

Thesis Inquiry Paper

Subway vs. Light Rail Transit

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1. Abstract

Prior to Rob Ford's appointment as Mayor of Toronto on December 1st, 2010 Toronto had committed to the Transit City Plan that focused heavily on expansion based on the Light Rail Transit (LRT) model. Provincial and Federal level governments had already committed to massive funding allowances for the project and construction contracts had already been tendered and secured. Mayor Ford's council however decided to withdraw all LRT plans as they wanted to give the roads back to the cars and "end the war on the automobile."

Was this a wise move, in a Toronto that has little space for new roads and with a shift in culture that looks at the car as a polluting dinosaur? Will Toronto digress while our European and Asian cousins are pushing forward in the field of public transit? Are Mayor Ford's plans of constructing subways going to help commuters in the longer term, with subway construction roughly three times more expensive as LRT construction?

It is clear that based on the data and information presented in this report, the demographic that relies on transit as their primary means of transit, the daily users of Toronto's public transit would be better served with the existing Transit City Plan.

2. Background and Motivation

As a trained civil engineer who specialized in transportation engineering, transportation efficiency has been my interest throughout my undergraduate studies. When I was given the chance to research an engineering related topic for this thesis, my first instinct was research into the Toronto Transit Commission's (TTC) transit planning ideas. Moreover, being an ex-employee of the City of Toronto, I have worked under both the Mayor Miller and the Mayor Ford governments. As an employee, I could feel the difference in leadership styles first hand at my workplace and I felt it important to quantify this difference in leadership styles and how it impacts the TTC and its riders.

Moreover, as Mayor Ford is trying to "eliminate the gravy" (Ford, 2011) from the municipal machine, I, from a scientific, engineering and a political science perspective, wanted to measure the positive and negative impacts of his decisions. Ignoring the infrequent hiccup, I greatly respect the TTC for its sheer size and operational capacity. It may not be at the same level of sophistication as other leading cities' transit systems such as London's, Montreal's and Tokyo's systems in terms of its size and investment, however, having lived and worked in Toronto, I know that without the TTC, Toronto could not function. Therefore, it is important for the TTC's future expansion planning to be conducted in the interest of the transit system and the citizens who use it on a daily basis. As an engineer and a citizen, it would be disastrous if such a vital task of transportation planning be left to a set of politicians who are more interested in their re-election rather than the interest of the common citizen. Such lack of strong planning can be seen in the ill-planned and poorly executed St. Clair Streetcar Expansion project (as shown in Fig. 1.0).



Figure 1.0: St. Clair Streetcar ROW(Source: BlotTO.com)

3. Central Question

The central question in this inquiry is to investigate whether the City of Toronto is correct in its decision to shift from an LRT based expansion plan (the pre-existing Transit City Plan) to one that mainly depends on underground subways (Mayor Rob Ford's new subway plan). A lot of factors are impacted based on this decision. As will be shown in the following sections, LRT's have a much quicker construction timeline, cost much lesser to construct, have a lower physical construction impact on neighborhoods and can reach a farther demographic and deliver services to more people for the same amount of resources when compared to subways. There are several issues behind this decision, all

of which will be investigated during the process of this inquiry. This inquiry shall address the views of all of Toronto's citizens, ranging from the upper echelon who can afford their private luxury transportation to the lower income citizen who is forced to rely on public transit due to the high cost of private automobile ownership. Also included are the socially and environmentally conscious citizens who choose to take transit out of free will since it suits their needs and belief system. This transit system was constructed to help all of Toronto's (see Toronto's vast and growing skyline in Fig. 2.0 below) citizens and any decision taken now and in the future should be analyzed with due respect given to the citizens of Toronto.



Figure 2.0: Toronto skyline at sunset (Source: www.wallpaperbase.com)

4. Anticipated Findings

While being as impartial and scientific as possible, based on my previous knowledge and formal training from my Bachelors in Civil Engineering from the University of Toronto, my work experience at the City of Toronto as a student intern and my experience as a citizen of Toronto, it is clear that Mayor Ford is not acting in the best interest of the TTC's transit system or the average citizen of Toronto. While his decisions do help a small minority of transit users, my initial investigations and observations show that the mayor's plan fails to address the needs of the wider population. As the research will come to prove, the subway model only services a narrow band of citizens, many of whom already have respectable transit service when compared to those living farther out in the suburbs (who would be serviced under the LRT model). Moreover, this new direction in transit planning alienates the low income communities including those in North Etobicoke, Jane and Finch and East Scarborough to name a few. Through this inquiry thesis, I hope to understand why the mayor is supporting this plan, since it alienates the constituents in his home ward – Etobicoke North, who voted very strongly in favor of him in the last election. His proposed plan under serves that particular ward and is geared towards more central areas of Toronto such as Toronto Center and Toronto North.

Regardless of my hypothesis, I shall attempt to conduct this inquiry in the most professional and academic manner. I aim to investigate the real issues and use facts to reach a conclusion.

5. Methods, Results and Discussion

5.1 Overview

When ex-mayor David Miller was running his mayoral campaign in 2006, a key component of his election platform was the TTC Ridership Growth Strategy (Acoba, 2011). This promise led to the birth of TransitCity; a coordinated effort of the City of Toronto and the Toronto Transit Commission (TTC). Prior to this plan, the TTC network consisted of two main subway lines (Bloor-Danforth East West Line and the Yonge-University North South Line) and two smaller subway lines (Sheppard Line and the Scarborough Rapid Transit Line). These transit lines were and currently are the backbone of Toronto's public transit network with various feeder streetcar and bus lines that funnel passengers into these four transit corridors. During both the AM and PM peak rush hours, the transit system is at capacity with daily over-crowding, equipment failures, system slowdowns and traffic queue formation due to the ageing and crumbling infrastructure. The TTC has several stations that are more than 50 years old and in 2008, it was estimated that it would cost approximately \$4B and 10 years to fully restore the system. The TTC spends "about \$400 million a year just to keep the system as it is," says TTC (ex)Chair Adam Giambrone(D'Souza, 2008). While regular maintenance is performed to keep the system at peak performance, the system cannot support the load placed on it during peak travel times (D'Souza, 2008) and the results are easily seen by the public which manifests itself in daily commuter frustration (D'Souza, 2008).

The Transit City Plan called for the formation of 8 new light rail lines (LRT) along priority transit corridors (Toronto Environmental Alliance, 2011). These LRT lines would be integrated with existing transit systems such as bus, streetcar and rapid transit

routes(TTC, 2011). Moreover, it would be integrated with neighboring systems such as Mississauga Transit, VIVA Transit and YRT, thereby providing a more seamless connection for inter-regional commuters. The TransitCity plan also called for the strengthening of 21 key bus routes. These routes were chosen due to the fact that LRT along those lines would be uneconomical given the funding available, yet there was strong demand along those corridors(Lee, 2011). The most logical answer was the improvement of bus service along those lines.

On December 1st, 2010, Mayor Rob Ford was elected as mayor of Toronto in the 2010 municipal. A key part of his election platform was to “end the war on the automobile” and to “stop spending money on a project we do not need anymore” (Ford, 2011)referring to the Transit City Plan. One of Mayor Ford’s campaign promises was to expand the subway system. He wanted to fund subway expansion over LRT construction and he knew during the campaign that he would be facing an uphill battle in convincing council to support his plan to put an end to TransitCity(Leger Marketing, 2011). He also knew that much of the funding promised by the provincial government would be impacted since it was supposed to help in the construction of “shovel ready” projects such as the LRT lines in the Transit City plan.

5.2 LRT Model (Transit City)

5.2.1 Public Opinion

Based on the recent Leger Marketing Survey (Leger Marketing, 2011)conducted via the internet in January 2011, the LRT plan (Transit City Plan) has a 40% public approval rating in Toronto. The sample size for this survey was 550 people. During Mayor Miller’s time in office, this plan had gotten council approval, the TTC’s blessing and

provincial funding. The construction for the LRT lines had already started during the 2010 mayoral election. During the time of the election, 65% of the polled public approved of the Transit City Plan and thought it was an effective step forward, while only 18% of the polled individuals thought it was a poor step forward. The remainder of people were undecided on the effectiveness and benefits of the plan. Additionally, this survey determined that the majority (89%) of people thought that just because a new municipal government is elected into office, transit plans should not be changed in order to maintain continuity and uniformity across governments. Moreover, 44% of those surveyed support the LRT as a technology, however would like to move the LRT system underground as to not interrupt pedestrian and road traffic above ground. Lastly, an astounding 90% of those surveyed feel that smart transit planning is done for the long term and should not be frequently changed and updated(Leger Marketing, 2011).

5.2.2 Facts and Figures

The Transit City Plan was split into two phases and was calling for \$8.73B for the construction of 52 kilometers of LRT lines in Phase I and an additional \$1.83B for the 23 kilometers planned in Phase II. (See Fig 3.0 for a visual representation of the Transit City Plan). The bulk of the costs were in the initial phase due to the complicated underground construction associated with that particular phase which was lacking in Phase II (Lee, 2011). Until the 2010 mayoral election, \$137 million had already been invested into the Transit City Plan and \$1.38B in contracts had already been signed. The city had already ordered 182 LRT train cars to service the lines. This plan was a hit in the council chambers and amongst the public, “And this system, this light rail system would actually allow these communities have better access to jobs and better access to the heart

of the city, the heart of downtown, so that they could grow and become more developed and hopefully get out of under-served allocated neighborhoods,” Jessica Roher – Coordinator for the Scarborough Civil Action Network (Lee, 2011). Moreover, as an example, during the debate for one of the transit lines in TransityCity – The Finch Weest Light Rail Line, council approved it by an astounding 31:5 - with 9 councilors absent (City of Toronto, 2011). Then councilor Rob Ford voted against this item.

The LRT plan resulted in a cost of \$111M per kilometer constructed whilst serving an additional 630 000 compared to the existing transit system (Toronto Environmental Alliance, 2011).

Recently, the Pembina Institute, a not-for-profit Canadian think tank, strictly focused on developing sustainable and innovative energy solutions released a report titled Making Tracks to Torontonians. This report focused on analyzing the steps Toronto is taking to improve its transit system. The Pembina Institute found that with the Transit City Plan, the eight proposed LRT lines would bring 290 000 more Torontonians within 500 meters or a six minute walk of a rapid transit strain, whereas Mayor Ford’s subway plan would only bring such access to 61 000 additional people (The Pembina Institute, 2011). A key setback for the LRT system is that the public compares and confuses LRT with the existing slow and cumbersome streetcar network. While both types of vehicles travel on rails and can be in mixed traffic, the differences between LRT and streetcars are vast as LRT vehicles are must faster, cost about a third of subways in terms of construction costs and can serve more people than both subways and streetcars(Lee, 2011). Moreover, LRTs usually operate on dedicated Right-of-Ways, making them much faster and more reliable than streetcar designs. The LRT plan would serve a vast array of neighborhoods

including: Scarborough, East York, York, Etobicoke, Old Toronto, Pearson Airport and North York. Moreover, would also connect 45 000 low income people and serve an estimated 126 million trips annually (The Pembina Institute, 2011). The LRT lines would also bring service to six times more low income residences than comparable subway lines since more kilometers of rapid transit can be constructed when compared to subway. This is due to the approximate 66% reduction in initial construction costs of LRT over subways allowing for more built infrastructure(The Pembina Institute, 2011). Additionally, the proposed LRT lines in Phase I and II have been planned to be in accordance with the broader transit strategy outlined in the Big Move Plan(The Big Move Plan, 2008); a comprehensive provincial plan that outlines the transit planning model for the Greater Toronto and Hamilton Area. As part of the Big Move Plan, the Province of Ontario already provided funding for 4 LRT lines in Phase I of the Transit City Plan in early 2009. The 126 million rides served by the first Phase of Transit City would result in 120 – 140 million cars removed off the roads annually resulting in a reduction of an estimated 201 000 tonnes of CO₂ by 2031(The Pembina Institute, 2011).

Quick facts about LRT systems(The Pembina Institute, 2011):

- a. Not the same as the existing street car network - more similar to above ground subways than the current TTC streetcar network.
- b. Does not block traffic as with the current streetcars. LRT has dedicated ROW unlike streetcars and busses and is separated and independent of street traffic
- c. Faster than streetcars: LRT travels at 25 to 30 km/hr, subways travel at 30 to 40 km/hr while streetcars and busses average at 10 to 20 km/hr.

- d. Increased capacity when compared to streetcars, however not as much capacity as subways: LRT capacity = 25000 people/ hr, streetcar capacity = 10 000 people/hr, subway capacity = 40 000 people/hr
- e. Very popular in other cities including San Francisco, Amsterdam, Paris, Madrid
- f. LRT has increased frequency when compared to subways due to shorter trains and shorter headways. Moreover, the resulting train setup is cheaper to purchase due to the inexpensive transit units.

A key argument for the use of LRT lines over subway lines in Toronto is that apart from the already established cores, Toronto does not have dense enough populations to necessitate subway construction. LRT peak capacities are approximately 15 000 passengers per hour while subways are nearly double at 30 000 passengers an hour at peak capacity. Based on the Transit City Phase I plan to construct the Sheppard LRT, Eglinton Crosstown LRT, Finch LRT and Scarborough LRT with projected 2031 ridership levels at 3 100, 7 800, 4 500 and 6 400 respectively. Any subway implementation along these corridors would result in an overinvestment of infrastructure and result in inefficient spending and planning.

5.3 Subway Model (Rob Ford's Plan)

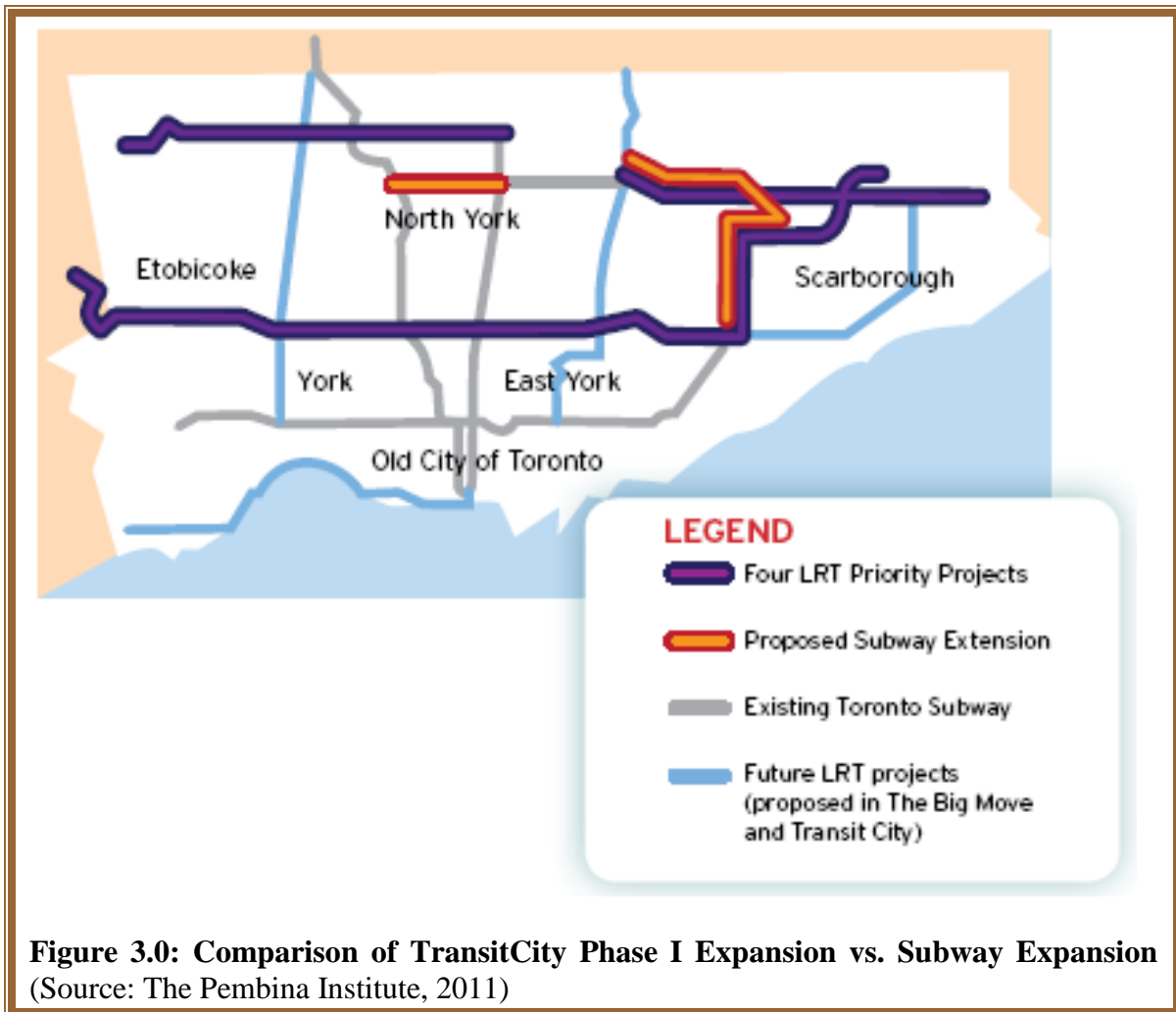
Based on the previously mentioned Leger Marketing Survey, Mayor Ford's proposed plan had a slight edge over the Transit City Plan by capturing a 44% public approval (Lee, 2011). This plan would cost an estimated \$6.2B for the 18 kilometers of subway(The Pembina Institute, 2011). This cost does not include additional costs such as vehicle purchases, yard improvements and auxiliary costs, but rather only reflects the construction costs. Moreover, this particular model would funnel passengers from the

periphery into the existing networks thereby increasing the demand on the existing and already stressed subway network, resulting in further money required to retrofit those lines and stations(The Pembina Institute, 2011). The resulting per kilometer construction cost would be an estimated \$344 million per kilometer while serving only a paltry 61 000 additional people compared to the existing system(The Pembina Institute, 2011). Compare this with an additional 630 000 more people who would be served under the Transit City Plan (a 10X increase over the subway model). Additionally, the subway model would only service the Scarborough and North York areas and would only connect 7 200 additional low income residents to the rapid transit network and serve 65 million annual estimated trips. This would result in the removal of 60 000 to 70 000 cars annually from Toronto's streets yielding a reduction of 75 000 tones of CO₂ emissions by 2031 (The Pembina Institute, 2011).

One key benefit of subway construction is that it will not eat into surface space, resulting in the removal of lanes from existing road traffic. While elevated LRT is a potential option for Toronto, it was not involved in Transit City's plans due to the obvious cost savings of surface LRT (The Pembina Institute, 2011). However due to the nature of subway construction, the physical infrastructure would require larger clearances, resulting in larger areas of land used for underground construction. This is primarily due to the larger curve radii associated with subway travel. This results in bulkier and more expensive construction underground. Additionally, subways require giant parking facilities since subways usually promote users driving into central zones to take the rapid transit to their destination. These structures could be placed in the periphery, or the core of the city, depending on the details of the transit planning, however in either alternative,

it would result in vast amounts of land being used for parking, resulting in even more parking space (which is one of the most ineffective uses of land in an urban environment). Moreover, as recommended by the recent KPMG report, the City of Toronto is planning on selling vast amounts of existing infrastructure, which includes TTC parking lots as a cost-saving measure (Core Services Review, 2011). Constructing new parking to support new subway infrastructure would be counter productive. The alternative is to use dirty diesel or inefficient and cumbersome streetcar vehicles which would again result in pollution and congestion on street level. Another key issue with the subway model is that by nature, subways are optimal for point to point travel. Due to their immense construction costs and high capacities, it is inefficient to build subways into a grid network thereby restricting interlining. Subways are best utilized when they serve as central trunks, ferrying large amounts of passengers along a central corridor (Bunker et. al, 2010). Even though subways have higher load capacities than LRT systems, they are less cost effective and will provide surplus capacity, which will likely go unused. This over design of load capacities results in subways being a poor solution for Toronto's needs into the year 2031 and beyond. As mentioned earlier in this report, LRT lines operate at a peak capacity of 15 000 passengers per hour per direction and the design demand loads for the proposed LRT and subway lines are in the ranges of 3 000 and 7 000 passengers per hour, a far cry from the 30 000 passengers per hour capacity of subway lines (The Pembina Institute, 2011).

As can be seen in Fig. 3.0, the proposed subway extensions are further loading the already packed Yonge-University-Spadina North-South corridor and will add further traffic to the jammed East-West direction via the Bloor-Danforth corridor.



5.3.1 Capacity Comparisons

One major consideration in deciding which transit type is optimal to support the needs of Toronto into the next few decades is the operating capacity of the vehicles in use. This capacity must be closely matched with the transit demand of the citizens using this system, over capacity would result in inefficient design and under capacity would result in over-crowding and inadequate transit planning. Capacity is determined by two factors: how many people can fit comfortably on a given vehicle and how many such vehicles can pass a given point in the system in an hour (Toronto LRT Information Page, 2011). This

issue is also related to the train size and the minimum headway between trains. Subway (heavy rail) trains can usually hold 1500 people at once while LRT can hold 350 if above ground and 875 if the LRT is in an isolated system underground. This translates to a capacity of 36 000 ppl/hr, 5000 – 7800 ppl/hr and 26000 people per hour respectively for subway, above ground LRT and isolated underground LRT (Toronto LRT Information Page, 2011). While subway construction appears to be very attractive due to its massive capacity, based on the Leger Marketing Poll, the average citizen (and it seems Mayor Ford is included in this group) fails to understand that the proposed subway routes will not have the demand to support the capacities that the subway system offers even after the year-2031 construction timeline (Leger Marketing, 2011). The Sheppard LRT, Eglinton Crosstown LRT, Finch West LRT and Scarborough LRT are projected to have a peak ridership of 3 100, 7 800, 4 500, 6 400 passengers per hour respectively during crush capacity period (rush hour). This pales in front of the 30 000 crush capacity of typical subway lines. Based on the predicted transit demand, a more realistic goal would be to use LRT's at an average capacity of 15 000 passengers per hour(The Pembina Institute, 2011).

5.4 Funding Issues

One of the main factors driving discussion about transit expansion in Toronto is the fact that Toronto faces the worst commuting times amongst 19 international cities which include Calgary, Los Angeles, London and New York. A recent study by the Toronto Board of Trade found that Torontonians commute on average for 80 minutes daily with that number only rising with time (O'Toole, 2010). The higher level governments have acknowledged this issue and have already committed large sums of money towards

furthering transit's reach within the GTA. So far, the provincial government has already promised \$7.2 B for the construction of the Finch West, Eglinton Crosstown and Scarborough RT upgrading plan under the Transit City Plan. Additionally, the province has given a further \$613 M for the Sheppard East LRT and the provincial government has promised to fund two-thirds of the Transit City Plan (Lee, 2011).

Much of the above mentioned transit funding promised by the upper-level governments have been channeled via the Metrolinx – MoveOntario 2020 plan. Since Mayor Rob Ford's new subway plan drastically changes Toronto's transit plans, this funding could be retracted since it may not meet provincial requirements (Lee, 2011). Moreover, \$137 M has already been invested into TransitCity under the Miller government and \$1.38 B in contracts have already been signed. Orders for 182 LRT cars have already been placed, an order that would have to be retracted under Rob Ford's new proposed plan which primarily relies on subways rather than LRT's. Based on the data presented above, Phase 1 of the Transit City Plan would be less than half the construction cost of Mayor Ford's proposed subway extension plan. Cancelling the LRT lines would result in Torontonians having lesser public transit access and will have to wait much longer till reliable rapid transit service arrives at their door step. Even under ideal circumstances, Mayor Ford's plan would require new environmental assessments, design processes and contract tendering. Each of these steps takes several years (Metrolinx, 2008) resulting in a major setback towards getting Torontonians moving smoothly again towards reducing their commuting times.

5.4.1 Cost Comparisons

Throughout the lifecycle of a transit project, depending on the type of project, construction costs are usually the largest cost for rapid transit. This does not hold true for low cost transit such as busses since the greatest cost is the ever-rising cost of fossil fuels(International Energy Agency, 2002). However, in the Subway versus LRT debate, both types of transit use electricity as the energy source and the primary differences between the two types of transit are operation costs, construction costs and maintenance costs.

5.4.2 LRT Costs(Source: Toronto LRT Information Page, 2011)

Underground Construction: \$130M to \$225M per kilometer

At Grade (in Concrete) Construction: \$50M to \$60M per kilometer

At Grade (with ballasted ties) Construction: \$30M to \$40M per kilometer

Table 1.0: Planned LRT expansion cost comparison

| Proposed Line | Cost Per Km (millions of \$) | Total Kilometers | Total Cost (billions of \$) | Explanation |
|-----------------------------|--|------------------|---|--|
| TransitCityEglintonCrostown | 55 for surface sections 260 for tunneled sections | 33 | 4.6 | Servicing area from PearsonAirport in the West to Kennedy Road in the East |
| TransitCity Sheppard East | 56.7 | 12 | 0.93 <i>0.316 from province</i> <i>0.317 from Canada feds</i> | Sheppard Road from Don Mills to Morning Side |
| Etobicoke Finch West | 50 for | 11 km with | 1.2 for | Etobicoke area |

| | | | | |
|--|---|---|----------------|---------|
| | Phase I 70.6 for Phase I and Phase II | 20 stops – Phase I 17 km with 30 stops – Phase II | both phases | service |
|--|---|---|----------------|---------|

All Costs are in 2011 Dollars

Other worldwide examples: Denver's T-Rex Project - \$41.5 M/km, St. Louis - \$35.7 M/km and \$21.6 M/km

5.4.3 Subway Costs (Source: Toronto LRT Information Page, 2011)

Underground Construction: \$250M to \$350M per kilometer

At Grade Construction: \$150M to \$200M per kilometer

Table 2.0: Planned subway expansion cost comparison

| Proposed Line | Cost Per Km (millions of \$) | Total Kilometers | Total Cost (billions of \$) | Explanation |
|---------------------------|------------------------------|------------------|---------------------------------------|--|
| Spadina – York Ext | 275.6 | 8.6 | 2.37 (includes 36 subway cars) | Extension from Downsview Station to Vaughan Corporate Centre at Highway 7 and Jane Street. |
| Sheppard East Ext. | 273.1 | 8 | 2.18 | Extension of Sheppard Line from Don Mills to Scarborough Town Centre adding 7 stations. |
| Bloor West Ext. | 270.3 | 3.7 | 1 | Extension of Bloor – Danforth Subway to Queensway and West Mall Area |

All Costs are in 2011 Dollars

Based on Table 1.0 and 2.0, it is clearly evident that subway construction is approximately five times more expensive in the construction stage when compared to LRT. Therefore, for the same amount of funding, LRT based systems can reach a much wider range of transit users and provide greater network access to the TTC's network.

6. Mayor Ford's Perspective

Ever since Mayor Ford was elected in late 2010, his priority was to "end the war on cars".

In a press release (Ford, 2011) issued by the newly elected mayor's office, he said that "It's time to get traffic moving and connect people with jobs." The press release mentions:

"For seven years, City Hall (under the Mayor Miller's government) has tackled Gridlock by declaring war on cars in Toronto. Toronto has eliminated lanes from busy roadways, increased parking charges, ignored roadway repairs and generally made life miserable for drivers. At the same time, the City has paid little more than lip service to transportation alternatives. Toronto has taken an irrational approach to bike lanes - fuelling an emerging and wholly unnecessary battle between cyclists and motorists."

(Ford, 2011)

The press release further mentions that rather than invest in subways, Toronto has decided to build streetcar lines down the middle of major arterial roads (referring to the St. Clair Streetcar Issue). Moreover, the report refers to the Transit City Plan as a looming disaster, as it heavily invests in LRT construction which will take over precious surface area on Toronto's roadways, rather than investing in underground subways which would be tucked underneath Toronto's streets.

6.1 Subways: The Clear Choice

In the official press titled "Respect for Taxpayers", Mayor Ford outlines his proposed plan for public transit in Toronto. The plan provides a brief analysis of subways versus streetcars (which Mayor believes is similar to L.R.T). The press release reads: "Streetcars are slow (average speed: 17km/h) and take hours to travel across town. This limits your ability to live in one part of the city and work in another." However, the analysis makes no mention of how subways fail to create a complete neighbourhood,

rather they create segregated neighbourhoods as they ferry passengers underground away eliminating any interaction people have with their surrounding environment as they are physically isolated from the city. The analysis continues to state that "subways are more reliable, carry ten times as more people than streetcars, move faster and can be scheduled at convenient times. The plan mentions that by 2015, Toronto will (Ford, 2011):

- Construct the Sheppard Avenue Line as a subway line which will include 12 km of new track with 10 new stations (cost \$3B)
- Extend the Bloor-Danforth Line to Scarborough town centre (cost \$1B)
- Use clean busses to fill in service gaps that subways cannot meet due to high cost of subway construction (failing to understand that busses by nature are dirtier than LRT and offer lower capacities)
- Remove streetcar routes downtown to improve vehicle flow (failing to understand that one streetcar carries more than 100 people, while a car on average carries one or two people) and replace the routes with clean busses (which have lower capacity than the existing streetcars and even lesser capacity than the proposed LRT routes).

In addition to the above mentioned transit plans, the city plans on investing \$250 Million to clear the investment backlog in road repairs (primarily focused on fixing the Gardiner Expressway). Additionally, the mayor hopes to improve the road network by maintaining the road network by maintaining the Gardiner Expressway, synchronizing the city's traffic signals, improving surface streets and parking rules. In order to keep bicycles off the roads, the mayor plans to invest \$50 Million to move bike trails off the roads onto unused lands such as hydro corridors.

6.2 Analysis

While the plans outlined in this press release have some valid points, they fail to understand that the pressures placed on this city's transit systems continue to grow as populations grow at a steady pace. Moreover, as any citizen will attest, the investment backlog is far greater than just the Gardiner Expressway, and \$250 Million will only be sufficient for a limited amount of time; till the infrastructure crumbles again. Rather than this short-range answer, it is wiser for the mayor to invest into a longer term solution. In order to be truly beneficial to the people of Toronto, Mayor Ford's plan needs to be for the long term. As mentioned earlier in this report, Torontonians are confusing LRT with the streetcars they see. Based on this press release, Mayor Ford is amongst the people who have fallen prey to this misconception. While subways do have far greater capacities than LRT or traditional streetcars, Mayor Ford's plans demonstrates that he does not realize that based on the projected demand values, Toronto will not need these huge capacities till the next century (well after the design timeframe of this project). Moreover, based on the current expansion plans, subways are being added to funnel people into the already crowded Yonge-University-Spadina Lines (Bunker et. al, 2010). Unless these two lines are upgraded, any further expansion to these lines will be futile. Moreover, while Mayor Ford did not officially mention it in his official plan, it is clear that he still has a bad taste for LRT's after the St. Clair Dedicated ROW issue that plagued Toronto in the recent years (Clarkson and Wesse, 2010). This issue involves converting the existing streetcar route into a dedicated ROW route to ensure quicker and faster transit service on St. Clair Ave. west of Yonge Street. This conversion, while having clear benefits for transit raised a firestorm of controversy from all types of stakeholders ranging from homeowners to the Fire Department. The main issue was the

conversion of a six-lane St. Clair Avenue (3 lanes per direction) into two split 2-lane roadways (east bound and west bound lanes separated by a raised streetcar route. Residents were afraid that they would lose street parking space as one lane would be sacrificed to allow for the streetcar ROW. Moreover, a subway was not cost effective since transit traffic only warranted a LRT model; a subway would have cost billions of dollars while providing only incrementally small benefits (Clarkson and Wesse, 2010). Toronto's council members were also split on the upgrades to St. Clair Avenue as cost predictions and timelines started to grow due to expensive construction delays. Lastly, due to poor planning and an inelegant construction process, the upgrades resulted in large traffic jams for commuter traffic, and crippled the direct vicinity. Residents, commuters and local businesses were all upset due to the lack of efficient planning (Clarkson and Wesse, 2010).

While we can draw some parallels between the St. Clair project and the proposed LRT plans outlined by the Transit City Plan, there are large differences between the two issues. Moreover, as Mayor Ford and much of the people of Toronto mistakenly assume, LRT vehicles are not the same as the existing streetcar vehicles. The proposed vehicles are much closer to above ground subways than any other type of transit. Lastly, the Mayor's proposed plans are incomplete and only offer an end of the pipe solution to Toronto's ever increasing transit woes.

7. Demographics

Note: All population values in this section is obtained from 2008 data, unless otherwise stated

Toronto is a mosaic of multicultural segments. A large portion of the GTA's economic portfolio is based on skilled and unskilled immigrants who have in the recent decades flocked to the GTA. Many of these immigrants were drawn to the GTA due to the perceived economic prosperity, well established social services and most importantly, due to the existing presence of other people of similar backgrounds. Toronto has always been the Canadian vortex of immigration (City of Toronto, 2008). This immigration has resulted in Toronto having 47% of its population from ethnic minorities. Moreover, due to the fact that regional boundaries have recently begun to melt away due to the immense population boom, the immigration has spilled over into nearby municipalities as newcomers see the GTA as one city, rather than just Toronto. As an example, Mississauga, Brampton, Richmond Hill, Markham, Pickering and Ajax all boast high percentages of ethnic minorities at 49%, 57%, 45.7%, 65.4%, 30.4% and 35.6% respectively (City of Toronto, 2008). While not all the people represented in these numbers are new immigrants, a vast majority of them are first or second generation immigrants who are seeking to grow and succeed and are looking for something that they could not obtain in their respective homelands.

As it is obvious to anyone who has walked the streets of Toronto, this city is home to a very diverse community. One in four visible minority persons in Canada resides in Toronto and 22.9% of all of Canada's population resides in Toronto (City of Toronto, 2008). While Toronto's share (amongst the GTA) of visible minorities is steadily decreasing since 1996 as more people move into the nearby suburbs, Toronto still has 52.4% of the GTA's visible minorities (City of Toronto, 2009) and still is the social focal point for most visible minorities in the GTA due to the strong social infrastructure present

in Toronto (City of Toronto, 2008). All of these factors result in a very large ethnic population that calls Toronto home. Moreover, 47% of Toronto's population consists of visible minorities (in 2006), which was an increase from 42.8% in 2001 (City of Toronto, 2009).

As with any new immigrant, reliable transportation is a necessity in their quest to finding a firm footing in Canada's economy and society. Many new immigrants cannot afford automobiles as they have not yet secured reliable, well paying jobs. Many new immigrants rely on public transit as their main and only way of navigating around G.T.A.

7.1 Demography and Transit Planning

Mayor Ford's subway plan consists of a new subway between the existing Yonge Line and the University - Spadina Line on Sheppard Avenue. This new addition would be an extension of the current Sheppard East Subway heading westbound from the Yonge - Sheppard interchange. This link will serve an estimated 1 - 24 % visible minorities (City of Toronto, 2008). The second subway line in Mayor Ford's transit plan involves linking the current Sheppard East subway line southbound to the Bloor-Danforth Line near the Pape Avenue area. This expansion would service an area with an approximate 20% - 35% visible minority population.

In stark contradiction, the Transit City's Plan consists of 4 LRT lines in Phase I (City of Toronto, 2008):

- i. Line # 1: North Etobicoke to University - Spadina Subway and Yonge Subway Lines. - serving a population of greater than 75% visible minority

- ii. Line # 2: Connecting Mississauga via Eglinton Ave to Eglinton West station on University - Spadina Line - serving a population of approx 45 - 50% visible minority
- iii. Line # 3: serving the Scarborough area with a population of greater than 75% visible minority
- iv. Line # 4: connecting Scarborough with the Eglinton LRT line serving a population of between 50% - 75% visible minorities.

Therefore, as it is clear, the four proposed LRT lines serve a much more ethnic population, one that is in need of reliable and affordable public transit. The alternative proposed by Mayor Ford is one geared towards to the well-heeled, non-minority crowds of North York and mid-town. It is clear that the LRT lines would be far more utilized and appreciated than the proposed subway lines.

Additionally, every year the City of Toronto formulates a list of high priority social areas based on its assessment of the area's need for social infrastructure. A high priority area is determined by its income, need for social assistance and overall economic growth amongst other factors (City of Toronto, 2009). Based on the proposed growth plans set out by the City of Toronto's plans for subway expansion, the proposed new subway lines would provide rapid transit service to only 2 - 3 out of the 13 total priority areas set out by the City of Toronto (City of Toronto, 2009). Contrasting this, the proposed LRT lines under the TransitCity plan would provide service to all 13 high priority areas outlined by the City of Toronto (City of Toronto, 2009).

8. Places to Grow

The Places to Grow Act was passed into provincial law in 2005 under Premier McGuinty's Liberal Government. This Act was designed to contain the urban sprawl that was eating away at rural Ontario as developers were converting prized farmland into high value residential units. This resulted in a steady degradation of farmland and natural features around the Greater Toronto Area (Places to Grow, 2006). This Act was given great powers as any major municipal growth plan had to be in accordance with this Act or face immediate repercussions from the provincial government. While Mayor Ford's proposed subway expansion plan is not in clear contradiction of the Places to Grow Act, it is clear that the Transit City Plan's LRT expansion option is better aligned to the Places to Grow Act. Examples of this disparity can be seen in the following excerpts from the Places to Grow Act (Places to Grow, 2006):

- *"Focusing on intensification in specified areas"* - The subway plan will rely heavily on busses to pull transit traffic into the designated subway routes, whereas the LRT lines will create specified "high transit priority corridors" that will promote intensification along lines such as Eglinton and Finch
- *"Reducing dependence on the automobile through the development of mixed use, transit supportive, pedestrian friendly urban environments"* and *"Offer a balance of transportation choices that reduce reliance upon any single mode and promotes transit, cycling and walking"* - Mayor Ford has vowed to relocate the bike trails off the streets and into currently unused lands to give the space back to cars in his effort to "end the war on cars" (Ford, 2011). Moreover, due to the nature of the LRT vehicle (which operates on the surface

streets), the resultant would be a mixed use neighborhood. This is in contrast to Mayor Ford's plan of hiding subways underground and isolating it from the people and neighborhoods involved. Moreover, the heavy reliance on dirty diesel shuttle busses and massive usage of onsite parking results in increased dependence on automobiles and fossil fuels. Moreover, Mayor Ford's plan is dependent on a few subway lines, where as the LRT plan would focus on a total of 8 new flexible LRT lines.

- *"Providing convenient access to inter city transit"* - Mayor Ford's subway plan is only focused on strengthening Toronto's inner city transit and provides no new intercity links. However, the Transit City Plan will connect Toronto with Mississauga in the West, Pickering in the East and Markham / Vaughan in the North via cheaper and more accessible LRT lines.
- *"Encouraging cities and towns to develop as complete communities with a diverse mix of land use, a range of employment and housing types"* - The subway plan only provides two additional lines in the near future and only a few more proposed lines thereafter. In contrast, the Transit City plan calls for 4 new lines in Phase I and 4 more in Phase II. Moreover, all of these lines are to be above ground, resulting in greater interaction with the community while providing reliable, rapid transit. LRT transit clearly provides a more diverse land use with mixed use housing alongside the LRT lines.
- *"Facilitating improved linkages from nearby neighborhoods to urban growth centers, major transit station areas and other intensification areas"* and *"increasing the modal share of transit"*- When compared to the Transit City's

LRT plan, the subway plan pales in performance when analyzed through these goals. The subway plan is heavily focused on a small number of high performing lines rather than a larger number of medium performing lines (as is the LRT plan). This subway model fails to provide the linkages needed among the various parts of the city as it funnels people into a few select points including the existing subway lines. The LRT offers much broader linkages and moves Toronto towards a network like grid. Moreover, it is clear that the LRT does offer the rider more transit options as it covers a broader area, thereby having greater potential of increasing modal share of transit.

9. Policy Recommendations

Based on the outcome of this report I have 3 policy recommendations for the TTC:

9.1 Policy # 1

Transfer all of the TTC's transit planning activities to the transportation arm of the provincial government formally known as Metrolinx. Metrolinx currently operates GO Transit and has until now proved to be a strong transit planner. There have been minimal issues with Metrolinx's transit planning and its expansion initiatives have always been greeted with wide applause from the parties involved. Upon approval of this policy by the Government of Ontario and the City of Toronto, after a fixed transition period, all of Toronto's municipal transit planning should be transferred to Metrolinx. However, all operations and day-to-day operations should still be in the TTC's control as the TTC has the practical experience and the skill-set required to operate the TTC on a daily basis. This is beneficial to both Toronto and to Ontario since Toronto is the focal point of

Ontario's economy. A strong local transit system in Toronto would be in the interest of the rest of Ontario as any economic conditions often echo through Ontario's wider economy. Moreover, Toronto is bound to benefit from the provincial government's expertise and wider access to resources. One of the key benefits of this initiative is that as shown in this particular inquiry, Toronto's transit priorities change based on the four year municipal election cycle. As was experienced with Transit City, when a new municipal government is brought to power, if the priorities shift, all old plans are scrapped and huge sums of money spent in the planning process and contract procurement are wasted. Based on the Leger public opinion poll conducted in January 2011 (Leger Marketing, 2011), 90% of Torontonians want smart transit planning done for the long term and not have it change with each municipal government. Moreover, when the responsibility shifts to the provincial government, the province will be more eager to fund such projects as it directly involves their reputation and bottom line. Also, they will be motivated to put heavier pressure on the federal government for additional funds; pressure that a municipality cannot assert. Lastly, if done on a wider scale, Metrolinx will be able to plan the GTA's transit systems more effectively and create a better intercity network rather than have each city build a hodgepodge of transit networks to serve those local neighborhoods. Also to be noted is that the planning control should be given to Metrolinx and measures must be in place to remove any control from the politicians. Metrolinx must be allowed independent control in order to avoid the 4-year election cycle issue with the provincial government.

9.2 Policy # 2

Revive the Transit City Plan that was in place prior to the Rob Ford administration. Bringing back this plan will be in the best interest of the people of Toronto, especially those who rely on the transit for their daily livelihoods as their primary means of transport. If done with provincial and federal approval, there is a high potential that all previous proposed funding from the upper level governments would be reinstated. Moreover, this is better than developing a brand new transit expansion plan as all the environmental assessments and necessary approval and planning have already been done and any red tape would be minimized or eliminated as a result. Additionally, this plan would increase the modal share of transit and would help Toronto meet the requirements of the Places to Grow plan. Mayor Ford has painted the Transit City Plan as a plan that is against the automobile. His main selling point for his subway based plan is that his administration wants to "end the war on the automobile". However, he has yet to prove that the automobile is in the best interest of public. Numerous European cities have openly declared a war on the automobile and cities such as London have instituted road tolls or congestion fees in efforts to reduce automobile travel within the urban areas. Bringing back the Transit City Plan would not only help bring transit to the people in greatest need of it, but would also help reduce automobile usage that is highly inefficient and clogging Toronto's surface streets. This plan would help set a healthy balance between automobile and transit usage in Toronto.

9.3 Policy # 3

Develop a social impact analysis framework that would analyze any publicly funded project from a social impact standpoint. Currently all major projects from highway

expansions to sewer extensions are mandated to submit an environmental impact analysis and can only proceed when it is proven that the project respects the environment it impacts. No such requirements are placed on projects to help maintain social balance in the community. The provincial government needs to mandate a social impact analysis and develop a framework that details the required steps and minimum standards a publicly funded project would have to meet in order to get approval to proceed. An accurate set of metrics need to be established in order to effectively quantify the social benefits of any given project. Based on the analysis of the subway vs. LRT debate, it is clear that our governments are failing at ensuring that public money goes to projects that best help the public. Rather, the current way of operation allows bureaucrats and politicians to change projects based on their own agendas and personal opinions, when it is clear that the project is not in the interest of the most number of citizens in the given design timeframe.

10. Summary and Conclusion

From the findings presented in the report, it is clear that Mayor Ford's choice to shift Toronto's transit future away from the Transit City Plan was a poor choice for the residents of Toronto and the neighboring cities. Whether or not Toronto wants to bear the burden, it is the focal point of the Greater Toronto Area. With this great position comes great responsibilities as well, namely, Toronto has to provide the infrastructural leadership and support for the region. In order for Toronto to survive itself, it needs to be well connected with its neighbors and as a result, bear a greater burden of supplying its neighbors with much required infrastructure and taking the lead in any new growth opportunities. While this burden does present an unfair disadvantage for Toronto, it

helps Toronto maintain its lead status in the region and as a result, helps the entire Greater Toronto Area thrive in an ever increasingly competitive economy.

Apart from the need to grow, Toronto's leadership needs to understand the practical considerations of the transportation landscape in North America. Mayor Ford and many of the citizens of Toronto are adamantly refusing to move away from the automobile and into smarter options such as transit. Compared to our European and Asian counterparts, Toronto clearly lacks much needed transit advancements and investments that have allowed those cities to use their land more effectively and productively. As an example, Tokyo's population density is 5.9 people/km² (Tokyo Metropolitan Government, 2011) while Toronto is starting to have land use (rising real estate prices and zoning problems) and transportation issues with a meagre 3.9 people/km² (Census Canada, 2008). Perhaps, part of that reason is the fact that automobile ownership is only 0.521 vehicles/household in Tokyo (Worsley, 2007).

It is clear upon completing this inquiry that it is very easy for newly elected governments to alter current policies based on their personal belief systems and agendas. Based on the data presented in this report (based on Leger Marketing Surveys) it is clear that the people of Toronto prefer that major capital projects continue uninterrupted as new governments come to power. Stronger legislation needs to be enacted to prevent such major overhauls in capital projects. This is of particular importance since such projects have long pre-planning phases and have lasting and pronounced impacts on the average citizen. Moreover, such changes usually are very expensive as contracts, designs and timelines are committed to at these later stages.

11. Further Research and Shortcomings

This inquiry was based on the comparison of the proposed subway model to the existing LRT model. However little thought was given to the analysis of the LRT plan itself. It is likely that there is more optimal design for the TTC that does not involve Mayor Ford's design or the Transit City Plan. However, due to the limited resources and lack of sufficient transit engineering capabilities, it is difficult to provide a new, independent design that would be a better solution to Toronto's future transit needs.

While great emphasis and effort was given during the research stages to keep this report as unbiased and scientific as possible, being an undergraduate student who majored in Transportation Engineering (having lived in a dense urban city such as Toronto) certainly has influenced my own personal beliefs. I myself strongly believe that Toronto's only solution for the future is to transition away from the automobile into mass public transit. There is a chance that this personal belief has impacted my scientific judgement and choose a position that opposes Mayor Ford's "end the war on the automobile" stance.

As a result of the today's economical and political environment, it is difficult to judge which government will be in power through the next few election cycles. Which ever solution the future governments choose, I hope that Toronto will be able to move itself back into the lead position it once commanded. As an engineer, and a citizen of Toronto, I hope this city can once again build a transit system its citizens need and deserve to be a true world leader.

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