SUBJECT: Traffic Signal System Efficiency and Effectiveness Initiatives (L.E.D. Conversion and Timing Optimization Programs) (PW06077) - (City Wide)

RECOMMENDATION:
That the City of Hamilton undertake Traffic Signal System “Efficiency and Effectiveness Initiatives to reduce the use of electrical energy, reduce the use of motor vehicle energy, reduce air emissions and improve traffic flow, through the following recommendations:

(a) That a traffic signal LED replacement project be undertaken as soon as the necessary technical investigations, tendering and purchasing can be completed, with the actual program of replacing all incandescent units be completed in one year or less.

(b) That the purchase and installation of the LED traffic signals, project management costs and incidental costs, estimated at approximately $1,930,000, be funded from the Roads, Bridges and Traffic Reserve (108041), to be repaid with 4.5% interest, over a time period of seven years.

(c) That the repayment of the project costs be funded through electrical energy savings and operations and maintenance savings from the Traffic Section current budget as outlined in Report PW06077 as Appendix A.

(d) That the addition of one F.T.E. to the Traffic Section staff complement be approved, on the basis that the position is required to coordinate the LED retrofit program and conduct the system optimization initiatives and on the basis that the position will be fully funded from energy savings.

(e) That the use of a contractor to undertake the LED Traffic Signal retrofit program be endorsed.
That staff be authorized to investigate and make application for any applicable grants and or loans which would reduce the cost of the LED replacement project.

EXECUTIVE SUMMARY:

The intent of the suggested program is to:

- reduce the use of electrical energy at traffic signals
- reduce the use of motor vehicle fuel by vehicles travelling through the City of Hamilton
- reduce air pollution generated by vehicular traffic in Hamilton
- improve traffic flow and potentially improve motorist safety

The program structure uses the conversion of existing incandescent traffic signals to light-emitting diode (LED) to save electrical energy and associated costs. While a significant proportion of the savings must be reinvested in the capital cost of the new LED equipment, the project business model also supports an initiative to permanently optimize traffic signal timings, with a significant effect on air pollution, motor vehicle fuel use and private car, transit and goods movement.

LED Conversion Program

City staff have been following the progress of the LED technology over the past few years and have maintained and updated a business case model for the retrofit of the traffic signals in the City of Hamilton. Three converging factors have now made the LED replacement program business case favourable:

- higher electrical energy costs.
- better LED durability with longer warranty periods.
- lower purchase costs.

The business case was prepared using very conservative factors for energy cost, purchase cost, installation cost, LED durability, routine maintenance, etc. Intersections equipped with light-emitting diode (LED) traffic signals use approximately 30% of the energy used by intersections with traditional incandescent traffic signals. In Hamilton’s case, the savings in electrical energy would amount to about $350,000 per year in 2006. The conversion would also defer expected future electrical energy cost increases, with an additional $25,000 increase expected for 2007. However, the program has associated with it, the capital cost of the new LED signals and installation. The break even period to pay back the capital investment, based on current energy cost, is between 5.5 and 7 years, depending on assumptions. The result of our business case
model compares well with business cases conducted by other municipalities. The present warranty on LED equipment can be as much as 7 years, and it is reasonable to expect the LED units to last from 5 to 10 years or more, depending on installation conditions. Conversely, traditional incandescent traffic signal heads can last up to 20 years or more (2 - 3 times as long), and are less expensive to purchase initially. Thus, while LED signals consume far less energy than incandescent signals, most of the energy cost savings must be put toward the cost of the initial purchase and more frequent, more expensive replacements. As such, an LED traffic signal replacement program would not result in the short term cost savings to the City. The prime reason for undertaking such a program would be fulfilling our obligations under Vision 2020 and the City’s Strategic Goals to be environmentally responsible. This program affords an opportunity to reduce our energy consumption which is particularly important in view of the present demands on the energy grid. The energy savings equate to the amount used by about 500 average homes. As secondary outcomes, there may be some traffic safety improvements associated with the signals being somewhat more noticeable and there will be a minor reduction in overall maintenance effort which would allow traffic signal staff to be redeployed to other projects which are presently awaiting staff attention.

**Traffic Signal Optimization Program**

Implementing the LED portion of the project provides an opportunity to use the same project staff member to operate a second, very important, program. The energy savings from the project will also be used to support a parallel energy reduction program in the form of dedicated, on-going traffic signal retiming. Traffic signals, as a system, should have the timings re-evaluated at least every 3 to 5 years. Hamilton last had a comprehensive system review 12 to 15 years ago. Since conditions change constantly, signals need to be reviewed and adjusted accordingly. The traffic energy staff member will be able to conduct in-house on-going reviews of signal timings on a system-wide basis. In other jurisdictions in North America which have done timing reviews, the results have shown significant savings in motor vehicle fuel consumption and air pollutants as well as reduced travel times. It is expected that a dedicated program in Hamilton will produce similar results, which would actually very significant benefits in terms of improved air quality, improved vehicle operating costs and improved traffic movements throughout the city.

**BACKGROUND:**

The information/recommendations contained within this report have city wide implications.

**LED Conversion Program**

LED traffic signals have been available in various forms for approximately 7 to10 years. Initially only red traffic light signal units were available. In the past few years amber and then green traffic signals as well as pedestrian signals have come on to the marketplace and the price of those units has slowly dropped. As well, the durability of the units has increased and the warranty periods have been extended. The primary benefit of LED traffic signals is the significant reduction in energy utilization. Overall, including all energy uses at a signalized intersection, a 70% savings can be realized.
City of Hamilton staff have determined that the business case is quite positive for the use of LED traffic signals at new signal installations and all new signal installations from 2004 onward have been equipped with LED traffic signals. The business case model for existing traffic signals is somewhat different however. The capital cost of purchasing LED traffic signals is significant, there is labour required to undertake the replacement and the traffic signals presently installed in the city have significant life and value left in them.

Staff have prepared a business case model which takes into account the many factors involved in purchasing, installing, and maintaining LED traffic signals. Until recently the business case was not felt to be strong enough to recommend proceeding with a replacement program. However with the increasing cost of energy, the decreasing cost of LED signals and the extension of the warranty periods to 6 and even 7 years on the LED traffic signals, the business case has become more favourable. Using very conservative estimates and assumptions, it appears that the break even point on the business case is between 5.5 and 7 years. Since the signals are warranted for a minimum of 6 years and it is expected that in some placements the signals may last for as long as ten years, the business case now makes sense and it is proposed to proceed with a program to replace existing incandescent traffic signals with LED units.

Traffic Signal Optimization Program

The cost savings from the LED component of the program provide an opportunity to undertake a second component. This is to implement other traffic signal energy saving programs, primarily re-timing of individual and group traffic signals. Projects of this nature have been carried out in many jurisdictions and the results universally reflect significant improvements in travel time, fuel usage and pollutant emissions. Since a single traffic signal with less than optimal timings can waste 40-50,000 litres of motor vehicle fuel per year though unnecessary stops, it is easy to see how a program such as this can be valuable. Given the City’s recent history of smog days, the pollution reduction may be equally valuable to our citizens. In addition, smooth traffic flow supports public transit and local business goods movement.

ANALYSIS/RATIONALE:

LED Conversion Program

As has been noted in the LED business case, the City would break even after approximately 5.5 to 7 years. The units are presently warranted for 6 or 7 years. Thus, at about 7 years there is potentially another replacement cycle as the LED units begin to reach their projected life span. However, many of the signals will last much longer than seven years. As the signals approach the 7-year point, the failure history of the signals will be analysed and a plan developed, which will most likely combine reactive replacement upon failure with some proactive group replacement.

Traffic Signal Optimization Program

The traffic signal retiming component is a key benefit of the program, and one which will actually provide greater overall benefit, both to road users and to all citizens, than the LED program. As noted in the “National Traffic Signal Report Card”, most agencies manage their traffic signal systems in an ad-hoc, reactive manner and over 50% do not
conducted timing reviews on a regular basis. Hamilton falls into the majority group. Our signal timings were last comprehensively addressed between 12 and 15 years ago, though an in-house project. Traffic signal timings require much more regular review and revision, because:

- traffic volumes increase continually
- directional and time-of-day flow changes happen due to new development, one-way street conversions, etc.
- new signals are added to the system
- changes to individual intersections, such as added left turn arrows, are not dealt with as part of the overall system

The report card suggests that agencies putting appropriate resources toward signal timing and maintenance, could reduce travel delay by up to 15-20%, reduce fuel consumption by up to 10% and reduce emissions by up to 22%. This last item is critical in view of the current trend towards poorer summer air quality and increased number of smog days. In 2001, transportation sources released over 1600 tonnes of particulates, 1600 tonnes of sulphur dioxide, 14,000 tonnes of nitrous oxides, 10,000 tonnes of volatile organic compounds and over 100,000 tonnes of carbon dioxide into Hamilton air. As signal operation is revised to promote more energy efficient travel, it will also promote reduced pollutant emissions.

**ALTERNATIVES FOR CONSIDERATION:**

The alternative would be to not undertake the program and only to replace incandescent traffic signal units with LEDs as they fail. Under this scenario it would take between 15 to 20 years to replace all traffic signals in the city and many intersections would be equipped with both types of traffic signals for extended periods of time. It would also miss the opportunity to put in place a dedicated, structured program to continually improve traffic signal timings.

**FINANCIAL/STAFFING/LEGAL IMPLICATIONS:**

**FINANCIAL:**

The 2006 traffic signal energy budget is approximately $505,000. In addition, the recently defined Hydro rate increase will result in a 2007 budget pressure of approximately $25,000 compared to the existing budget allocation, and this type of increase may be expected to continue in the future. As noted, incandescent traffic signals use significantly more energy and LED traffic signals would reduce overall energy consumption by about 70% over current usage. This is an annual savings in energy of about $350,000. In addition, maintenance costs will be lower due to fewer failures and lower annual preventative maintenance costs. The annual maintenance savings are estimated at $60,000. The energy and maintenance costs savings will be balanced against the capital cost of purchasing the LED units, the labour required to install them, the replacement of existing signals which have significant life span left and the potential cost of having to replace the LED units 7 to 10 years after the first installation. The business case breaks even, depending on assumptions, between year 5.5 and year 7. The complete program including materials, contracted services, staff and interest on the capital loan will have no impact on the tax levy.
The total initial project cost is about $1,930,000. The estimate is based on current prices, but with a newly revised international LED standard, changing U.S. interest rates and other factors, the final project cost may vary. This will be determined from the final bids on the material and installation contracts. The above estimate does not include repairs to wiring or support structures not directly related to the LED replacement, but that may be caused by the LED replacement work. Depending on the final project budget status, additional repairs may be charged to the project budget or will have to be accommodated within the current budget for maintenance activities.

Staff recommends that the Roads, Bridges and Traffic Reserve 108041 be utilized as a source of financing for the initial capital investment and associated project management cost. The recommendation calls for savings to be directed to repayment of the initial investment with an associated cost to borrow of 4.5%, as per recommendation (d) of Report PW06077. The Roads, Bridges and Traffic Reserve, was created as a consequence of a one-time grant from the Province of Ontario, and announced in the Province’s 2006/07 Budget. In Report FCS06042, Council approved the creation of the Roads, Bridges and traffic Reserve with a balance of approximately $20.8 million.

The following table summaries the recommended 7 year financing strategy.

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
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The intent would be to borrow the necessary funds and repay the principle and interest charges from energy cost savings and potential operating and maintenance savings. The business case recognizes a reasonable interest rate of 4.5 per cent a year in repaying these loans.

The Horizon Utility Corporation (HUC) has indicated that a grant of approximately $60,000 would be made available from Energy Conservation Funding HUC announced in 2005. The LED project must be completed by mid-2007 to be eligible for the grant. The business case model takes into account the Horizon Utility Corporation grant. Staff have pursued several federal grant alternatives, do far without success. Staff will continue to seek grants or alternative financing sources which may be available to further reduce the costs of the project to the city and shorten the repayment time period. It is recommended that staff be authorized to proceed with application for grants should Council endorse the program.

**STAFFING:**

In order to undertake this project successfully, an additional F.T.E. to the existing staff complement is required. In total, over 13,000 individual signal sections will have to be retrofitted or replaced. Technology and formal technical standards continue to change and the marketplace must be investigated very carefully before making a decision on particular styles and brands of LED traffic signals. It is anticipated that the City will purchase the hardware and then employ a contractor to perform the actual replacement.
It will be necessary to research installation details with suppliers and other municipalities to ensure techniques are specified which result in the maximum reliability and lowest cost. A project manager is required to prepare the RFP for the purchase of the hardware and the tender for the contractor. As well, additional effort over present levels will be required to manage the stock and warranty issues associated with the materials, to follow-up on the reliability of the equipment and to prepare a program for longer term replacement of these units as they approach their 7-10 year lifespan. With a contractor involved, the installation must be regularly inspected to ensure compliance with the tender specifications and for electrical and traffic safety issues. Progress payments will have to be prepared and authorized. With the very large number of individual units to be installed and tracked for warranty purposes, a system for recording the serial numbers in Hansen will have to be devised and implemented. In addition, it is anticipated that some incidental damage will occur in the course of replacing the signals, necessitating rewiring or replacement of traffic signal hangers in some cases, and this must also be managed. The approval of an additional staff member is essential to the success of this initiative.

As well, as noted above, once the LED program has been implemented, the staff person would switch the majority of their focus to the traffic signal optimization program. The successful use of in-house staff was demonstrated the last time a full system retime was conducted in Hamilton, over 10 years ago. Compared to the use of consultants, this is a much more cost-effective approach. It also allows for continuous on-going reviews, rather than a one-time effort, and retains the knowledge and experience within City staff.

The staff position recommended would be completely funded from within the project budget and there would be no impact on the tax levy.

**POLICIES AFFECTING PROPOSAL:**

N/A

**RELEVANT CONSULTATION:**

The business case was developed with the assistance of Finance staff. The business case has subsequently been reviewed several times with Finance staff and is deemed appropriate and acceptable.

This project is being coordinated with other energy management initiatives in Public Works.
Horizon Utilities Corporation staff was consulted about grant possibilities. Initial contacts have been conducted with a federal granting agency about possible grant funding for this project.

**CITY STRATEGIC COMMITMENT:**

By evaluating the “Triple Bottom Line”, (Community, environment, economic implications) we can make choices that create value across all three bottom lines, moving us closer to our vision for a sustainable community, and Provincial interests.

Community Well-Being is enhanced. ☑ Yes ☐ No
LEDs use less energy, thereby allowing for additional energy to be available to other users during periods of peak energy load on the power grid. LED traffic signals may improve traffic safety due to somewhat higher profile. The program manager for this program will also improve traffic signal operations in other areas, producing very significant savings in motorist fuel consumption and travel time.

**Environmental Well-Being is enhanced.** ☑ Yes  ❑ No
Less energy used translates to less use of coal-fired energy generation. As well, the other traffic energy saving programs to be undertaken will result in reduced motor vehicle emissions.

**Economic Well-Being is enhanced.** ☑ Yes  ❑ No
In the long term, the LED signal program will save the City significantly.

**Does the option you are recommending create value across all three bottom lines?**

☑ Yes  ❑ No

**Do the options you are recommending make Hamilton a City of choice for high performance public servants?**

❑ Yes  ☑ No
## CITY OF HAMILTON
### DEBT REPAYMENT SCHEDULE

**DEPT:** PW-O&M-Traffic  
**PURPOSE:** Traffic Signals Retrofit  
**SOURCE:** Roads, Bridges and Traffic Reserve 108041  
**DATE:** March 1, 2006  
**PRINCIPAL:** 1,930,000  
**INTEREST:** 4.5%  
**TERM (YRS):** 7

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