls on LRT expansion, nor has it polled them *publicly* on the purchase of LRT cars, or the expansion of the diesel fleet.

Some results of the staff surveys defy rational explanation. For instance, according to p. 4-5 of the Leger report, operators were over 50% more likely than the general public to express dissatisfaction with the emission levels of trolley buses, even though they are not exposed to any emissions when operating them. One wonders to what extent the opinions of staff have been influenced either by recent administrative proposals to abandon trolley operations, or by the fact that the current trolleys are among the oldest vehicles in the fleet and lack modern features as power steering.



with hybrid second at 28% and the trolley at 2%.

Key stakeholder groups were generally cautious about eliminating trolleys, but foresaw hybrids as an option for the future.

Members of CFBT and ETC were present at the stakeholder consultation. In fact, the discussion that took place at the end of the session indicated that stakeholders saw trolleys and hybrids as the vehicles of the future, and did not see a big future role for diesel buses. When questioned about the breakdown of numbers in their 'future' scenario at the April 23<sup>rd</sup> Information Sharing Session, the consultants from Leger Marketing refused to release the numerical results.

**Budget/Financial Implications**

*Capital*

*2010 and 2011 One Time*

*Requirements*

- \$30.6 million in 2010 to purchase 47 hybrid buses.
- \$11.0 million in 2010 -2011 to take down remaining trolley infrastructure.
- The funding source of the \$41.6 million will be identified in the 2009 -2011 Capital budgeting process.

The current public consultation stands in stark contrast to a public opinions survey conducted by Malatest on trolley bus routes a year ago, in April of 2007. That survey showed that 35% of respondents chose to ride a particular route because it was operated by trolley buses, and 16% would stop riding if trolley buses were (permanently) replaced with diesel buses. (See Attachment IX) While these numbers are higher than reported in other cities, it has been stated by other transit authorities that trolley buses attract more passengers than if the same routes were served by diesel buses. Booz Allen Hamilton makes this claim for Seattle and San Francisco in its 1993 report to Los Angeles. Salzburg Austria and Arnhem Netherlands have recent data that shows the same phenomenon. Professional Engineer and Transportation Consultant E. L. Tennyson attributes ridership losses to trolley abandonment in a 1998 paper for the U.S. Transportation Research Board (#1503, E.L. Tennyson, 1998)

*2012 and Beyond Savings Opportunity*

- Elimination of difference of \$44.5 million (unfunded) for trolley infrastructure rehabilitation.

If sources can be identified to fund hybrid bus purchases, one ought to be able to identify funds to purchase trolley buses at least equally well, especially since they can use renewable energy and would be much 'greener' than hybrid buses.

*Operating*

*2010*

- Savings of \$1.0 million in overhead maintenance.

*2011 and Beyond (annual)*

- Savings of \$2.2 million in overhead maintenance.
- Savings of \$0.4 million in vehicle maintenance.

Since this is considered unfunded, it cannot be claimed as a "savings opportunity". Money cannot be 'saved' that one does not have; the money also cannot be considered available for other projects. At best, this is a potentially avoided cost, provided that the figures are accurate in the first place (which appears doubtful, see p. 6 above), and provided Epcor does not seek to compensate for lost income by raising the rates on other services it provides to the City.

As it stands, the \$44.5 million quoted for infrastructure rehabilitation could be funded with provincial/federal infrastructure money and need not represent a local tax burden. However, if trolleys were removed, taxpayers could end up paying not only part or all of the \$44.5 million, but the claimed 'savings' on overhead maintenance for the first two items under "Operating" as well if Epcor raises other rates.

**Justification of Recommendation**

1. The current trolley system is outdated and expensive to maintain and operate.

Despite administration's and the consultants' claims that new vehicles all have similar vehicle maintenance costs, these figures seem to assume that new trolleys would cost the same to maintain as 28-year old vehicles. This 'error' loads trolley costs by \$7 million over 18 years compared to diesels and hybrids.

2. Hybrid buses best meet all of the City's criteria; functionally, operationally, financially and environmentally to replace the existing trolley system. Replacing trolley buses

On whose assessment is the trolley system outdated? The City's most current infrastructure inventory (2006) lists 70% of the trolley system to be in good or very good condition, with an expected asset life of 36 years. (Attachment X)

with hybrid buses avoids costs of \$99.7 million.

3. The trolley infrastructure must be removed in order to realize identified savings and maintain safety.

Unused trolley overhead has remained in Highlands for 11 years after trolley service was discontinued without any apparent safety issues or significant financial liability to the city.

### Attachments

1. Lifecycle Cost Comparison Details (chart).
2. Lifecycle Cost Comparison Details (graph).
3. GHG Emissions (graph).

Reviewed by:

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Planning

K. Brown, BA, MA, Acting Chair, Citizens for Better  
Transit Edmonton

P. Marriott, Vice Chair, Edmonton Trolley Coalition

Route kms Operated by Trolleys per ETS Schedules, effective Sept. 2007

Attachment I

<b>SEPT 2007 - SCHEDULED TROLLEY TRIPS</b>			
	<b>Weekday km</b>	<b>Saturday km</b>	<b>Sunday km</b>
Route 3	2120	1198	1070
Route 5	2028	1834	1450
Route 7	1116	938	820
Route 9	51		
Route 120	870	260	
Route 133	441		
Route 135	712		
<b>TOTAL</b>	<b>7337.9</b>	<b>4230.4</b>	<b>3340.7</b>

<b>ANNUAL KM</b>		
	<b>sched km</b>	<b>days/year</b>
<b>Weekdays</b>	7337.9	252
<b>Saturdays</b>	4230.4	52
<b>Sundays/Holidays</b>	3340.7	61
<b>Annual KM</b>	<b>2.3 Million</b>	

## TTC hybrid bus batteries losing their power - Cells only lasting half of time promised

JEFF GRAY – The Globe and Mail

May 16, 2008

The box-like batteries on top of the Toronto Transit Commission's brand new and premium-priced hybrid electric-diesel buses are lasting only half as long as their manufacturer promised.

They were supposed to last five years, but about a third of the lead-acid battery cells in use in the current fleet of 275 hybrids - which started arriving in 2006 - have already worn out, Gary Webster, the TTC's chief general manager, said in an interview.

The battery failures come on top of TTC testing that has shown the buses are producing just half the expected fuel savings, using just 10 per cent instead of 20 to 30 per cent less diesel than a conventional bus, although TTC officials expect this number to improve.

Still, Mr. Webster defends the decision to buy the Orion VII hybrids - which cost \$734,000, compared with \$500,000 for a conventional bus. He says the TTC and the manufacturer, Daimler Buses North America, are trying to sort out the battery problem, which is covered by the warranty and not costing the TTC money.

"We think the hybrid bus is a good bus. That's the bottom line for us. It's got some issues, absolutely," Mr. Webster said. "... We think we're going to address these issues."

By year's end, the TTC will have 564 hybrid buses - making up about a third of its bus fleet - with much of the cost of buying them covered by the federal and provincial governments in funding that mandated buses using alternative fuels. Within five years, close to half of the TTC's fleet is scheduled to have hybrid engines.

But Adam Giambone, the city councillor who chairs the TTC, said the battery problems mean the jury is still out on whether the buses were a good investment: "We're still formulating our opinion on the hybrids."

He said the hybrid engine could be a "transitional technology" and that down the road, electric buses could come onto the market, or **the TTC could, on busier routes, even return to using trolley buses - powered by overhead wires like streetcars** - which it abandoned in the 1990s.

Mr. Webster said yesterday that New York has had some similar problems with its fleet of Orion VII hybrids.

But Jake Keyes, a spokesman for Daimler, which runs the former Orion Bus Industries plant in Mississauga where the buses are partly manufactured, said the battery problem was specific to Toronto's buses and has not occurred with its other hybrid buses running in New York and San Francisco.

The company's newer models include a different, lithium-ion battery that Mr. Keyes said lasts longer, but Mr. Webster said the TTC is not convinced the new battery will fix its problem.

"... We've said to them, 'Happy to consider it, but you've got to prove to us these things actually function,' " he said.

It is common for transit agencies to run into kinks with new vehicles, and the TTC has had problems before, including with vehicles running on compressed natural gas that it bought from Orion Bus Industries in the 1990s.

It has had to scrap 50 of those buses and convert another 50 to diesel, after engine problems, potentially leaky gas tanks and other complaints.

The TTC blames its hybrid buses' fuel-economy problems on the fact that they are being used more on suburban high-speed routes, where hybrid engines are less efficient.

Once more of the buses are running on stop-and-go congested routes downtown, Mr. Webster says, their fuel economy numbers should go up as the bus can rely more on the electric power it creates with its regenerative braking system.

The fuel-economy problems, which likely cost the TTC \$1.3-million this year, are a small part of what is expected to be a massive rise in diesel costs as a fixed-price contract for fuel runs out at the end of this year.

The TTC estimates that its fuel bill could go to \$97-million next year from \$65-million this year, and Mr. Webster has said the transit agency may even consider a "fuel surcharge" for riders.

## ANOTHER MAJOR CITY SOURS ON CNG

Excerpted from *Diesel Fuel News*, August 14, 2000, page 6

Joining a growing list of cities souring on high-cost compressed natural gas (CNG) buses, Toronto Transit Commission last month decided to explore alternatives to CNG including hybrid diesel-electrics and diesel particulate matter exhaust traps with ultra-low sulphur diesel fuel.

At the same time, Boston's MBTA transit agency last week announced plans to buy up to 24 diesel-electric hybrid buses, 28 electric trolley buses and up to 44 CNG buses for inner-city areas where neighbors complain about MBTA's diesel buses.

However, MBTA lacks the experience with CNG that has led Toronto, Los Angeles and other transit bus users to find major and costly reliability problems with CNG.

In Toronto, TTC owns 125 CNG buses with 16 million kilometers and 10 years of CNG operating experience that were aided by big provincial government subsidies. Now TTC faces unacceptably high CNG infrastructure costs and major CNG bus maintenance problems, according to a new TTC report. So TTC won't be buying any more CNG buses when its next big round of purchases comes up in a few years.

... "We were conned into natural gas by the provincial government in the 1980's," TTC Chairman Howard Moscoe announced at TTC's board meeting last month.

... CNG also "left a bitter taste in our mouths because it was claimed as a 'clean' substitute that supposedly justified banishing electric trolley buses from Toronto streets, a move that TTC now regrets." ...

## Victoria Dumps Hybrids

"No business case" – Ron Drolet, BC Transit

Summarized from *Victoria News*, July 11, 2007

BC Transit plans to upgrade its fleet in 2008-09 and may be purchasing between 85 and 90 new buses. But there won't likely be any hybrids in the fleet.

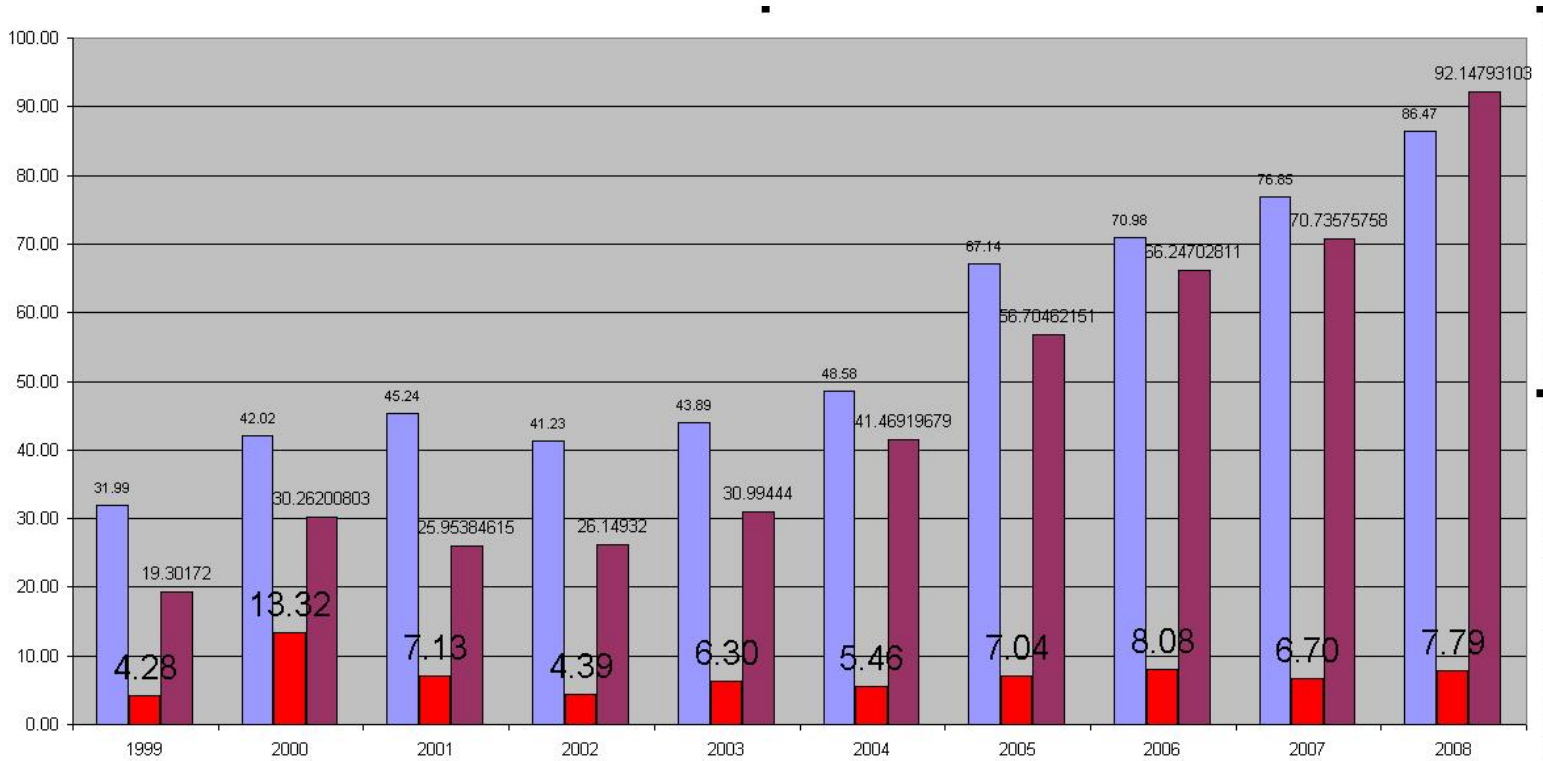
Over a year ago, BC Transit unveiled three hybrid diesel buses for Victoria as part of a trial to gauge their reliability and measure their fuel efficiency. The buses utilize an electric battery power source for acceleration and low speeds and switch to a diesel engine for higher speeds. Officials thought the technology would set the standard for fuel efficient, environmentally friendly bus fleets in Canada.

The buses were initially found well suited to Victoria's busy stop and go urban environment. In fact, fuel savings targets that were set at 20% over the fleet's 1992-2003 generation of buses, were exceeded by the new buses. In some cases, the savings ran as high as 28%. However, compared to the newest Cummins equipped Nova buses, the hybrids achieved only 8% better fuel efficiency.

Officials determined that the fuel savings realized by the hybrids, calculated over the 18-20 year expected life of the vehicle, did not offset the more expensive purchase price. Hybrids cost about \$800,000, whereas a new Nova diesel bus costs \$500,000. "There is no business case for buying hybrids," summarized Ron Drolet, Vice-President of Customer Service for BC Transit.

## Diesel, Oil and Electricity Prices 1999 to February 2008

- Rack Diesel Price in Canadian cents per litre (Edmonton area)
- Oil Price (NYMEX) in U.S. dollars per barrel
- Electricity price in Canadian cents per kWh (Alberta Power Pool)



Sources: Natural Resources Canada [http://fuelfocus.nrcan.gc.ca/prices\\_bycity\\_e.cfm](http://fuelfocus.nrcan.gc.ca/prices_bycity_e.cfm);  
 Energy Information Administration <http://www.eia.doe.gov/>; Alberta Electric System Operator <http://www.aeso.ca>

## Contest corner: win a FareCard!

**METROTOWN GIFT CARD WINNER** We had 163 correct entries in our last contest, and **Teresa Y.** won a \$50 gift card to Metropolis at Metrotown. The contest answer? The Major Road Network stretches over 2,310 lane kilometres of road.

**WIN A FREE FARECARD!** Enough with gift cards—let's give away a FareCard! It will be a 1, 2, or 3 zone card, based on where the winner travels. Just e-mail [thebuzz@translink.bc.ca](mailto:thebuzz@translink.bc.ca) with your full name, daytime phone number, and the answer to this question:



**How many bikes can a TransLink bus carry on its bike rack?**  
(Hint: the answer is on our website!)

Enter by **Mon May 19 at 12 noon**; we'll draw a name from all correct entries if more than one is right. See who won in the **May 23** issue!

## UniverCity at SFU wins award

Congratulations to the UniverCity community at SFU, which won an excellence award for Innovation in Green Community Planning from the American Planning Association in April!

We're especially proud since TransLink worked with the SFU Community Trust—the developers behind UniverCity—to offer Canada's first ever Community Transit Pass. UniverCity residents can buy an annual pass at a substantially discounted rate for unlimited three-zone transit travel. It's possible because the Trust guarantees an annual payment to TransLink equal to the estimated revenue which would have been received through TransLink's fare boxes and monthly passes.

Congratulations again, UniverCity!

## B-Line passengers: don't stick your arm in the back doors!

As the B-Line buses pull away from the curb, some transit operators have noticed that customers still trying to catch the bus have started putting their hand between the back doors, aiming to open the doors up so they can jump on. Please don't do this—you could get seriously hurt in many different ways trying to board the bus in this manner. Plus, if you wait a few minutes, another B-Line will be there shortly.



The 99 B-Line on the move.

## Victoria Day holiday service

For the **Victoria Day** holiday on **Monday, May 19**, bus and SkyTrain service will run on a Sunday schedule. Riders, this means you'll only need to pay the single-zone fare to travel in all zones all day.



Also, if you're looking to get your car looked at in the Lower Mainland, **AirCare Inspection Centres will be closed on Monday, May 19** for the holiday. The stations will resume normal business hours (8:30 a.m. to 5 p.m.) on Tuesday, May 20. (Yes, TransLink administers the AirCare program in Metro Vancouver. We also administer AirCare in Chilliwack and Abbotsford on behalf of ICBC.)

## Surrey timetable booklet correction

For those who picked up the latest Surrey timetable booklet, there is a correction to the #341 schedule. The #341 will leave Guildford Exchange on Saturday, Sunday & Holidays at **8:54 p.m.**, not **9:54 p.m.** The rest of the times are correct. The TransLink website has also been updated to reflect this change.

## BACK ISSUES

*Back Issues* is a new section that mines past issues of *The Buzzer* for nuggets of transit history. Huzzah!

**1955** For transit help in 1955, you could head to one of three brand new transit information booths set up in downtown Vancouver.

B.C. Electric, who ran Lower Mainland public transit from 1897 to 1962, launched the brightly-painted booths with the help of the Downtown Business Association. Four veteran operators were trained to help with routes, times, and schedules: Russ McKay, J.E. Browne, Dunc Macdonald, and Lloyd McLaren (pictured at right).

The booths were conveniently located at Georgia and Granville, Hastings and Richards, and Hastings and Abbott, near the Woodward's, Eaton's, and Hudson's Bay department stores. You really might have needed their help, too—back then, the streetcars were being converted to trolley buses, so the downtown streets were being repaved and consequently disrupting traffic. (And *The Buzzer* added that you could always call Kerrisdale 7500, the local transit information number, for help day or night.)



A BCE transit information booth from 1955. The customer is "pretty Marcia Young" of 3780 Cambie, who is being helped by operator Lloyd McLaren.

## COMING EVENTS

- ✓ The **Beaty Biodiversity Museum** at UBC presents "Effects of Climate Warming on Polar Bears and Seals in Canada's Arctic," a public lecture from Ian Stirling, a polar bear expert. Sun May 11, 6pm, UBC Woodward Building - Room 2 (2198 Health Sciences Mall). Free admission. Info: [biodiversity.ubc.ca/museum/proglect7.html](http://biodiversity.ubc.ca/museum/proglect7.html)
- ✓ The **2008 Vancouver International Children's Festival** runs May 12-19 at Vanier Park, with music, theatre, dance, storytelling, and more. Take transit - from Burrard St Skytrain, transfer to #2 or #22 southbound to Cornwall and Cypress. Tickets on sale at Ticketmaster. Visit [www.childrensfestival.ca](http://www.childrensfestival.ca) for details.
- ✓ **Prince of Wales Secondary School** presents *Thoroughly Modern Millie*, a madcap Roaring Twenties comedy directed by Fred Galloway, on May 12, 13, 14, and 16 from 7:30-10pm, 2250 Eddington Drive, Vancouver. \$10 adults, \$7 students/seniors. Info: Fred Galloway, 604-713-8974.
- ✓ **SFU's City Program** presents "Cycling for Everyone: Lessons for Vancouver from the Netherlands, Denmark, and Germany," a lecture from John Pucher, professor of planning from Rutgers University. Thu May 15 at 7pm, Segal Graduate School of Business Building, 500 Granville Street, Vancouver. Free admission but reservations required. Email [cstudies@sfu.ca](mailto:cstudies@sfu.ca) or call 778-782-5100.
- ✓ The **YWCA** hosts a **Career Zone Summer Hiring Fair** on Wed, May 21, 1260 Granville St, 2-5pm. Meet BC's top employers and apply for jobs. Bring your resumé. Info: 604-605-4666 or [ywcavan.org](http://ywcavan.org).
- ✓ The **Vagabond Players** present *Here on the Flight Path* by Norm Foster, at the Bernie Legge Theatre, Queens Park, New Westminster. Shows Thu May 22 to Sat June 14 at 8pm, matinees on Sundays at 2pm. Info: 604-521-0412.
- ✓ **Retro Design & Antiques Fair** on Sun May 25, 10am-3pm, Croatian Cultural Center, 3250 Commercial Drive, Vancouver. 175 tables of fabulous finds for you and your home. \$4 at door, kids under 13 free with adult. Info: 604-980-3159, [21cpromotions.com](http://21cpromotions.com).
- ✓ Directors of **Good Noise Vancouver Gospel Choir** will hold a **gospel choir workshop**, Fri May 30 & Sat June 1 at Northwood United Church, 8855 156th Street, Surrey. \$115; includes vocal technique and buffet lunch. Ability to read music not required. Concert at 7pm, Sat June 1 at Northwood, \$10; kids under 12 free. Info: 604 876-6624 or [gospelmusicproductions@hotmail.com](mailto:gospelmusicproductions@hotmail.com).
- ✓ **Mature Women's Network** (women 40+) presents **Creative Gift Packaging & Annual Bake Sale**, with talk and wrapping demos by Julie Lind, Manager of Creative Packaging. Sat May 31; registration at 12:30pm; program and social 1-3 pm. \$4; includes refreshments. 411 Dunsmuir, Vancouver. Guests welcome. Info 604-681-3986.

Send your community events to [thebuzz@translink.bc.ca](mailto:thebuzz@translink.bc.ca)

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## WIN A FREE FARECARD! Attachment IV

# BUZZER

THE

PUBLISHED BY TRANSLINK • FRIDAY, MAY 9, 2008



## Get ready to roll with Bike to Work Week!

### In this issue...

- » All about Bike to Work Week
- » Trolley fleet converts to low-floor buses
- » Grade 12 GradPasses are here
- » Happy trails to a longtime commuter
- » Victoria Day holiday service

## WIN A FREE FARECARD!



# Get ready to roll with Bike to Work Week

Get on your bike and join thousands of cyclists on the Metro Vancouver streets during Bike To Work Week, running from May 26 to June 1.

Now in its second year, Bike to Work Week asks commuters to try cycling to work for one week.

Participating workplaces win prizes based on staff participation and kilometres travelled—register your workplace at [vacc.bc.ca/biketowork](http://vacc.bc.ca/biketowork), which will keep track of your stats (and your competitors' stats) throughout the week.

A free bike will be given away every day to seven lucky commuters registered with the site. As well, Bike to Work Week will also provide 22 commuter stations along major bike paths and routes in the Lower Mainland, with drinks, food, and even more prizes.

If you've never biked to work before, don't panic. The Vancouver Area Cycling Coalition—the group behind Bike to Work Week—offers one or two-hour workplace workshops to teach safety skills and address other bike-related concerns.



Try cycling to work during Bike to Work Week, May 26 to June 1.

The workshops cost a small fee, which your company could purchase for your staff. Bike skills courses are also offered throughout the year at various locations in Metro Vancouver. For more info, check out [vacc.bc.ca/biketowork](http://vacc.bc.ca/biketowork).

So give it a try: you'll rediscover your commute, meet other cyclists, and reduce your impact on the environment and your waistline. What are you waiting for?

## Biking by the numbers...

**3,500**  
Number of cyclists who rode in last year's Bike to Work Week

**900**  
Number of cyclists in last year's Bike to Work Week who were car commuters and almost never rode a bike

**33**  
Tonnes of CO<sub>2</sub> emissions emitted, if everyone in last year's Bike to Work Week had driven a car instead

**7,000**  
Number of cyclists expected in this year's Bike to Work Week



Goodbye, Flyer trolleys! The last one made its final run on April 20 on the #3 Main route—the trolley fleet is now converted to New Flyer low-floor buses.

## Entire trolley fleet shifts over to low-floor buses

Say goodbye to the old red and white Flyer trolley buses—TransLink's entire trolley fleet has now been converted to the next generation of New Flyer low-floor trolleys.

The last red and white Flyer E902 trolley bus made its final run on April 20, carrying members of the media and transit enthusiasts along the #3 Main route. The Flyer trolleys served Vancouver residents for 26 years, arriving between 1982 and 1984 as replacements for the Brill trolleys from the mid-1950s.

But now, the New Flyer trolleys will take over, producing zero emissions just like the Flyers, but providing better access for those with mobility issues and using one-third less electricity. Unlike the old trolleys with their stairs and high floors, our new trolleys have low floors to make it easier for all customers to board.

The new trolleys also sport the blue TransLink livery—the red and white of the old trolleys are the colours of BC Transit, who previously ran public transport in the Lower Mainland.

And trolley fans, take heart: **the anticipated service life of the new trolleys is 25 years, so you can count on the trolley network for another quarter century!**



The new low-floor New Flyer trolleys can easily carry those in wheelchairs or scooters.

## Happy trails to a retiring transit commuter!

We're sending our best wishes out to retiring transit commuter **Mike Mezzabarba**, who has been a regular on the #701 Coquitlam Centre for six years.

Transit operator **Sandra Weatherbie**, who drives the #701 and picks up Mike every weekday at 5:40 a.m., asked *The Buzzer* to spotlight him in this issue.

"It's a real commuter bus and everyone knows everyone's name," said Sandra. "We're really losing a member of our community. I'll miss him a lot: he makes me laugh!"

Mike lives in Maple Ridge and commutes to his job at the Coquitlam School Board every day. He says he's been riding transit to get to work since he was 15—a total of 45 years.

He retires on May 14, and even though he plans to travel to England and sail the Gulf Islands with his wife, he says he'll miss the #701 group he commutes with every morning too.

"We joke around and have great conversation on the way to work," he said. "We have a lot of fun."

The group also looks after each other—for instance, when one #701 commuter fell and smacked her head on the sidewalk over Christmas last year, Mike said everyone pulled together to help get her to the hospital.

The #701 crew is already helping Mike celebrate his upcoming retirement: "Laura [another #701 commuter] made me a big batch of cookies," Mike said.

And Mike can't say enough about what Sandra brings to the commute. "She could teach a lot of the bus drivers how to react to the people getting on the bus," he said. "Even if someone gets on with a rough demeanor, she knows how to respond. She should be commended in my books."

Enjoy your retirement, Mike!

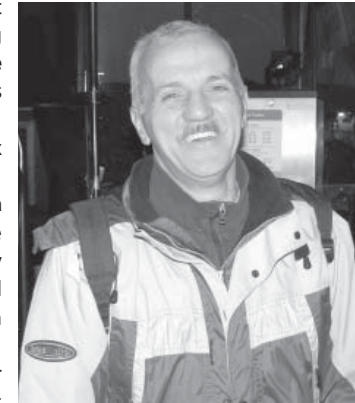


Photo by Sandra Weatherbie  
Mike Mezzabarba, a regular commuter on the #701 Coquitlam Centre, will be retiring on May 14.

## Graduating high school? Get yourself a GradPass!

If you're finishing grade 12 this year, pick up a GradPass and let transit take you home from your high school graduation celebration.

All graduating grade 12 students residing in the TransLink transportation service area are entitled to a free GradPass, which can be picked up at your high school, either through homeroom or the main office.



The pass is good for two days of unlimited travel on bus, SeaBus and SkyTrain. It's valid for any two days you choose between May 15 and June 30, and the days don't have to be consecutive.

You must sign the back of your GradPass right away, as the pass isn't transferable—it's only valid for the student to whom the pass is issued. Validate the pass by scratching off the month and day (grey panels) before you board. You must also carry your GoCard and present it along with the GradPass.

## Hurrah for articulated trolleys!

Rider **Carole Karkhairan** sent TransLink this note of thanks:

*I just wanted to celebrate the appearance of articulated buses on the No. 20 bus route this morning! This will make such an enormous difference to a route that had become increasingly 'Third World like', with people squashed in like sardines, and having to start negotiating their exit two stops prior to disembarking. There are a lot of commuters on this route who need to bring baby buggies, shopping bags, boxes, and often suitcases, onto the bus, as well as students with backpacks. As you know, it is an extremely busy and well-used route, being one of the major eastside arteries, linking up to SkyTrain and the Broadway corridor, among others.*



*As a regular commuter on this route for the past 6 years, I would like to congratulate the visionary who decided to assign articulated buses - and to express my hope that this will be a permanent arrangement.*

*Thank you again.*



Comparison of Administration's Previous and Current Capital Cost Projections relating to the Trolley System (not adjusted for inflation)

Attachment V(a)

Year	Report	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019-2024	2025-2029
2004	Booz Allen Hamilton	"On-going capital improvements to the trolley overhead system (including substation related costs) will average \$350,000 per year in the long term." (p. 49)											
2004	Administration Report	"\$2.4 million is projected from 2009 to 2013" (p. 3)					"Beyond 2010, major overhead infrastructure upgrades valued at \$14 million" (p. 3)						
2005	Admin. Letter to ETC (\$million)	\$ 1.13	\$ 10.40										
2006	Administration Report (\$million)	\$ 1.10	\$ 9.16	\$ 7.97	\$ 0.60	\$ 0.50	\$ 0.50	\$ 0.50					
2008	Checkel (per ETS/MES) (\$million)	\$ 8.74	\$ 5.90	\$ 4.00	\$ 3.43	\$ 3.67	\$ 3.77	\$ 8.29	\$ 3.18	\$ 3.18	\$ 2.28	\$ 14.74	\$ 16.13

**Analysis and Comments relating to Administration's Estimated Trolley Capital Budget of \$66.3 million**  
**For Upgrades to the Trolley System Infrastructure over next 21 years**

as broken down in Appended Spreadsheet to  
Checkel, *Hybrid Diesel-Electric Bus/Trolley Bus Demonstration Project: Technical Comparison of In Use Performance*

The following is a commentary and analysis of the *Estimated Trolley Capital Budget of \$66.3 million* for upgrades to the Trolley System Infrastructure. The breakdown of the \$66.3 million was taken from the calculation spreadsheet appended to the Checkel report. The base data was apparently supplied to Checkel by administration.

\$8.17 Million for substations. According to the spreadsheet, all eight substations are scheduled to get new transformers, rectifiers and switchgear over the next 21 years, but it must be questioned as to why all eight substations require this upgrading within the specified time frame. One substation, No. 060, was new in 2000, and new equipment was installed in substation 160 in the summer of 2007. Trolley substations typically have longer life cycles than this. Vancouver projected a 35-40 year life for new technology substation equipment; there is no reason to expect this would be different in Edmonton. [[http://www.vcn.bc.ca/t2000bc/learning/etb/trolleybus\\_essay.html](http://www.vcn.bc.ca/t2000bc/learning/etb/trolleybus_essay.html)]

\$10 Million for replacing feeder cable. The spreadsheet data suggests all the feeder cable in the system will be replaced (139 km) at a cost of \$60/m. At \$60/m, this is *THREE TIMES* the \$21/m that Vancouver is paying for feeder replacement. [<http://vancouver.ca/ctyclerk/cclerk/20070724/documents/a19.pdf> p. 10] Arithmetic errors were also found in the spreadsheet relating to this item. Even after adjustments were made to correct these arithmetic errors, \$2.14 million of the \$10 million figure remained unaccounted for.

\$5.45 Million for SCADA (System Control and Data Acquisition) upgrading. SCADA refers to the system that allows remote monitoring and control of the trolley system (to pinpoint issues with power supply, for instance). One wonders what is wrong with the existing SCADA system, why it needs to be replaced, and why the cost is coming out of transit's capital budget.

\$38.714 Million to replace poles. Based on Booz Allen's approximation of 4,600 poles in the trolley system, the \$38.714 million appears to assume that *almost every pole* in the entire trolley system would be need to be replaced over the next 21 years. This is difficult to believe, since Epcor has been replacing poles on the system every year for the past 11 years now with brand new, galvanized poles that ought to outlast a new generation of trolley buses.

Transit projects that \$10.8M of the \$38.714 million would still be spent if we abandoned trolleys. However, at the Vehicle Technologies Information Sharing Session on April 23<sup>rd</sup>, 2008 attendees were told that half the poles, at 60% of the cost of trolley poles, would still require replacement. If this information is correct, then the required expenditure would actually be \$11.6 million. On the other hand, if Booz Allen (2004) is correct, and 80% of the poles support streetlights and traffic signals, then we would be spending close to \$19 M without trolleys. The latter may well be the more likely scenario, as we observed in a number of trolley corridors that *every pole* houses a streetlight. If trolleys were abandoned and only half the poles were replaced with regular streetlight poles throughout the system, then a number of main streets in the city would be more dimly lit.

\$6.112 Million to replace contact wire. Attempts were made to find cost figures for contact wire replacement in other cities for comparative purposes. A 2005 contract for the Southeastern Pennsylvania Transportation Authority (SEPTA) for replacement of overhead wire on three North Philadelphia trolley bus routes totalled \$466,000.00. There is around 62 km of one-way twin wire on these routes, according to maps on the internet. This appears considerably cheaper than the cost quoted for Edmonton, but further investigation is necessary.

\$450,000 to replace the 156 St/107 Ave intersection. K&M style intersections in Edmonton have been replaced in recent years with Ohio Brass designs because the Ohio Brass designs are less maintenance intensive in our climate. There ought to be a maintenance savings, or at least an increase in reliability associated with this improvement. This type of information may demonstrate the value of this particular investment.

\$5.5 Million to replace special work. This appears to be based on spending \$50,000 a year, according to the spreadsheet. But the total seems to be inflated by an arithmetic error. The last two columns on Dr. Checkel's spreadsheet consolidate five years' worth of capital into one column. Five years x \$50,000 is \$250,000--but Checkel puts \$2.5 Million in each column (ten times too big). If the figure of \$50,000 per year is the correct one, then the total is only \$1.05 million.

\$2.1 Million to replace "powered switch control - 84 total". This seems to indicate every switch on the system would need to be replaced. Some switches may suffer from lack of use or require parts/maintenance, and some may indeed need to be replaced, but it seems unlikely that *every* switch requires replacement.

Finally, \$640,000 for lightning arresters. What is the life span of lightning arrestors if they are not struck by lightning?

**Concluding comments:** The \$66.3 million estimate seems well beyond what would actually be needed to keep the trolley system safe and functioning reliably for another generation of trolley buses. The projected expenditures are of the magnitude that they would essentially provide Edmonton with a new trolley bus system, with all new poles, wire, new substation equipment, new switches and a new feeder system. Given that in past infrastructure inventories, most of the system has been listed in "good" to "very good" condition with an average asset life of 28-36 years, it seems unlikely that the entire system should need to be renewed to this extent in the next 21 years.

However, if renewal were actually undertaken according to this schedule, then Edmonton ought to have a trolley system that would last for another 18-21 years beyond the life of a new generation of trolleys. In order to represent fairly the costs associated with the life of new trolleys might buy today, portions of these infrastructure investments would need to be amortized over the life of two generations of trolley buses (i.e. 30-50 years). This was not done in either the Checkel or Booz Allen analyses.

## Greenhouse Gas Reduction Potential of Trolley Buses

1990 Transit Greenhouse Gas Emissions - 62,297 tonnes\*  
 2005 Transit Greenhouse Gas Emissions - 64,623 tonnes\*

**Increase in Greenhouse Gas Emissions = 2,325 tonnes**  
 (reduction required to match 1990 levels per Kyoto Accord)

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Greenhouse Gas Emissions for 2,300,000 km (per trolley  
 Route schedules, rounded) of transit service on trolley routes  
 using either diesels or trolleys w. Alberta grid power - **4,600 tonnes**  
 (assuming 2000 g of CO<sub>2</sub> per km based on Checkel report, rounded)

**Greenhouse Gas Reduction with 2,300,000 km  
 of transit service on trolley routes using zero  
 emission green power - 4,600 tonnes**  
 (= maximum GHG reduction potential with existing levels of trolley  
 service and new trolley vehicles using green power)

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Minimum number of annual trolley service kms required  
 With green energy to reduce Transit Greenhouse  
 Gas Emissions from 2005 to 1990 levels - 1,162,500 km

NOTE that this figure  
 is similar to current  
 'actual' kms operated  
 by trolleys.

\*Source CO<sub>2</sub>RE Carbon Dioxide Reduction Edmonton Workshop, May 10, 2007  
 (latest data available at time of writing)

Greenhouse Gas Reduction Potential - Hybrid vs. Trolley Attachment VII

	Annual km (millions)	Vehicles	CO2 (kg/km)	Annual Total Emissions (t)	Reduction vs diesel (t)
<b>New Diesel</b>	2.38	47	1.97	4672	
<b>Hybrid (assume cleanest tested)</b>	2.38	47	1.58	3756	917
<b>Trolley (coal power plants)</b>	2.38	47	1.93	4579	93
<b>Trolley (renewable)</b>	2.38	47	0.00	0	4,672

A trolley bus powered by renewable energy eliminates more than five times as much CO2 as the cleanest hybrid bus tested.

**240 hybrids would be needed to equal the emission reduction of 47 trolleys powered by renewable energy.**  
**Capital purchase cost for 240 hybrids = \$156 million**

[Note that \$156 M is only the capital cost for buying the hybrid buses and does not include fuel, maintenance, etc. over the life of the vehicles.]

## Communities Served by Trolley Buses in Edmonton, by Name

Alberta Avenue	Norwood
Allendale	Oliver
Belgravia*	Parkallen/Beau Park
Boyle Street [95-97 St.]	Parkdale
Britannia/Youngstown	Pleasantview
Canora	Prince Charles
Central McDougall	Prince Rupert
Crestwood	Queen Alexandra
Cromdale/Stadium	Queen Mary Park
Dovercourt	Rossdale
Downtown/Jasper Avenue	Sherbrooke
Eastwood	Southgate/Empire Park
Edmonton Northlands	Spruce Avenue
Garneau/Strathcona	Walterdale
Glenora	West Jasper Place
Glenwood	Westmount
Groat Estates	Westwood
Grovenor	Woodcroft
High Park	
Inglewood	
Kingsway/Royal Alexandra	
Lendrum	
Mayfield	
McCauley [95-97 St]	
McKernan	
McQueen	
North Glenora	
Northwest Industrial [includes smaller divisions of High Park Industrial, Sheffield Industrial, Garside Industrial, Alberta Park Industrial, Hawin Park Estate Industrial, Mitchell Industrial, Dominion Industrial, Huff Bremner Estate Industrial]	

## BRZ's/Business Associations Served by Trolley Buses in Edmonton

124 Street & Area Business Association  
 Alberta Avenue Business Association  
 Chinatown & Little Italy BRZ  
 Downtown Business Association  
 Inglewood Business Association  
 Kingsway Business Association  
 Northwest Industrial Business Association\*  
 Old Strathcona Business Association\*  
 Stony Plain Road and Area Business Association

\* denotes that this community was consulted by Leger Marketing at the Stakeholder Workshop, April 16, 2008.

The current project involves gathering survey data to understand how important trolleys are in customers’ decisions to use ETS. Interviewers distributed and collected surveys on the routes where trolley buses were used. Three routes were involved in data collection (Routes 3, 5, and 9). Respondents were those individuals who rode the trolley buses during survey administration times between April 10, 2007 and April 19, 2007.

Results from the survey are as follows:

- 1 - 35% of respondents agreed that they ride a particular route because it is a trolley bus, 65% neither disagreed nor agreed.
- 2 - 16% would not ride Routes 3, 5, and 9 if a regular bus was substituted for a trolley bus 84% neither disagreed nor agreed.
- 3 - 49% of respondent’s agreed that they preferred Trolley buses over other types of buses, 51% neither disagreed nor agreed
- 4 - Of note, 10% of respondents reported that the trolley buses are too high and difficult to board especially for those with strollers or wheelchairs and those who are elderly or disabled.
- 5 - 71% of respondents were between the ages of 20 and 54.
- 6 - 52% of respondents reported that they used ETS at least 2 times per day, over 40 times a month
- 7 - 46% of respondents reported that the purpose of their trip was to go to or from work, 25% said their purpose was to go to school, and 24% said their purpose was for personal reasons.
- 8 - Reasons Prefer Trolley Buses

Reason Prefer Trolley Buses	Percent
Better for environment, less pollution	27%
Comfortable (seats, bigger)	11%
Faster ride and schedule	9%
Cheaper to maintain, fuel efficient	7%
Cleaner, smell better	6%
Easy to drive, smoother ride	6%
Quieter	4%
Nostalgia, history, riding for years	3%
Need more and newer	3%
Cheaper to ride	2%
Safer	2%
More reliable	2%
Waste to buy new buses	1%
Add more features, hydraulic lift, bike rack <sup>1</sup>	1%
Different atmosphere than city buses	1%
Scenery	1%
Other	1%

n=198 Note: Respondents could identify more than one response to this question. Totals may not add to 100% due to rounding and due to multiple responses.

## 9 - Reasons Do Not Prefer Trolley Buses

Reason Do Not Prefer Trolley Buses	Percent
Delay (break, off cables/tracks, stuck, lose power)	16%
Hard to board/high (strollers, wheelchairs, elderly, disabled)	10%
Slower	6%
Not a smooth ride (rough starts/stops)	5%
Uncomfortable (things fall, stink, dirty, crowded)	4%
Old (look bad)	3%
No bike rack/hydraulics	3%
Cost more to maintain	2%
Minor problems	2%
Other buses are better	2%
Inefficient	2%
Interfere with radio	1%
Rather have trolleys downtown only	1%
No route to work	1%
Noisy	1%
Sometimes have to ride but then takes longer to get home	1%

n=198 Note: Respondents could identify more than one response to this question. Totals may not add to 100% due to rounding and due to multiple responses.





## **APPENDIX A: SURVEY INSTRUMENT**



**EDMONTON TRANSIT  
TROLLEY RIDER SURVEY**

I am from R.A. Malatest & Associates Ltd. We are conducting a survey on behalf of the Edmonton Transit System to gather the public's opinion about the ETS. All information you provide is protected under the provincial **Freedom of Information and Protection of Privacy Act**.

The survey is completely voluntary and should only take 5 minutes to complete. As tokens of appreciation for completing the survey, the ETS would like to offer you a bus ticket and an ETS pen. Please complete the survey and drop it in one of the boxes located near the exits of the bus.

For each question, please circle your response OR write your response in the space provided.

- 1) In which age category are you in?**
- Less than 15 years \_\_\_\_\_ 1
  - 15-19 years \_\_\_\_\_ 2
  - 20-24 years \_\_\_\_\_ 3
  - 25-34 years \_\_\_\_\_ 4
  - 35-44 years \_\_\_\_\_ 5
  - 45-54 years \_\_\_\_\_ 6
  - 55-64 years \_\_\_\_\_ 7
  - 65 years or more \_\_\_\_\_ 8

- 2) In the last month (4 week period) how often have you used ETS, including trolleys buses and other buses and the LRT?**
- At least 2 times per day (40+) \_\_\_\_\_ 1
  - At least once per day (25-39 times a month) \_\_\_\_\_ 2
  - Several times a week (9-24 times a month) \_\_\_\_\_ 3
  - Once a week or less (< 9 times a month) \_\_\_\_\_ 4

- 3) What is the main purpose of your trip today?**
- Going to/from work \_\_\_\_\_ 1
  - Going to/from school – secondary \_\_\_\_\_ 2
  - Going to/from school – post-secondary \_\_\_\_\_ 3
  - Personal business, e.g. shopping, appointments, errands \_\_\_\_\_ 4
  - Social functions, meet friends \_\_\_\_\_ 5
  - Other \_\_\_\_\_ 6



4) For each of the statements below, please indicate if you agree or disagree with the statement.

	Strongly Disagree	Somewhat Disagree	Neither Disagree nor Agree	Somewhat Agree	Strongly Agree
a. I take this route because it is a <u>trolley bus</u> .	1	2	3	4	5
b. I would continue riding this route if a regular bus was substituted for the trolley bus.	1	2	3	4	5
c. I prefer trolley buses over other types of buses.	1	2	3	4	5

5) For what reasons do you prefer or not prefer riding trolley buses?

I prefer trolley buses because...

I DO NOT prefer trolley buses because...

a) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

a) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

b) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

b) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

c) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

c) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Thank you for completing this survey.**  
**Please drop it off in one of the boxes located near the exits of the bus.**

# Edmonton City Council's Infrastructure Strategy

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Revised 2006



January 2006

Edmonton City Council's Infrastructure Strategy

Infrastructure Element	Unit of Measure	Quantity	Average Age	Expected Asset Life	Physical Condition	Demand / Capacity	Functionality	Replacement Value (millions)
			(Note 1) (Years)	(Note 1) (Years)	(Note 2) A+B / C / D+F (%) (Note 3)	(Note 2) A+B / C / D+F (%) (Note 3)	(Note 2) A+B / C / D+F (%) (Note 3)	
<b>Drainage</b>								
Wastewater Treatment Facilities	each	1	29	50	100 / 0 / 0	100 / 0 / 0	0 / 100 / 0	\$424
Sanitary System	km	1,873	29	75	35 / 54 / 11	61 / 14 / 25	60 / 40 / 0	\$1,251
Storm System	km	2,048	31	75	82 / 16 / 2	35 / 38 / 27	50 / 50 / 0	\$3,896
Combined System	km	937	57	75	31 / 56 / 13	17 / 33 / 50	0 / 100 / 0	\$1,107
Service Connections	each	282,388	33	75	67 / 25 / 8	100 / 0 / 0	0 / 100 / 0	\$1,728
<b>Drainage Total</b>			<b>35</b>	<b>75</b>	<b>66 / 28 / 6</b>	<b>53 / 24 / 23</b>	<b>32 / 68 / 0</b>	<b>\$8,406</b>
<b>Road Right-of-Way</b>								
Roads	km	4,451	34	20	41 / 40 / 19	35 / 38 / 27	60 / 30 / 11	\$5,072
Sidewalks	km	4,460	32	30	60 / 7 / 32	100 / 0 / 0	61 / 30 / 9	\$769
Bridges	#	142	34	63	63 / 34 / 3	35 / 38 / 27	60 / 30 / 10	\$473
Auxiliary Structures	#	25,835	N/A	15	0 / 75 / 25	N/A	N/A	\$56
<b>Road Right-of-Way Total</b>			<b>35</b>	<b>25</b>	<b>45 / 36 / 19</b>	<b>68 / 19 / 13</b>	<b>62 / 31 / 8</b>	<b>\$6,369</b>
<b>Parks</b>								
Horticulture	varies	N/A	varies	60	11 / 89 / 0	100 / 0 / 0	10 / 90 / 0	\$1,040
Access	varies	N/A	22	60	3 / 62 / 35	60 / 35 / 5	60 / 0 / 40	\$244
Playgrounds / Water Features	#	604	21	20	86 / 5 / 9	79 / 11 / 10	79 / 7 / 14	\$115
Parks System Inventory	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sports Fields / Fixtures	#	2,998	N/A	18	100 / 0 / 0	57 / 43 / 0	57 / 43 / 0	\$50
Protection Elements	varies	N/A	N/A	13	0 / 100 / 0	0 / 89 / 11	0 / 100 / 0	\$23
Park Furniture	#	10,839	27	15	0 / 100 / 0	0 / 100 / 0	0 / 100 / 0	\$9
<b>Parks Total</b>			<b>20</b>	<b>55</b>	<b>18 / 75 / 7</b>	<b>88 / 10 / 2</b>	<b>25 / 67 / 8</b>	<b>\$1,482</b>
<b>Transit Facilities and Equipment</b>								
LRT Major Facilities	each	10	21	95	93 / 6 / 1	100 / 0 / 0	92 / 7 / 1	\$233
LRT Fleet	each	37	24	40	0 / 50 / 50	0 / 100 / 0	0 / 50 / 50	\$155
LRT Line	route KM	72	22	60	79 / 19 / 2	92 / 8 / 0	79 / 20 / 1	\$398
LRT Equipment	varies	293	23	31	52 / 39 / 9	85 / 15 / 0	48 / 36 / 16	\$73
Bus Fleet (Growth)	each	5	0	18	100 / 0 / 0	100 / 0 / 0	100 / 0 / 0	\$2
Bus Major Facilities	each	24	16	26	42 / 34 / 24	58 / 9 / 33	46 / 15 / 39	\$33
Bus Stops	each	13,084	9	16	57 / 20 / 23	59 / 20 / 21	48 / 14 / 38	\$16
Bus Communications	each	874	11	11	9 / 24 / 67	100 / 0 / 0	8 / 92 / 0	\$4
Bus Equipment	each	911	11	13	69 / 17 / 14	51 / 35 / 15	70 / 0 / 30	\$13
<b>Trolley System</b>	<b>route KM</b>	<b>140</b>	<b>22</b>	<b>36</b>	<b>70 / 10 / 20</b>	<b>100 / 0 / 0</b>	<b>72 / 16 / 12</b>	<b>\$89</b>
<b>Transit Facilities &amp; Equipment Total</b>			<b>20</b>	<b>60</b>	<b>65 / 22 / 13</b>	<b>78 / 21 / 2</b>	<b>65 / 22 / 13</b>	<b>\$1,018</b>
<b>Fleet</b>								
Transit Fleet	each	910	15	19	53 / 7 / 40	23 / 23 / 54	60 / 0 / 40	\$397
Municipal Department Vehicles	each	2,208	8	9	39 / 24 / 37	80 / 15 / 5	45 / 40 / 15	\$185
Shop Equipment	each	585	19	22	22 / 25 / 53	20 / 60 / 20	55 / 25 / 20	\$30
<b>Fleet Total</b>			<b>15</b>	<b>15</b>	<b>47 / 13 / 40</b>	<b>40 / 22 / 38</b>	<b>55 / 13 / 32</b>	<b>\$611</b>
<b>Buildings</b>								
Service Yards / Operations	ft2	2,122,488	30	45	42 / 42 / 16	39 / 27 / 34	48 / 20 / 33	\$280
Offices	ft2	1,339,743	31	45	81 / 19 / 0	64 / 35 / 1	96 / 1 / 3	\$170
Emergency Response	ft2	337,472	25	45	71 / 22 / 7	88 / 12 / 0	82 / 14 / 4	\$76
Library Buildings - Owned	each	8	41	40	90 / 10 / 0	98 / 0 / 2	90 / 8 / 2	\$44
Police Buildings	ft2	593,440	15	20	41 / 47 / 12	41 / 47 / 12	40 / 48 / 12	\$104
<b>Buildings Total</b>			<b>30</b>	<b>40</b>	<b>58 / 33 / 9</b>	<b>55 / 29 / 16</b>	<b>65 / 18 / 17</b>	<b>\$675</b>
<b>Traffic Control &amp; Street Lighting</b>								
Streetlighting	unit	70,399	22	30	25 / 25 / 50	35 / 38 / 27	29 / 22 / 49	\$425
Traffic Signals	unit	4,788	17	27	56 / 28 / 16	35 / 38 / 27	61 / 22 / 17	\$86
Parking Meters	unit	3,343	1	10	100 / 0 / 0	100 / 0 / 0	100 / 0 / 0	\$3
Traffic Signs	unit	127,740	18	23	27 / 45 / 28	35 / 38 / 27	55 / 29 / 15	\$27
<b>Traffic Control &amp; Streetlighting Total</b>			<b>20</b>	<b>30</b>	<b>30 / 27 / 43</b>	<b>35 / 38 / 27</b>	<b>35 / 23 / 42</b>	<b>\$541</b>