3. Scarborough RT Alternatives

3.1 Potential Technologies

Recognizing that the purpose of the study is to develop a strategic plan for the Scarborough RT that results in service which is comparable to or better than the present Scarborough RT service, the range of potential technologies is limited to those that provide improvements over surface transit operating in mixed traffic. These include:

- Replacement of the existing fleet of Scarborough RT vehicles by a larger fleet of, more or less, identical vehicles or the acquisition of longer Scarborough RT vehicles similar to those now used in Vancouver,
- Conversion of the Scarborough RT route to bus rapid transit (BRT) or light rail transit (LRT),
- Construction of alternate BRT or LRT service in exclusive right-of-ways on surrounding streets, and
- Replacement of the Scarborough RT by an extension of the Bloor-Danforth subway from Kennedy Station, either using some segments of the existing right-of-way or on a completely separate alignment.

For the various technologies, there may be differences in the number and location of intermediate stations between Kennedy Station and Scarborough Centre.

3.2 RT Technology

As noted in Chapter 1, the original RT vehicles are no longer manufactured. Vancouver, the second city to employ a similar technology, originally acquired equipment that is almost identical to the present RT vehicles in terms of vehicle dimensions. Subsequently, however, Vancouver acquired longer Mark II vehicles.

A shorter version of the Vancouver Mark II vehicle that is expected to better conform with present alignment requirements (designated Mark IIA), is presently estimated to be about the same price as the Vancouver Mark II cars, with only about 2/3 of the capacity.

A number of issues are important in this regard.

First, acquisition of the longer Vancouver cars would require reconstruction of the curve on the approach to Kennedy Station, a change that would require suspension of service during construction.

Second, increasing train length to provide additional capacity requires lengthening station platforms, not a particularly onerous requirement *except* at the Kennedy and McCowan stations where costly reconstruction would be necessary. Alternatively, increasing train frequency (for both Mark IIA and Mark II vehicles) would also require major reconstruction of the Kennedy and McCowan stations in order to shorten turnaround times. (For the

McCowan station, however, these constraints would be less important if the route is extended to Malvern.)
In other words, assuming sufficient vehicles, under present constraints, operating four-car Mark IIA or three-car Mark I trains every 2½ minutes provides a maximum capacity of about 5,300 pphpd. This capacity can be increased by lengthening trains, or increasing frequency, or both.

Expanding capacity with these vehicles, of course, would require additional maintenance and yard facilities, a factor that applies to any of the alternative technologies, as well.

3.3 Light Rail Transit (LRT)

Some explanation and definition of the term LRT is appropriate, particularly as it applies to alignments other than the existing Scarborough RT, as well as to the extension from McCowan station to Malvern where more choice exists. LRT essentially involves steel wheeled streetcars or light rail vehicles (LRVs) capable of operation:

- As single units or multiple unit trains relying on electrical propulsion,
- Within a range of environments including:
  - reserved or partially exclusive lanes on existing streets, and
  - dedicated railway and hydro corridors, or
  - some combination of the above, as well as some portions that involve operation on existing streets within mixed traffic, depending upon the site specific application.

Where LRT operates on existing streets, higher speeds and more reliable service can be achieved through a combination of:

- dedicated lanes with physical barriers that prevent use by automobiles (as, for example, concrete curbs or bollards delineating the LRT lane or lanes), and
- traffic engineering that provides priority for LRT at signalized intersections in order to minimize delays due to road congestion.

Space permitting, two-way, double track LRT operation is fairly standard, either in the centre of the street or in curb lanes. However, unless streets are widened, the use of exclusive LRT lanes reduces the capacity for other vehicles and/or on-street parking. Some street widening may be required at intersections to allow for passenger platforms and, depending upon what restrictions are introduced, for vehicular turning movements.

Generally speaking, a centre lane configuration is preferable from the standpoint of automobile access to local businesses, turning movements, and utility relocation. For two-way operation, centre lanes also reduce installation costs for track and overhead electrification. However, for a centre lane configuration, all passengers must walk across active road lanes.

One example of a centre lane configuration is shown in Figure 3.1. For two-way operation at stations (typically at intersections), passenger platforms are separated by direction on the far side of the intersection. A typical LRT cross section is illustrated in Figure 3.2 for a six automobile lane configuration. A similar configuration would be used for only four automobile lanes.

Figure 3.1 – Typical Centre Lane Platform Configuration

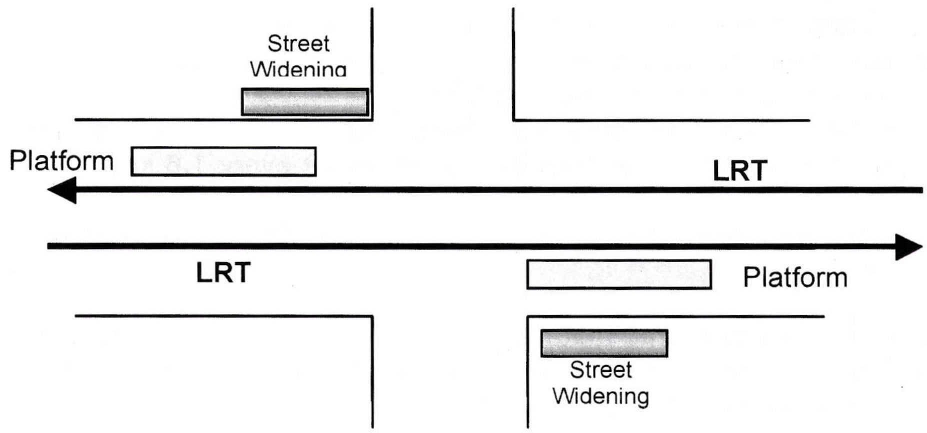
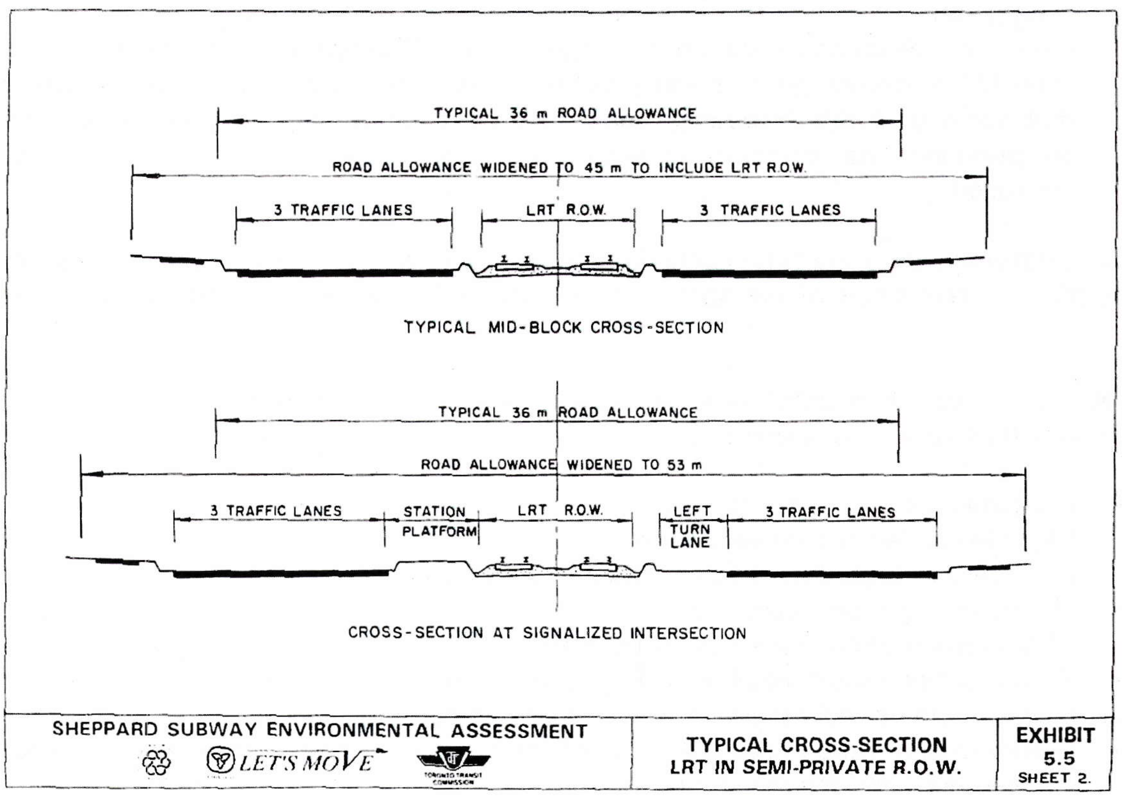


Figure 3.2 – Typical LRT Surface Cross Sections



There is also considerable variability in the type of vehicles pertaining to vehicle length, multiple unit capability, door configurations (one side or both sides), and whether low (street) or high (platform) level passenger loading is envisaged. In this study, low level loading is assumed for a variety of reasons, the most important of which relates to the advantages of procuring vehicles that are, more or less, similar to planned streetcar replacement vehicles. Typical LRT vehicles (examples of which are shown in Figure 3.3):

- are approximately 30 m in length,
- can be operated from either end of the vehicle or train,
- have doors on both sides to facilitate turnaround at terminals,
- obtain power from an overhead wire, and
- require substations (rectifiers and transformers) for the conversion of high voltage AC power to low voltage DC power, about every 1.6 km.

Two car trains, considered reasonable for existing street segments, would require platform lengths of about 65 m.

The main LRT performance measures that influence ridership and transit modal split concern travel times (both absolute and relative to other modes), service reliability, frequency of service, and comfort. In this regard:

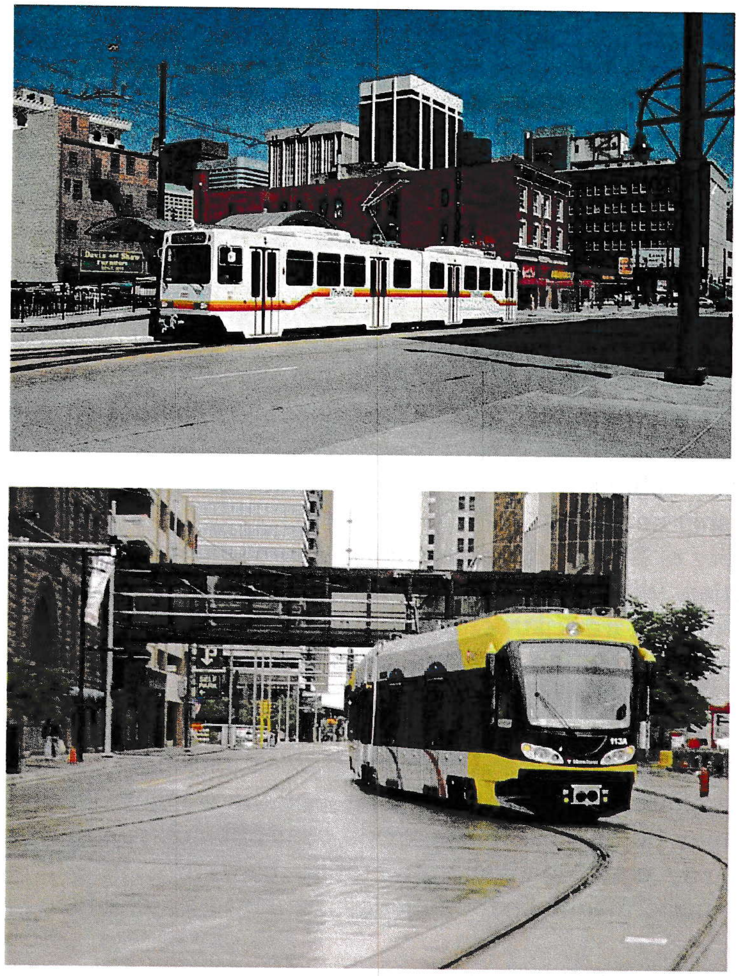
- Travel time depends upon vehicle performance (acceleration, deceleration), estimated stop dwell times, turnaround times, and delay due to traffic congestion.
- Frequency of service is dictated by two factors. The first is essentially a service "criteria" inasmuch as it is independent of demand levels and simply assumes that some minimum frequency consistent with the concept of rapid transit will be provided. As demand increases, frequency and/or train length can be increased.

Fleet size is determined by the total cycle time (including turnaround) divided by the service headway plus an allowance of for spares (about 15 to 20 percent depending upon fleet size).

A number of vehicle manufacturers produce a wide range of vehicles and vehicle configurations that vary with respect to:

- Car dimensions, notably length,
- Multiple unit entraining capability,
- Body design (rigid four axle or articulated bodies),
- Minimum negotiable curve radii,
- Door configurations (one side or both side),
- Placement of control cabs (single or double ended),
- Electrical power collection (trolley pole or pantograph), and
- Power-weight ratios that affect such performance measures as acceleration, deceleration, and maximum speed.

Figure 3.3 – Typical LRT Vehicles



It should be noted that acquisition of LRT vehicles (or any other form of rail vehicle, for that matter) is typically characterized by "lumpy" investments because a premium is paid on small orders. The initial order of cars, therefore, may be larger than needed for operation during the early years of any new service.

3.4 Bus Rapid Transit (BRT)

BRT essentially involves bus operation within a range of environments similar to those for LRT. Vehicles may be more modern versions of the standard city bus, such as low floor, articulated buses that provide higher service capacity. Depending upon service frequency, other local bus services may use segments of BRT facilities, thus, unlike LRT, eliminating the need for some passenger transfers.

As in the case of LRT, higher speeds and more reliable service can be achieved through a combination of:

- segregated lanes with physical barriers that prevent use by automobiles, and
- traffic engineering that assures priority for BRT vehicles at signalized intersections in order to minimize delays due to road congestion.

BRT can also be located in the centre of the street or adjacent to curbs and sidewalks. Unless streets are widened, the use of exclusive BRT lanes reduces capacity for other vehicles and/or on-street parking. Some street widening is usually required at stations to allow for passenger platforms and at intersections, depending upon what turning restrictions are introduced for automobiles.

The major differences between BRT and LRT technologies obviously relate to:

- the vehicle technology, which may have some impact on relative attractiveness and ridership potential,
- the inability of BRT to increase capacity through multiple unit configurations,
- construction within railway and hydro corridors where new paved lanes, as opposed to new track structures would be required, and
- propulsion systems; most LRT requires electrification whereas BRT does not.

In general, BRT and LRT have similar service characteristics in terms of station locations, right-of-way requirements, the need for road widening at intersections, and station configurations. Only the vehicles are different but, because they are generally smaller, higher frequencies may be necessary to provide capacities comparable to LRT. The shorter length of vehicles may also mean shorter station platforms. In addition, there are also minor differences in performance characteristics related to acceleration and deceleration.

Despite these similarities there appears to be a difference in perceived quality of service that may affect ridership. "Stated preference" surveys related to higher order transit carried out in different cities, for example, usually show a preference for rail-based over bus-based service, all other things being equal. In other words, the surveys suggest that an LRT service offering the same frequency, travel time and fare level as BRT would attract more riders[12].

3.5 Subways

An extension of the Bloor-Danforth subway to the Scarborough City Centre has the major advantage of eliminating the need to transfer at Kennedy Station and would, of course, provide a very significant increase in capacity. However, unless every train proceeds to the end of the line (Scarborough Centre), during peak hours, some passengers would have to wait for a "Scarborough" train to avoid having to change trains at Kennedy. In practical terms, this could result in a wait between trains of about 5 minutes instead of 2½ minutes for peak period service on the Bloor-Danforth subway west of the Kennedy Station. During

---

[12] A recent stated preference survey carried out for a proposed LRT service in Waterloo, for example, suggests that LRT would attract seven to eight percent higher ridership.

off-peak periods, there would probably be no need to change trains (on the basis of TTC minimum frequency standards for subway operation).

Aside from very high capital costs, the number of stops would be reduced, probably to one intermediate stop at Lawrence Avenue. In other words, it is unlikely that there would be direct access to rapid transit at the present Ellesmere, Midland, and McCowan stations.

There are two general subway route possibilities, one that uses segments of the existing Scarborough RT route, and another that follows a completely different alignment for terminals at Kennedy Station and Scarborough Centre Station.

Earlier assessments by TTC engineering and more recent consideration suggest that attempting to retain some "salvage" value from the existing Scarborough RT right-of-way and structures is unlikely to save any capital investment and would, of course, involve a significant period of service disruption during reconstruction (probably four to five years).

A subway extension on an entirely new alignment would eliminate service disruption of any consequence (if decisions are made in a timely fashion) and would likely involve one intermediate station (probably at Lawrence Avenue in the vicinity of Brimley and McCowan Roads).

3.6 Summary of Scarborough RT Corridor Applications

For the existing Scarborough RT, potential technologies can be grouped into two categories.

The first group uses the existing route, either in total or in part, and includes:

1) acquisition of replacement Mark IIA or Mark II RT vehicles,
2) conversion of the existing route to a BRT service,
3) conversion of the existing route to an LRT service, or
4) conversion of the existing route to an extension of the Bloor-Danforth subway.

These alternatives require varying degrees of reconstruction and corresponding periods of service disruption (ranging up to three or more years in the case of the latter three).

The second group of technology applications involves new service on *alternate* routes between Kennedy Station and the Scarborough City Centre that are unlikely to involve service disruption of any consequence. This group includes:

1) BRT service on surrounding streets,
2) LRT service on surrounding streets, or
3) Extension of the Bloor-Danforth subway on a completely separate alignment.

These applications, of course, differ with respect to performance characteristics such as capacity, reliability of service, average speed, and costs. Capacity, for example, depends upon frequency of service, the design number of passengers per vehicle, and, in the case of rail vehicles (RT, LRT, and subway), train length.

Average speed and capital costs are dictated primarily by the nature of the right-of-way. Operation in fully protected rights-of-way (as in the case of the present Scarborough RT) permits much higher speeds than can be achieved in shared facilities where transit vehicles are delayed by turning movements and signal timing. However, providing fully protected rights-of-way is considerably more expensive than providing partially segregated or reserved rights-of-way within an existing road allowance.

3.7 Evaluation of Alternatives

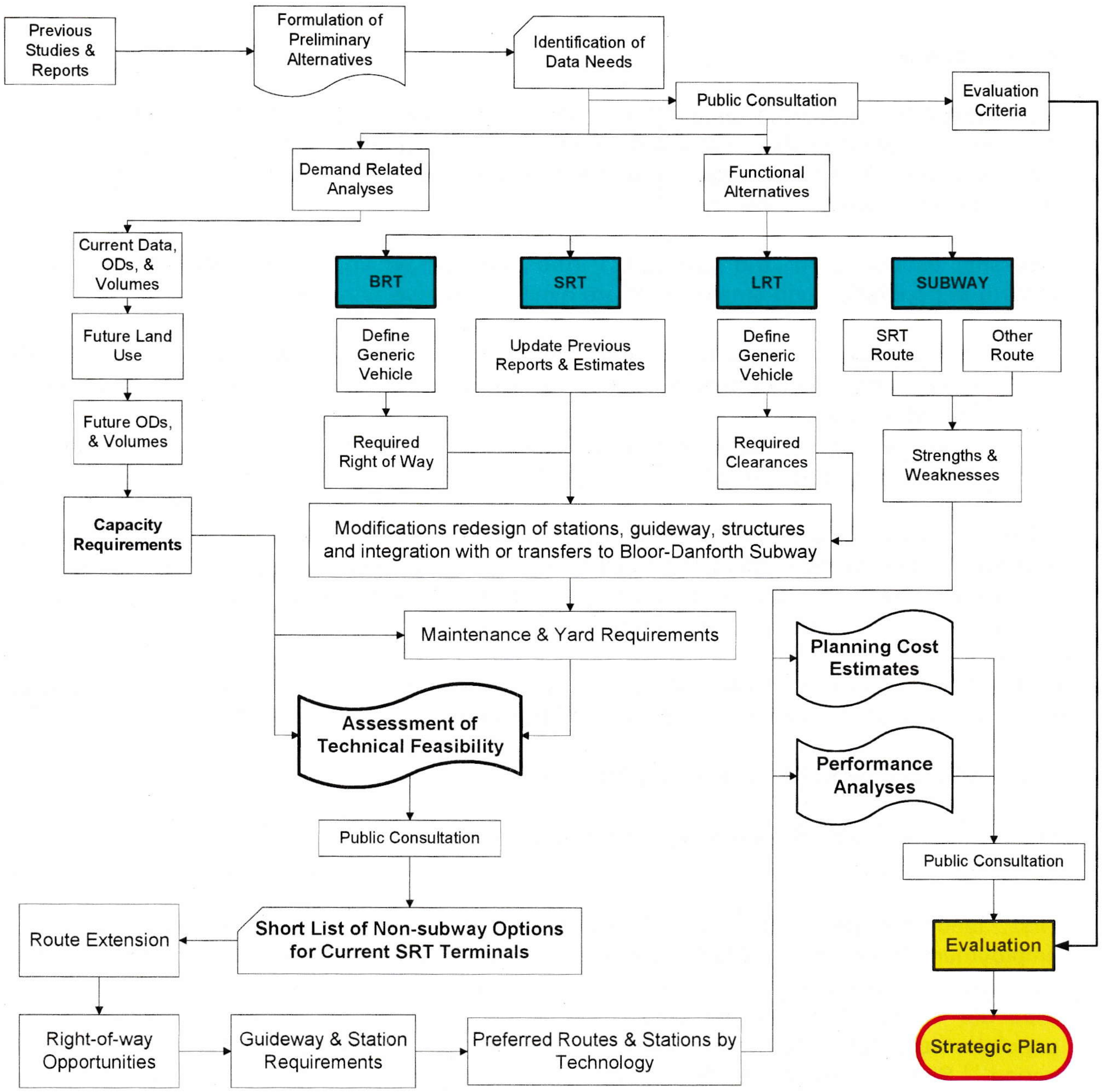
The general approach for evaluating the seven alternatives noted above is shown in Figure 3.4. Two basic stages of evaluation are involved, namely, one in which the broader range of alternatives is reduced to a "short list" based on preliminary screening treated in the next section, the other based on more detailed analyses of the remaining alternatives.

Figure 3.4 also shows two main streams of technical studies, one concerning potential ridership and needs based on land use considerations, as well as implied assumptions regarding general expansion of TTC service, and a second stream that primarily concerns technical feasibility and costs. In this regard, the determination of future capacity requirements, usually expressed in terms of the maximum number of riders per hour by direction is highlighted as one of main criteria that affect preliminary screening.

In addition, public consultation has been an integral component of the evaluation process, involving public information meetings, presentations to the TTC and the Scarborough Community Council, as well as special meetings with representatives of Centennial College, the University of Toronto Scarborough Campus, the Scarborough business community, Scarborough members of the Ontario Liberal Caucus, and individual City Councillors.

These public consultation activities have stimulated considerable public and political interest in replacing the Scarborough RT by an extension of the Bloor-Danforth subway. However, the need for a broader network of higher order transit services covering larger areas of Scarborough was also frequently suggested during the consultation process.

Figure 3.4 – Evaluation Approach



4. Estimating Future Needs

4.1 Introduction

Alternatives for increasing capacity and improving service in the Scarborough RT corridor each have different implications for likely ridership. Estimated ridership, of course, is one of the main determinants of required performance for potential technologies, most notably with respect to design capacity.

Ridership estimates for the year 2021 (the year for which Official Plan projections of growth in population and employment are available) derive principally from:

- projections of population and employment distributions (that is, land use projections) within the area of the City of Toronto affected by the alternatives being considered, and
- characteristics of the alternative transportation facilities and networks that are most likely to affect demand for TTC service and utilization.

All other things being equal, for example, it is reasonable to expect that corridor ridership and the number of new riders attracted to the Scarborough RT will differ for variations in technology, station locations, and level of service (most notably, frequency of service, hours of operation, and average speeds).

Because it is important to understand just how these forecasts are prepared, the following section describes the general nature of the forecasting process used in this study.

4.2 The Scarborough RT Forecasting Process

For the Scarborough RT analysis, a four step procedure has been followed in developing forecasts for 2021.

First, land use projections have been defined based largely on the population and employment forecasts for 2021 embodied in the new City of Toronto Official Plan. It is the distribution of population and employment that defines the "market" from which transit trips are drawn. For any particular area or traffic zone, for example, the higher the population estimate, the greater will be the number of trip origins during the morning peak period.[13] Similarly, the higher the number of jobs in a specific area, the greater will be the number of trip destinations.

Second, for each alternative, service characteristics are defined on the basis of network assumptions (technology, routes, stations, and level of service) that influence travel choices made by individuals.

---

[13] Although travel occurs throughout the day, data collection and forecasting concentrate on the morning peak period where the predominant travel involves the journey to work (or school).

Third, using these data, a travel forecasting model known as the "GTA Model" is used by the City of Toronto Transportation Planning Department to predict the pattern of origins and destinations for all AM peak period trips, associated travel times, the proportion of trips made by all modes for all purposes during the same period, and ridership on particular transit routes and road segments.

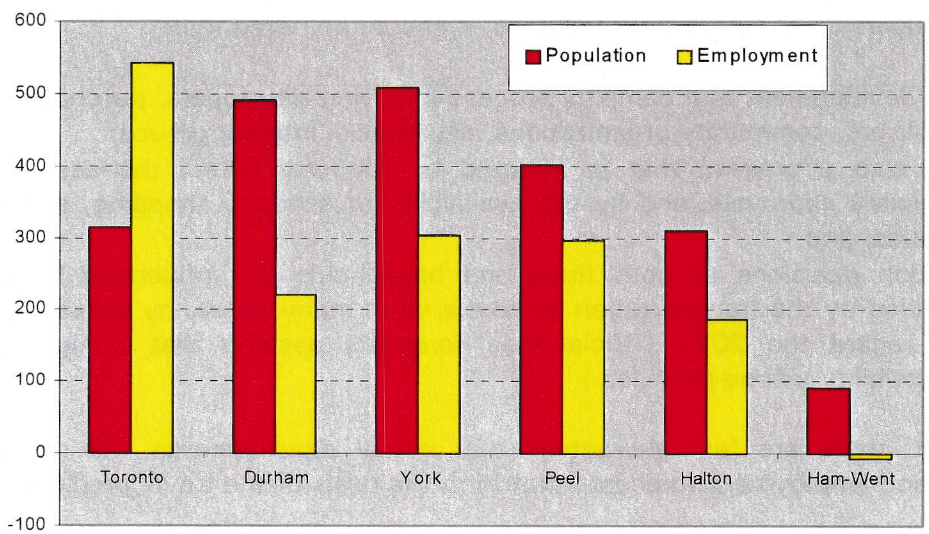
Although the GTA Model is widely used by the City for a variety of transportation studies, there is a general consensus that estimates of trip origins and destinations are more reliable than estimates of utilization or ridership on specific road facilities or transit services. For this reason, the fourth stage involves the use of a different model (Madituc) that is applied within the TTC Service Planning Department to estimate transit use of specific services based on the main origin-destination data produced by the GTA Model.

This process produces estimates of peak period ridership by direction on specific TTC services. These estimates form the basis of establishing capacity requirements and predicting annual ridership.

4.3 Population and Employment Assumptions

Significant effort has been devoted by municipal, regional and provincial government agencies to develop estimates of population and employment growth. For the period 1996-2021, Figure 4.1 shows the estimated distribution of this growth for the GTA regional municipalities.

Figure 4.1 – 1996-2021 Projected Change in GTA Population and Employment (1000s)



These projections, of course, are subject to periodic adjustment. A 1998 analysis[14] of travel trends within the GTA, for example, concluded that:

[14] Data Management Group, *1986-1996 Travel Trends in the GTA & Hamilton-Wentworth*, Toronto: University of Toronto Joint Program in Transportation, March, 1998, p.39.

> .. land use assumptions that underlie recent and ongoing transportation planning activities should be updated to recognize the distinct possibility that Toronto's employment will be substantially below the expected 2011 and 2021 levels. Current estimates of 2011 and 2021 employment in Toronto *and the GTA* represent the highest levels that *might* be achieved, rather than the *most likely* scenario. (emphasis added)

For the Scarborough RT study, the distribution of population and employment used as the basis of travel forecasts derive from the City's Official Plan. Table 4.1 shows the data and forecasts from which the land use estimates have been made for the City as a whole, as well as for Scarborough.

Table 4.1 – Comparison of 2001 and 2021 Population and Employment Changes

Item	2001 (1000s)	2021 (1000s)	Percent Change
City of Toronto Population	2,451	2,800	14.2
Scarborough Population	563	659	17.1
City of Toronto Employment	1,454	1,719	18.2
Scarborough Employment	217	246	13.4

Figure 4.2 illustrates the growth in population and employment (comparing 2001 actual and 2021 predicted values) within Scarborough based on refined forecasts from the City's Official Plan.

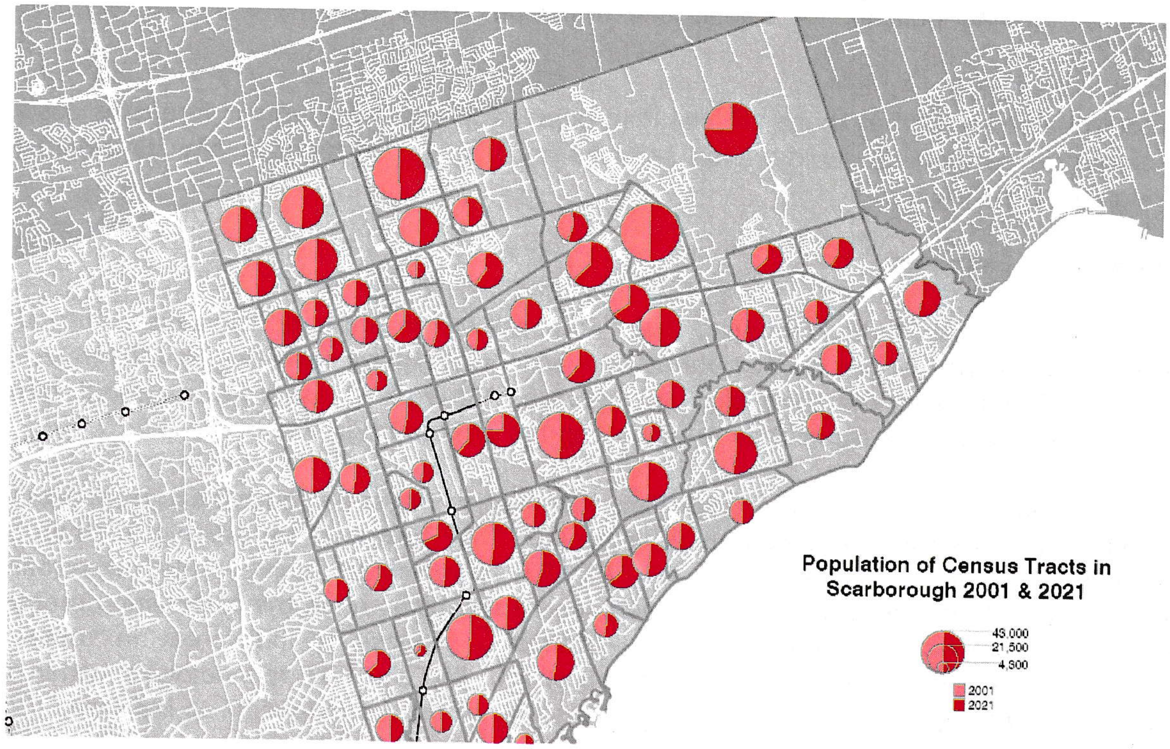
Because these population and employment distributions are so important for the analysis of changes in ridership and peak hour volumes, it should be noted that:

- land development is a complex process involving developers, purchasers of homes, employers, community organizations, and special interest groups,
- it is also a process that is affected by property taxes, the ease of obtaining necessary approvals, and by the availability of schools, shopping, and recreational facilities, and
- location decisions of both firms and households are influenced by accessibility provided by the transportation system and, in many cases, by access to transit. (In this regard the 2021 Official Plan forecasts assume that a high level transit accessibility will be provided.)

As a result, there are few guarantees that actual developments will conform to the population and employment forecasts that form the basis of the travel predictions.

Similarly, as noted previously, forecasting models generally assume that current travel behaviour will remain the same in the future. However, behaviour could well be altered by changes in pricing and cost recovery policies (such as reductions in transit subsidies or the introduction of road pricing), environmental policies aimed at reducing greenhouse gas emissions, and economic changes that affect employment and automobile ownership.

Figure 4.2 – 2001/2021 Population and Employment Estimates for Scarborough by Census Tract



At this time, there is little or no agreement as to what GTA-wide transportation improvements and changes are likely to be in place, particularly in view of changes in provincial funding policies for transit and municipal roads that were introduced around 1998.[15]

It should be stressed that these Official Plan population and employment forecasts assume an extensive network of rapid transit services and mixed use high density developments throughout the City.

4.4 Ridership Estimates

Using the GTA and Madituc models, 2021 forecasts were prepared for seven alternative networks involving various combinations of transit technology for Sheppard Avenue, the Scarborough RT, and the extension to Malvern. Network 1 assumes no rapid transit improvements are made other than re-equipping the Scarborough RT.

2021 forecasts of Scarborough RT corridor ridership for the seven alternative networks are tabulated in Table 4.2 and compared in Figure 4.3. "RT" refers to the existing Scarborough RT technology. In all cases where RT/BRT/LRT is indicated, comparable performance characteristics (e.g., frequency and average speed) are assumed in the forecasting process. Thus, for example, in Network 5, the estimating process is indifferent in terms of performance characteristics between the use of RT, BRT, or LRT technologies within the existing Scarborough RT corridor, Sheppard Avenue, or for the extension to Malvern.

The first row of Table 4.2 can be considered as the "base" case, that is, the situation in which there are no significant changes in transit service within the study area other than increases in frequency of service that correspond with increases in population and employment as they develop. In this base case, the capacity of the Scarborough RT is increased through the purchase of additional vehicles. Again, it is important to note that the Official Plan land use forecasts for 2021 assume that adequate transit and road capacity will be provided to achieve these estimates.

Figure 4.4 shows a range of forecasts for three networks, namely, the base network (1), an intermediate scenario (network 5) that provides additional higher-order transit within the Sheppard corridor and the proposed Malvern extension, and network 7 which includes both the Scarborough and Sheppard subways. These estimates have been extrapolated to 2031 in order to provide a general picture of likely ridership over the next 25 years.

In this figure, current demand is estimated at about 4,500 pphpd, about 500 more than can actually be carried with the existing fleet of vehicles. The three examples shown in

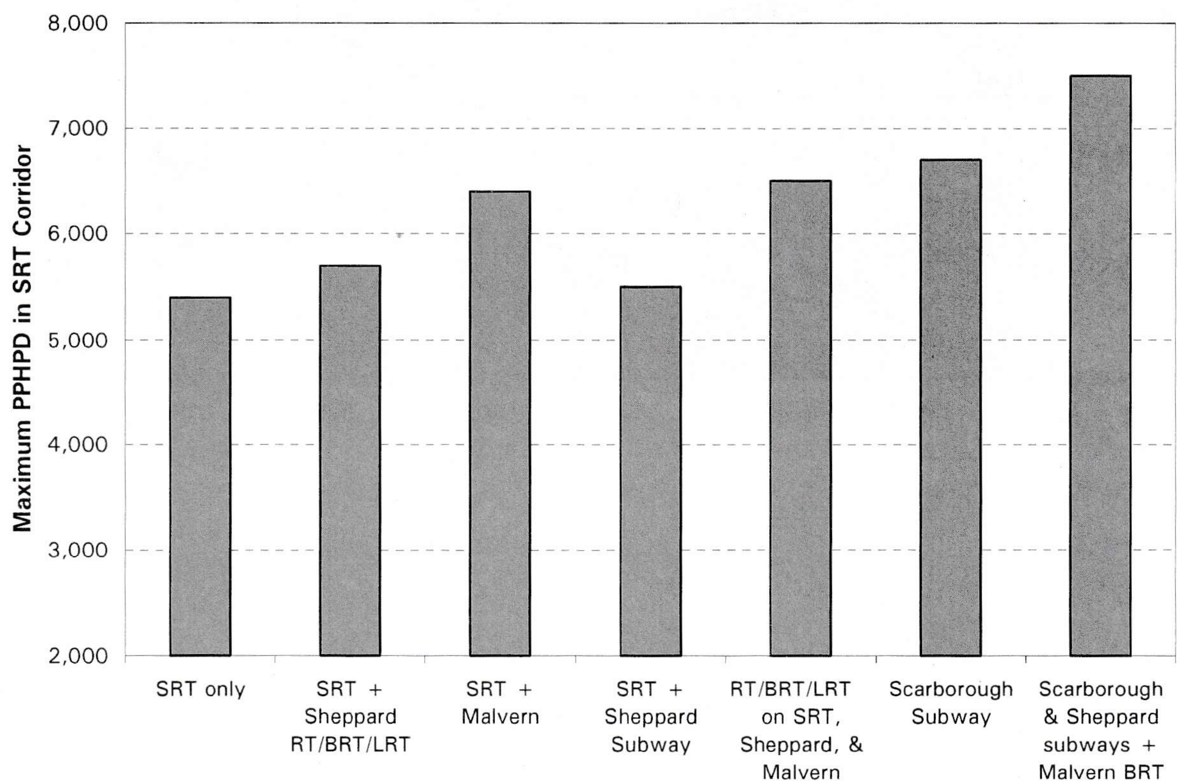
[15] During the previous 25 year period, Ontario's *Municipal Transit Program* provided subsidies that covered up to 75 percent of capital investment and 50 percent of operating losses based on a cost recovery target for the TTC of 68 percent. (In other words, the provincial government subsidized 16 percent of operating costs).

Figure 4.4 essentially estimate what ridership would be if there were no capacity limitations due to insufficient vehicles.

Table 4.2 – Summary of 2021 GTA Model and Madituc Forecasts

Network	Technology Assumptions			SRT Corridor Ridership
	SRT	Sheppard Corridor	Malvern Extension	Maximum pphpd
1	RT	no change	none	5,400
2	RT/BRT/LRT	RT/BRT/LRT	none	5,700
3	RT/BRT/LRT	no change	RT/BRT/LRT	6,400
4	RT/BRT/LRT	Subway	none	5,500
5	RT/BRT/LRT	RT/BRT/LRT	RT/BRT/LRT	6,500
6	Subway	no change	none	6,700
7	Subway	Subway	BRT	7,500

Figure 4.3 – Comparison of 2021 GTA Model and Maditus Forecasts



These data are required primarily to asses capacity needs within the Scarborough RT corridor itself (regardless of the technology used). Excluding the alternative that involves construction of both the Sheppard and Scarborough subways (where capacity is not an issue), the most important conclusion to be drawn is that 2021 estimates suggest a capacity requirement of less than 7,000 passengers per hour in the peak direction. In practical terms, prudent planning that allows for growth beyond 2021 suggests that a minimum capacity requirement of between 7,500 and 8,000 pphpd appears appropriate.

In addition, as indicated in Table 4.2, it should be noted that extension of the existing RT to Malvern (network 5) produces corridor ridership estimates that are comparable to estimates for replacement of the Scarborough RT by a subway, illustrating the impacts of network expansion.

Figure 4.4 – The Range of Design Capacity Requirements