To summarize:

A detailed analysis of its contents reveal this study has many shortcomings. It asks the City to make a decision soon on the long-term future of our trolley system and is highly suggestive that we abandon trolleys in favour of an all-diesel fleet:

☞ **without an analysis that factors in current and future passenger levels on the trolley system**

☞ **without any analysis of the "life cycle costs" of trolleys vs. diesels**

☞ **in light of data that indicates the maintenance costs of an 11-year-old diesel bus are <u>twice</u> those for a 20+ year old trolley**

☞ **when diesel fuel prices can't be predicted for more than <u>three years</u> down the road, and after Council has had to inject funds to cover rising diesel fuel costs for <u>three years</u> in a row**

☞ **when the city has been able to negotiate very low power prices with its own power company, but has no control over the price of diesel fuel**

☞ **without knowing what the public prefers or how trolley abandonment might impact transit ridership or downtown revitalization**

☞ **in the absence of a community noise impact assessment, and while knowing that diesel bus noise has been a concern in certain neighborhoods**

☞ **based on faith that future emission standards will somehow make diesel tailpipes in the street better for our health than zero emission vehicles, and in light of information that NOx and particle emissions at diesel bus stops are up to 40 times higher than ambient levels**

☞ **while there is uncertainty about the exact technology that will be used to meet post-2007 emission standards, and when one can't predict the capital or long-term operating costs associated with that technology**

☞ **knowing that most of the old diesel fleet will have been replaced <u>before</u> the new standards come into effect, so Edmontonians won't benefit completely from the new emission standards until about 2028**

☞ **in the absence of any discounted cash flow (DCF) analysis to compare the "trolley phase out" vs. "keep trolley" scenarios and where the only assessment provided shows only a 5% difference in total costs between trolley phase-out and trolley retention over the next 6 years (less than the margin of error in many studies)**

☞ **in light of information that if hybrids are needed to meet the 2007 emission standards, the capital difference between trolley phase-out and trolley retention is much smaller, and phase-out could cost more than keeping trolleys**

☞ **when the consultants themselves are reluctant to make any recommendations**

What the study does not say

1. The trolley system represents a capital asset. Capital assets have a value. The study does not estimate a value for the trolley system or consider that value as part of the equation. The fact that the Vancouver system--about twice the size of Edmonton's—was valued at $184 million was a strong factor in the recent decision to purchase a new fleet of Canadian-built trolleybuses.

2. Using the data on p. 19, one can calculate that this practice appears to have a cost penalty of about 0.30 per km of operation (or $350,000 to $400,000 annually).

3. This practice is unique to Edmonton and not in line with "industry practices". In a 1993 submission to the City on behalf of Transport 2000, civil engineering professor John Bakker stated he was not aware of any other city in the world that maintains 100% diesel back-up for its trolley fleet. Vancouver, Seattle and San Franciso do not habitually substitute diesel buses for trolleys on weekends, during inclement weather, for minor roadway projects, for pole painting or even to perform routine maintenance on the overhead wire system.

4. Cost appears to be the main driver and focus for this study. (When the Department of Asset Management started looking at trolleys back in July of 2003, both the *Journal* and the *Sun* identified costs and budget pressures as the main reason.) Perhaps this may explain why some important factors (such as capital value of the system, passenger levels, public preference for trolleys, population growth patterns in the city core, localized noise and emissions impacts, etc.) were either not or only briefly considered.

In spite of the cost motivation, even the cost analysis itself is incomplete—never having considered passenger levels and revenue as part of the equation. It is also based on questionable assumptions. For instance, the long-term pricing of diesel fuel is presumed stable, contrary to recent experience. The long-term maintenance costs of post-2008 diesel (ULEV) technologies are assumed to be similar to current technologies, when these costs are actually unknown at present. (see 19 below)

If the consultants feel that operating costs could be reduced by using more trolleys, should trolley expansion not have also been considered as part of the study?

5. The percentage of stops served by trolleys would appear to have little relevance in assessing the worth of the trolley system to the citizens of Edmonton. LRT has only ten stops--less than 1% of the all the stops in the transit system. By this logic, one could judge the LRT system too small to operate. The primary function of transit is not to serve stops; it is to serve riders. Trolleys carry thousands of riders.

In its introduction, the study states that trolleys are optimally used on higher patronage routes (p. 12). To determine how trolleys fare financially compared to diesels, an examination of the current and future ridership levels/passenger loadings in trolley corridors is needed. In a 1992 study in which Booz, Allen and Hamilton evaluated building a trolley system for Los Angeles, they established that trolley service was viable on routes with passenger boardings of at least 60 per hour and average loadings of 18 passengers. Dayton, Ohio was deemed to have a viable trolley system at 49 boardings per hour (with a per passenger cost of 0.79 *less* than diesel).

6. *Worldwide*, the number of trolley systems has grown in the past 30 years--from around 250 in the early 1970's to over 360 today. A significant factor in the shut-down of the systems in Toronto and Hamilton was pressure by the Ontario provincial government to capitalize on plentiful natural gas reserves and sell "made-in-Ontario" natural gas buses. Only seven years after the Toronto system was shut down, the chairman of the Toronto Transit Commission stated the abandonment of trolleybuses had been a "regrettable mistake" (*Diesel Fuel News*, Aug. 14, 2000) In Philadelphia, the installation of new overhead lines at the Frankford Depot (garage) and on both Bridge and Pratt Streets was just completed in February 2004. It seems unlikely Philadelphia is about to abandon trolleybus operations.

7. For the most part, these are the types of routes trolleys serve in Edmonton. They are well-established, high patronage routes in the more densely populated core areas of the city.

8. Edmonton has a history of public support for trolleybuses. In a 1992 survey of over 500 Edmontonians conducted by MarkTrend research, the majority of respondents (4/5) favoured electrically powered modes. Only 15% of all comments about diesel buses were positive, and 59% disagreed with investing further in diesel buses. About 65% of respondents who favoured investment in trolleybuses and LRT said they would stick with their choices even if these modes were more expensive. In their 1992 study for Los Angeles, Booz, Allen and Hamilton devote several pages to the premise that trolleybuses attract ridership. They state that converting diesel routes to trolley resulted in patronage gains of 10-18% in San Francisco and 10% in Seattle. They also state that conversion of trolley routes to diesel has resulted in patronage losses. A marketing assessment for the transit authority in Arnhem, Netherlands projected patronage gains of up to 16% with trolleys, but ridership losses of 5% if the city were to convert entirely to diesel. (*Stadtverkehr*, 6/98) A report for the US Senate issued in the 1970's cites the conversion of streetcar and trolleybus routes to diesel buses as a contributing factor in ridership losses that eventually bankrupted some transit systems. These factors were omitted in this study, but should be important in any balanced assessment of the benefits and drawbacks of trolleybuses.

9. This statement is not substantiated by the data. The data (p. 17) show show the maintenance costs of 20+ year old trolleys to be significantly lower than all diesel buses greater than 10 years of age. In other words, except for the very newest diesel buses, the trolleys actually have the lowest maintenance costs. The trolleys provide service all day long, while the oldest diesels are now used mostly for peak hour trippers. Despite this reduction in use, those diesels are still more expensive to maintain than the trolleys. (A 2003 Regina Transit report confirms that the optimal life of a new diesel bus is 10-12 years; as the vehicles approach this age,

maintenance costs rise sharply and rebuilding/refurbishment becomes necessary. Edmonton's trolleys have already lasted 22 years without refurbishment.)

The study only compares maintenance costs for various sub-fleets for the past three years. (p. 17) This ignores the fact that for a significant portion of their life, the maintenance costs for the BBC trolleys were much lower than the diesel fleet average. (D.L. MacDonald, 1991) Booz, Allen's data show that portion of the diesel fleet of similar age to the trolleys (high floor 40 foot GM's) now costs 0.11 more to maintain than the trolleys, and the 11- year-old 6V-92 diesels cost 0.57 more than the trolleys, but these high costs are 'hidden' by using an average of all three diesel sub-fleets as a basis for the comparison. ~40-55% of the diesel fleet consists of brand new diesel buses with low maintenance costs, skewing the diesel fleet average toward the low end. In other words, the study really compares the cost of maintaining a diesel fleet of comparatively new age with a 20+ year old trolley fleet. This is a dubious comparison**.** But it begs the question: if an 11 year old diesel costs 1.23 to maintain vs. 0.66 for a 20+ year old trolley, how will the city afford the maintenance costs on the large number of newly purchased diesel buses when they get to be 11 years old?

The only equitable means to evaluate and compare maintenance costs different types of vehicles is to use life cycle costing—i.e. look at the cost of maintaining the vehicle over its entire life cycle. The report could have provided this analysis for the existing fleets, in particular for trolleys and diesels of similar age.

It cannot be assumed that the maintenance costs for future diesel technologies will be similar to current diesels. The technological changes required to meet future emissions standards may mean post-2008 vehicles will require more intensive maintenance.

10. For the past three years, City Council has had to inject additional funds into the budget to cover rising diesel fuel costs. The study claims there would be future cost savings by going all-diesel, yet it can't predict the cost of diesel beyond 2007. Recent experience should generate doubts about the report's claim that diesel fuel prices will rise by no more than 0.02 per litre by 2007. Petroleum prices have risen across the board in recent years.

The cost of power for the trolley system is negotiated on contract and so is likely to be more stable. Because the city owns the power company, it is more likely to obtain good rates on electricity than diesel fuel.

Numerous studies have concluded that world petroleum production will reach a peak in the very near future and then begin to decline, resulting in a dramatic rise in the cost of petroleum products.

11. If one accepts Booz, Allen's cost per km comparison, the most expensive vehicle in the fleet, strictly speaking, is not the trolleybus, but the 11-year-old 6V-92 diesels. Had the trolley system been used maximally (to "industry standards"), the total per km operating costs for the relatively new 6V-92 low floor diesels would have exceeded the cost for operating 20+ year old trolleys in two out of the three years examined.

Cost per (fleet) km was refuted as a reliable basis for comparing different transit modes back in 1966 because it ignored the operating conditions and the passenger loads (revenue earned). This study's cost per km comparisons are misleading because they are artificially skewed in favour of the diesel fleet by virtue of the relative fleet kms operated, the relative fleet ages and the use of an average maintenance cost for the diesel fleet (see 9 above). A more complete picture of costs would have resulted if a cost per passenger or cost per passenger km were included. This would require looking at passenger levels on the diesel and trolley systems. In their 1992 study for Los Angeles, Booz, Allen compared cost per mile, cost per hour and cost per passenger in six North American cities. They declared trolleybuses had the lowest per passenger costs in every city examined. Ideally, a discounted cash flow (DCF) analysis should have been included as part of the study.

12. The study could have suggested some possibilities for financing the cost of new trolleys without adding huge amounts to annual bus purchase expenditures. In order to enable new buses to be purchased each year, bus purchases have been moved from being part of the city's capital budget into the operating budget. The city has purchased ~50 new diesel buses each year recently. From order to delivery date, there is a span of up to two years. The total number of new trolleys required to meet service requirements plus spares is cited as 49 (in fact 46 trolleys would meet the service requirements plus the industry standard spare ratio of 15%). By 2008, the older diesel fleet will have been largely replaced, so funds earmarked for bus purchases could then be devoted to the purchase of new trolleys. If the total order were spread over two years, the annual cost for trolley purchases would be about the same as the annual expenditure for diesel buses. (I.e., the only difference would be in the number of vehicles received per year.) The trolley fleet would be fully replaced by 2010. By 2008, a large number of GM diesels will have been rehabilitated. These should be able to provide service to 2010 to cover any requirements for additional diesel bookouts. The city could begin receiving new diesel buses again in 2011. In other words, it should be possible to replace the trolley fleet without exceeding the annual budget for bus purchases.

By the end of 2007, the Vancouver trolley order will have largely been filled. Should Edmonton elect to buy from Canadian New Flyer, that company would be in a position to continue operating their trolley assembly line to fill the order.

13. The study promises a noise impact assessment (p. 14), but offers none. There are streets in Edmonton where a trolleybus passes by over 400 times in a typical weekday, each time with minimal noise impact. Diesels generate noise in excess of 80 db; replacing trolleys with diesels would have significant negative impacts on some neighborhoods.

Noise is disrupting to communities, in particular intermittent loud noise such as associated with diesel buses. Noise has been one of the most significant complaints regarding diesel buses in Edmonton. Parkallen residents recently voice strong objections to plans to locate a transit centre in their community to connect with South LRT not just because it would increase diesel emissions, but because of the disruptive effects of diesel bus noise (Kaleidoscope Consulting). In a number of areas, diesel bus layover points have had to be modified

on because of noise complaints (Eg.: Belgravia, Dunvegan, Bonnie Doon, Highlands). As transit service frequencies increase to meet demand, so does the noise problem associated with diesel buses. This is of particular importance downtown, where high density residential development is taking place. The noise from 90 diesel buses per hour on Euclid Avenue in the heart of Cleveland, Ohio was blamed for the deterioration of the area. (The Euclid Corridor Improvement Project, *Busline*, Jan. 2000)

14. The study's overemphasis on 'area emissions' leads to some contradictions. The main emissions issue in the trolley vs. diesel consideration has always been local (street-level) impacts, not 'area emissions'. Thus, a more thorough examination of local emissions impacts is needed. In some dense areas of the city core served by trolleys, a trolleybus passes by over 400 times in a typical weekday. If replaced by a diesel bus, the change in local emissions is significant if levels of NOx and particulate at bus stops actually rise by 40 times the ambient levels as a result. 'Perceptions' should be less important than the reality of exposing people to toxins.

It is doubtful that Edmontonians living in the city core perceive agricultural activity as the source of local air pollution.

15. Exposure to diesel particulate emissions is also blamed for heart disease. In fact, the Canadian Government (Environment Canada) states there is no safe level of particulate exposure.

16. The ultra-low diesel emission standards are proposed to come into effect in 2007, but this does not mean the existing diesel transit fleet will suddenly become cleaner. The majority of the high polluting GM fleet will have been replaced by 2008 with vehicles built prior to the new standards. These buses would remain in service for about 18-20 years. If trolleys are abandoned in 2010 or earlier, it would be at least another 10 years before any significant portion of the fleet comprises low polluting (ULEV) diesels. If ULEV diesels really do turn out to be cleaner than power plants, achieving the lowest contribution to "area emissions" would actually entail retaining trolleybuses until nearly all pre-2008 diesels have been retired, in other words, until after 2028.

It is evident there is some uncertainty about the technology that will be used to meet post-2007 emissions requirements. At one point, the consultants allude to hybrid buses (p. 38). All technologies required to achieve the post-2007 standards must currently be considered in testing and development. The long-term cost and performance of these technologies are not yet known. Hybrids currently cost about $700,000 each and would likely cost more to maintain (40 batteries to replace every two years).

In addition, pollution from vehicles operating in real world conditions can often vary considerably from certification standards. In the particulate filter evaluation recently conducted by ETS, emission levels for NOx and PM in the control tests were higher than certification levels. In other words, in the real world, post-2008 diesel buses may put out more pollution than the emission standards suggest.

The study focusses on "area emissions". The real issue is with diesel bus emissions released in the streets (see 14 above). Emissions from powerplants outside of Edmonton hardly have the same impact as diesel engines operating within the city. The study says NOx and particle levels from diesel buses (not from power plants) are up to 40 times higher than ambient levels at bus stops. The health impacts need to be considered, as newer diesels would still release their emissions into the streets.

The health impacts of diesel particulate are affected by the size and number of the particles, not their measure by weight. For example, 0.1 g of ultrafine particules pose a greater risk than 0.3 g of course particles. The particles from newer diesel engines are finer and greater in number, but the total weight is less. Thus, a particulate measurement of 0.1 g/km does not necessarily represent less health risk than a measurement of 0.3 g/km. Thus, the lower emission weights of newer diesels should not imply health risk is always reduced or removed.

It is known that particle emissions from different fuel sources have different toxicities. Diesel particles are many times more toxic than gasoline exhaust particles, for instance. The study treats diesel particulate and power plant particulate as though their toxicity were equal. This may not be the case.

17. Calculating the *percentage* of emissions contributed by transit is basically just a mathematical exercise. By this formula, one can decrease the percentage of emissions contributed by transit by curtailing transit service and increasing the number of cars and trucks on the roads. This exercise is not a logical basis for deciding whether to tear down millions of dollars of investment in transit infrastructure.

Reductions in total emissions are achieved by everyone playing a small part. Turning off lights, keeping your vehicle in tune, taking transit AND operating cleaner buses. An investment in green power removes power emissions for trolleys and LRT from the equation entirely.

'Area emissions' appear overemphasized in this study; the important issue has always been localized (street level) emissions (see 14 and 16 above).

18. There doesn't seem to be a funding problem when it comes to paying the high costs to keep old diesel buses on the road (see 9 above). Why does the cost of rehabbing trolleys double over the course of the study?

19. The capital cost difference between trolley retention and trolley abandonment is about 5% over 6 years. (A 5% variation is less than the "margin of error" in many cost studies.)

The difference between keeping trolleys and phasing them out decreases to only $8.75 million if (1) instead of purchasing 15 new diesel "spares", the city simply retains older vehicles for this purposes; (2) the spare ratio on the new trolley fleet is reduced from 25% to 15%--the same as in Vancouver; and (3) an allocation for refurbishing old trolleys is reduced to $25,000 per vehicle—about the same as is currently allocated for refurbishing old diesels in the current (2004) city budget.

If hybrid buses (at $700,000 a piece) are required to meet post-2007 standards, the difference between the two scenarios is much smaller, and the trolley phase-out option could become more expensive than retention. Again, a discounted cash flow (DCF) analysis would provide a more reliable means to compare the different investment scenarios.
20. This conclusion cannot be supported because: (1) the maintenance costs for 11 year old diesel buses were actually twice as high as for 20+ year old trolleys; (2) uncertainty about the technology required to meet post-2008 diesel emission requirements exists in the report, and of the possible technologies that could be used, the long-term maintenance costs are all unknown at this time; (3) passenger boardings and revenue in trolley corridors were never considered as part of the equation, so one doesn't actually know how the trolley system fares in terms of covering its costs vs. the diesel system; (4) there is no discounted cash flow (DCF) analysis; (4) the study can't predict the price of diesel fuel more than three years in advance.
21. Perhaps the analysis, being incomplete, does not provide sufficient basis to make recommendations?

What the study says

1. Edmonton has a trolley system comprising 140 km of overhead wire, 8 substations (plus aerial and underground feeder cable) and over 4,600 specialized support poles. (p. 4)

2. The trolley system is underutilized. (Mr. Kreeb described it as "not being utilized to industry standards".) (p. 57) There are about 2 million scheduled trolley kilometres annually, but diesel buses are frequently substituted on trolley runs reducing trolley system utilization to between 45%-65%. (p. 17, 18)

3. Spare diesels are kept to back-up the trolley fleet at about a ratio of 1:1. (p. 51)

4. There is pressure to reduce costs, and this was one reason for the study. (p. 3) The per km cost of operating trolleys can be reduced by increasing the utilization of the system. (p.18, 19)

5. Trolleys serve 8 percent of bus stops in the system. These stops are primarily in the downtown core. Thus, the trolleys form a part of a much larger transit system. (p. 5)

6. The number of trolley systems in North America declined sharply during the 1950's and 60's in favour of cheaper diesel buses, before the advent of environmental awareness and pollution standards. (p. 9) The trolley systems in Toronto and Hamilton were closed about ten years ago; trolley operations in Philadelphia have been suspended (p. 9, 10).

7. Trolleys are optimally used on high patronage routes where the increased farebox revenues help cover the cost of maintaining the overhead wire system. (p. 12)

8. There is often strong popular support for trolleys (p. 12)

9. The vehicle maintenance costs for trolleys and diesels are similar. (p. 17)

10. Both electricity and petroleum prices should remain relatively stable over time (p. 16) The cost of diesel fuel will rise by about 0.02 in 2007 when ultra low sulphur fuel will be required. (p. 48)

11. If we calculate operating costs in cents per kilometre of travel, trolleys appear more expensive than the diesel fleet because of the maintenance requirements for the overhead wires. (p. 19)

12. New trolleys cost almost twice as much as new diesels. (p. 20)

13. Trolleys are markedly quieter than diesels. (p. 21)

14. Air quality is not 'perceived' as a problem in Edmonton. Agricultural activity is 'perceived' as contributing to poor air quality. (p. 23) But CO, NOx and particulate emissions near heavily travelled bus stops/transit centres are high, particularly when diesel buses are nearby—as much as 40 times greater than ambient levels. (p. 23-25) Local street conditions will continue to favour trolleys. (p. 57)

15. Diesel exhaust causes cancer, and possibly at very low levels of exposure. (p. 31) It also has many other negative health effects such as aggravation of allergies, genetic mutations and defects, reproductive disorders. (p. 32)

16. Diesel emission regulations are getting stricter. When the 2008 model diesel buses appear, they will have to meet certification standards that are much lower than those built prior to 2008. (p. 34) The emissions from power generation are also being reduced. (p. 36) In terms of "area emissions", the forecasts seem to indicate that post-2008 diesel buses will produce slightly less pollution per km than power plants for trolley operation. (p. 40) Regardless of whether a mixed fleet of trolleys and diesels is retained, or whether Edmonton goes all-diesel, the impact of the transit fleet on area emissions will probably remain about the same. But there is much uncertainty in the assumptions. (p. 54, 55)

17. In the Edmonton area, the ETS bus fleet contributes just under 2% of the total NOx and 1.6% of the total particulate matter of all transportation sources. (p. 41)

18. Old pre-1980 GMC diesel buses are being rehabilitated at the rate of 15 per year, and 1992 6V92 Flyers are also being rehabbed, but trolleys are not (p. 43, 48, 52). Rehabbing the trolleys will have a cost associated with it, identified as $25,000 per bus on page 4 and later as $50,000 per bus on page 48.

19. It will cost $368.9 million to phase out trolleys by 2010; it will cost $388.7 million to continue with trolleys and renew the trolley fleet. The figure of $388.7 million includes the refurbishment of 30 existing trolleys. (p. 52)

20. Trolleys will continue to cost more to maintain and operate than equivalent diesel service. (p. 57)
21. The consultants can’t (or won’t) make any recommendations.