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## **1. Introduction**

Transportation is the second largest source of green house gas emissions in Canada<sup>1</sup>. Urban transportation accounts for a significant portion of this and the City of Regina realizes the importance of reducing the environmental damage caused by urban transportation. The focus of our study and proposal is how we can reduce the environmental impact of the transit system in Regina and help Regina continue to be a leader in sustainable development.

## **2. Principles**

Twenty percent of the average Canadian's non-working, waking time is spent traveling. Urban Transportation is much more than just a means of travel; it is a foundation on which we build our lifestyles. An efficient public transit system will increase the quality of life for its users. A good transit system can help build a city and not just be a responsive measure to meet the current demand. Our focus in this project is on the people of Regina. The work we do as engineers will have an impact on society. Our responsibility is to realize where that impact will be, and to choose the impact we want to see. Regina is a growing city and has the opportunity to be a leader in sustainability.

## **3. Possible Solutions**

### **3.1 Light Rail Transit (LRT)**

Light Rail Transit is an efficient form of urban public transportation that utilizes numerous forms of electric trolleys to move people from one location to another. LRTs

often operate on tracks that are separate from other methods of transportation, but are sometimes mixed with other traffic in city streets. The railcars used by different cities vary, but on average they can carry around two-hundred people per car. While LRT expansion will likely be discussed and required in the future for the City of Regina, at its current population state and the optimal goal of a ten year rate of return, the purchase of a LRT system is simply not cost effective. For example the current LRT expansions occurring in the city of Edmonton are expected to cost nearly a billion dollars. The further interest in the development of a LRT system will likely be more appropriate in ten to fifteen years.

### **3.2 Efficient Traffic Flow**

The environmental impact of each motorist is directly related to the time they are on the road for. When a motorist is stuck in traffic or searching for a parking space more fuel is being consumed than the trip actually requires. The Efficient Traffic Flow system would involve a series of road developments and overpass construction aimed to minimize the amount of time each driver spends in their car on a trip. This approach is attractive because it also saves the people of Regina time they would otherwise spend in traffic. The most important part of this project is improving the quality of life for the people of Regina and everyone would appreciate more time in their day. However, we chose not to go with this option because it is only a short term fix. Given the growing nature of this city, shortly after the infrastructure developments are made more cars would be on the road and the same time delays and parking restrictions we are experiencing now would trouble us again. Another detriment of this option is the high cost of the construction that would not be regained, as well as the fact that it may simply

increase the number of cars on the road hence not really doing anything to reduce emissions after all.

### **3.3 ECO–Lead Program Introduction**

The ECO-Lead Program is a low cost and high impact initiative. The entire program can be realized within the allotted budget of \$10 million for capital expenditures and \$35 million in infrastructure upgrades. The plan is centered around enhancing the bus system. It involves new route planning, the addition of eco-friendly busses to the fleet, new fuel sources for the current diesel busses and a group of social programs targeted at increasing ridership by enhancing the public perception of Regina Transit. This plan seemed to have the most obvious benefits and as such was chosen as our solution.

## **4. The ECO-Lead Program**

### **4.1 Transportation Pollution**

In order to understand the environmental impact of any project, it is important to understand the types of emissions generated by combustion of fuels. Carbon dioxide is the most well-known by-products of combustion and is a major contributor to the greenhouse effect<sup>1</sup>. Nitrogen oxides and sulfur oxides combine with water vapour in the atmosphere to create acid<sup>1</sup>. This can have quite harmful effects on the respiratory system, and, in large enough quantities, can cause acid rain<sup>1</sup>.

### **4.2 Fuel Alternatives**

#### **4.2.1 Bio-Fuels and Ethanol**

A wide range of fuel alternatives is available, each with its own advantages and drawbacks. One of the most prevalent types of alternative fuel is biofuels. Conventional

internal combustion engines can be converted to accept biofuel or a gasoline-biofuel mixture. Ethanol is the most widely-used biofuel and is known for having low carbon dioxide emissions<sup>3</sup>. Ethanol produced from maize produces approximately 18% less carbon dioxide in combustion than gasoline, while ethanol produced from sugarcane can produce up to 91% less carbon dioxide than gasoline<sup>3</sup>. An engine conversion on a typical one-ton truck costs about \$7,500<sup>3</sup>.

#### **4.2.2 Hydrogen**

Hydrogen-fuelled vehicles are another alternative to conventional transportation methods. However, hydrogen vehicles require a significant alteration to an internal combustion engine. Traditional vehicles cannot be easily converted to accept hydrogen as a fuel. In addition, infrastructure for hydrogen-fuelled vehicles is severely limited.

#### **4.2.3 Compressed Natural Gas**

Another fairly common alternative to gasoline- or diesel-powered vehicles is compressed natural gas. Once again, this fuel necessitates heavy alterations to a conventional internal combustion engine. The main advantage to using natural gas costs less than half of the equivalent amount of gasoline needed to power the vehicle<sup>4</sup>. However, filling stations are few and far between, and a typical fill-up can take as long as half-an-hour<sup>4</sup>.

#### **4.2.4 Gas-to-liquids**

A relatively new fuel technology on the market is diesel produced through the method of gas-to-liquids (GTL)<sup>4</sup>. GTL is a process by which natural gas is refined to produce diesel fuel. The advantage of producing diesel through such a process is that it significantly reduces the amount of carbon dioxide, nitrogen oxides, and sulfur dioxides

released during combustion<sup>4</sup>. GTL fuel was developed by Shell and is sold as a blend in their V-Power diesel<sup>4</sup>. GTL diesel is available in many parts of the European Union and is in the trial phase in North America<sup>4</sup>. GTL can be used without any alterations to a typical diesel engine and can also be used in diesel hybrid vehicles<sup>4</sup>. The cost would likely be between \$0.09 and \$0.16 more per liter than regular diesel, based on estimates from Great Britain.

### **4.3 Conventional Compared to Hybrid Buses**

Conventional city buses are powered by a diesel engine. A typical hybrid bus will use a diesel engine in tandem with an electric motor, along with energy recovery systems such as regenerative braking. The electric motor assists the diesel motor specifically during acceleration, as electric motors have much higher low-end torque than diesel motors. Hybrid buses have been proven to be an eco-friendly and cost-effective method of public transportation. (See Figure 1) Conventional buses typically cost between \$450,000 and \$530,000 while hybrid buses can cost between \$700,000 and \$830,000<sup>5</sup>.

Taking into account budgetary constraints and available alternatives, our recommendation is to maintain a fleet of buses that are primarily diesel-fuelled. Hydrogen and compressed natural gas do not lend themselves very well to the City of Regina because they can be adversely affected by extremely cold weather. The temperatures that accompany Regina winters can cause problems with these systems because the fuel is stored under pressure, which is closely related to temperature. Ethanol, while fairly widely available, is not compatible with diesel engines and, therefore, could not be used with the current fleet. GTL could be used on the existing fleet, while offering much of the same benefits as the other fuels. In addition, GTL is

compatible with diesel hybrid buses. We recommend that the City of Regina purchase two hybrid buses to start the transition from diesel to more environmentally friendly alternatives. They are robust enough to operate in harsh weather conditions, while decreasing operating costs and harmful emissions.

#### **4.4 New Route Planning and Infrastructure Enhancement**

The present state of the City of Regina's public transit system currently has a series of compounding issues. One of the primary reasons for low ridership is the inefficiencies of the current bus system and the distinct lack of direct transportation between the city's major hubs. The primary focus of our proposal is to increase fast, efficient travel between these high traffic areas. Currently the three most problematic areas of the city are the University of Regina, Downtown, and the rapidly growing area east of the Ring Road. Traffic in these three areas of the city account for a high percentage of the overall congestion in the area surrounded by the three zones. The construction of high priority bus routes between the three major zones would open up an extra lane for buses without removing any available space from regular traffic. These bus routes would be constructed by widening the current primary roads between each zone. Further studies would be required to specify optimal routes but by estimating the distance between each zone the rough cost of the construction would come to a total of approximately 32 million dollars (breakdown of cost estimation located in Appendix A). The newly purchased buses will be used for these new routes. In addition, we plan on implementing increased service for peak hours. Reasonable peak hour service for heavy used transit routes would be every seven to ten minutes, based on Saskatoon's recently implemented Bus Rapid Transit<sup>6</sup>. As well, we plan on implementing fifteen minute wait

time during the day and thirty minute wait time during the evening. Local bus stops will run every thirty minutes during the day and sixty minutes during the evening, also based on the recently implemented changes in Saskatoon<sup>6</sup>.

#### **4.5 Community Consultation Program**

In order to involve the people of Regina and pinpoint the problem areas within the city, a comprehensive consultation program will be implemented prior to bus rerouting and infrastructure changes. This will be based on Roadmap 2020's implementation of transportation change in Saskatoon in 2006 called Bus Rapid Transit<sup>6</sup>. There are several programs that will be executed in order to consider societal views and receive first-hand feedback on the current issues with the public transit system. These include, but are not limited to a rider survey, a telephone survey, an online survey, a system to monitor rider frequency on given routes. In addition, we plan on creating focus groups targeting businesses, students, and seniors for examples, as well as visionary groups with businesses and community leaders. Although we have discussed a few of the possible restructuring and additional routes that would likely see positive changes, we want to ensure that we are creating a new transportation system that the people will be likely to use in order to reduce traffic and greenhouse gas emissions. Our consultation program will likely allow us to achieve this, as seen positively in Saskatoon, Saskatchewan<sup>6</sup>.

#### **4.6 Additional Components**

##### **4.6.1 Public Perception Campaign**

With the restructuring of Regina's public transportation system, we hope to introduce Regina as a leader in sustainability and set a trend for the rest of Canada and the world alike. A major component of our campaign is to engage the general public and

have them buy into the concept that public transportation is effective, efficient, and accessible as well as environmentally friendly. We have set aside \$500 000 to put toward a campaign to advertise Regina's new public transportation system. This will include billboards, television and internet advertisements, and other forms of mass media, as well as targeting specific audiences such as children and students in face to face promotion. In addition we hope to gain corporate support in having companies offer rebates or discounts for employees that purchase bus passes rather than drive to work. As was discussed one of the major issues with Regina's current transportation system is the lack of routes that frequent newer suburban areas of the city. By making it well known to families that live in the outer areas of the city that new options exist we hope to change the mindset of Regina's society as a whole. Essentially, through effective advertising, we want to make taking the bus the thing to do.

#### **4.6.2 R-Trans Pass**

The R-Trans Pass is a free bus pass for all postsecondary students. The bus passes are paid for by an increase in student fees. The advantages of the R-Trans Pass system are that it strongly encourages students to take public transit and in doing such teaches the students firsthand how to use the system and the advantages of public transit. This means that when the students graduate they are more likely to continue riding. The increased level of ridership in the post secondary institutions also encourages more high school students to ride the bus because high school students often look up to university students. An additional advantage of the U-Pass system is that it creates a secure and predictable stream of cash for Regina Transit.

## **4.7 Social Impact**

The program we hope to implement to change the face of Regina transport will greatly benefit the community. Not only will there be a drastic reduction in local air pollutants, but the city will see less traffic as well. Accessibility, especially for those that already take the bus, will be greatly improved and jobs will be created as more bus routes will require more bus drivers. The city will feel proud in knowing that their voice was heard in creating this new system. The potential negative impact that this project may encounter is the displacing of homes and businesses upon road extensions. Construction measurements will be taken to avoid this such as removing meridians and narrowing sidewalks, however if things do need to be displaced the utmost compensation will be offered to those individuals. In the big picture though, the negative consequences of relocating a few things along the road will be outweighed by all the positive outcomes that are expected to result from this new system.

## **4.8 Economics**

Through a discounted cash flow analysis we determined the payback period on the project to be 1 year and the rate of return on the ten year period to be 93% (Table I). The assumptions necessary in our analysis are all indicated in the notes in Table 1. The capital costs are spread over the first four years of the project to reflect a likely financing agreement that we could establish with our suppliers and contractors.

## **5. Summary**

There are many ways to decrease the environmental impact of the Regina Transit System. A light rail transit system has many benefits it does not suit Regina because of

the city's current population and the high initial cost for they system. Building more bridges and roads will create a temporary fix for traffic congestion but only postpone the current problem. We recommend the ECO-Lead Program because it is cost effective, high impact and most importantly will be the will help create the foundation for a healthier sustainable Regina. The programs many components will compliment each other and use Regina's existing infrastructure to increase bus ridership and the availability which will take cars off the road and decrease the environmental impact of transportation in Regina.

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