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Christine Kirby
Department of Environmental Protection
251 Causeway Street
Boston, MA 02114

**Re: Arborway Study**

**July 8, 2001**

Dear Ms. Kirby:

The Department of Environmental Protection (DEP) is collecting comments on the Executive Office of Transportation and Construction (EOTC) and Massachusetts Bay Transportation (MBTA) determination of infeasibility and project substitution for the restoration of light rail service in the Arborway corridor. Specifically, the EOTC/MBTA has submitted a document which purports the infeasibility of restoring light rail service to Jamaica Plain, from Heath Street to Arborway, and have suggested an alternative in the form of Compressed Natural Gas (CNG) buses.

I wish to submit information to the DEP which will prove that restoration of light rail service is not only "feasible," but that it is strongly favorable from an environmental, operational, and economic standpoint. Restoration of light rail service will allow us to achieve regional air quality standards, but just as importantly, it will result in a great diminution of local pollutants in the neighborhoods and along the streets of Jamaica Plain. Also, the public will be served with a safe, efficient, and highly superior transit system that will increase transit usage and enhance the local economy. From an operational perspective, restoring light rail service can be accomplished effectively in terms of engineering, traffic concerns, and cost. Also, the light rail option offers the best guarantee for compliance with the Americans with Disabilities Act (ADA).

The enclosed information questions and corrects what has been submitted by the EOTC/MBTA regarding light rail service, and will help prove that restoring light rail is, as Webster's dictionary defines it, "feasible:"

> fea-si-ble *adj.* Capable of being put into
> effect or accomplished.

Light rail transit will decrease emission of pollutants (hydrocarbons, carbon monoxide, nitrogen oxides, etc) compared to the bus alternative, not only by decreasing point-of-service emissions (which is obvious), but by resulting in increased transit ridership in the region. Auto-based trips will more likely shift to transit if the light rail option is chosen, as seen in many other cities which have embraced this environmentally friendly and operationally successful transit choice.

Sincerely,

# *Comparative Multi-City Analysis*
# *of Transit Ridership*
# *on Light Rail vs. Bus*

**Prepared by**
**Srdjan S. Nedeljkovic, M.D.**

**July 17, 2001**

**Presented to: Christine Kirby**
**Department of Environmental Protection**
**Re: MBTA Arborway Feasibility Analysis**

**COMPARATIVE MULTI-CITY ANALYSIS OF TRANSIT RIDERSHIP ON LIGHT RAIL VERSUS BUS**

**Table of Contents:**

**LIST OF TABLES AND FIGURES**

## Figure 2: LA Blue Line: Total Operating Cost (LRT vs. Bus)

## Comparative Multi-City Analysis of Transit Ridership on Light Rail vs. Bus

### Introduction

All over the country (and in Europe), cities are choosing light rail systems over bus transportation and improving transit options for their inhabitants in a quieter and environmentally cleaner way. Light rail offers an operational solution that allows for high capacity transit with more amenities for passengers, including a more comfortable ride in a state-of-the art system which accommodates people with disabilities. Institution of light rail systems provides a faster and more efficient ride, as these systems often have sections of routes which are in exclusive rights-of-way.

Cities which have instituted light rail service have invariably seen an increase in ridership when these lines replace buses. Not only is this higher ridership evident on the route in question, but the presence of light rail increases usage of buses that access the line, leading to an overall increased ridership on the entire transit system. The evidence is apparent in many transit systems throughout the United States **(Table 1).**

## Evidence of increased transit ridership with rail

For purposes of this review, light rail systems can be categorized as functioning in either exclusive or semi-exclusive transit corridors, or as streetcar routes, which exist in mixed traffic along city streets. As can be seen in **Table 1,** cities which have existing streetcar service (similar to that proposed by the restored Arborway line) include Philadelphia, San Francisco, New Orleans, and Toronto, much of which has been in service for many years. Newer service exists in Kenosha, Memphis, and Seattle, and Portland is inaugurating new streetcar service in July, 2001. In addition, Sacramento and Pittsburgh have streetcar systems. Major new investments in maintaining or expanding mixed-traffic streetcar service are planned in cities such as San Francisco, New Orleans, and Philadelphia.

In virtually all cities which have had new investments in streetcars and light rail service, transit ridership has increased markedly over the ridership which had used bus routes, when these were present. Examples of increased rail ridership which occurred when mixed-traffic streetcars were introduced can be found in Toronto and San Francisco, whereas in Philadelphia and Boston, decreased ridership was seen when streetcar routes were converted to bus lines. Philadelphia is now in the process of restoring light rail service along one of its suspended streetcar routes.



Cities which have created new light rail corridors have also seen increased ridership on these lines, much greater than the ridership when these routes were serviced by buses. Recent examples include Dallas, St. Louis, Los Angeles, and Denver. In many cases, usage of the entire transit system increased with the opening of the rail line. Although these types of systems differ from the Arborway situation in that they run along dedicated rights-of-way, their example serves to confirm that there is a mode preference by riders, invariably prefering light rail to buses.

### *Cases where ridership grew when streetcar lines replaced buses*

*Toronto*

Toronto has recently made efforts to maintain and enhance its extensive streetcar system, having not closed any lines since 1974. In 1990, a new streetcar line (604 Harbourfront), running from Union Station to Spadina Avenue, replaced a branch of the Spadina bus (77B). Ridership was noted to increase dramatically. By the late 1980s, the 77 bus carried 31,000 passengers per day, whereas even in the winter, the streetcar ridership on this line is now about 38,000 per day. Passenger congestion is actually a problem, as this line services a busy tourist and recreational destination.

Recently, a new line was instituted along Spadina Avenue, replacing bus service (Route 510) in July, 1997, with the service design being much like the old bus route. Transit users have found this line to be more attractive and it has led to higher ridership on this route. Interestingly, the level of service on the Spadina streetcar line is less frequent than the official level of service of the old bus route, but ridership has increased anyway. Also, the connecting Harbourfront line has seen more traffic, as compared to when buses connected to it. (Reference: Steve Munro). After the Spadina line was converted from buses to streetcars in July 1997, ridership increased 7% on weekdays and 15% on weekends. Patrons comment on how the trip is more pleasant than the old Spadina bus weaving in and out of traffic.

Finally, in 2000, a connecting streetcar line was initiated between Spadina and Bathurst Streets, allowing direct service between Union Station to the Canadian National Exhibition Grounds. This new 509 Harbourfront route partly replaced the 121 Front/Esplanade bus, and ridership was noted to increase four-fold on this route! (Reference: Steve Munro).

In Toronto, total annual transit ridership is 410 million, with the most passengers of any line riding the King/Queen streetcar lines (75 million per year).



There are 1701 buses, 248 streetcars, 640 subway cars, and 28 LRT vehicles. The biggest problem seems to be excess ridership on the streetcars, and it cannot be accommodated by the number of vehicles running. On routes in Toronto where bus service temporarily replaced streetcars because of rail reconstruction, ridership was noted to decline. Meanwhile, in Toronto, in contrast to rail lines, many bus routes have seen declines in ridership, leading to cut-backs in service. (Reference: Mike Olivier). The Toronto example clearly shows that running streetcar lines as part of a comprehensive transit policy is feasible in a densely populated major metropolitan area.

Regarding the issue of whether to use new bus technologies, such as CNG buses, the city of Toronto has had experience with these buses and has decided to retire their fleet, with no further expansion of this technology planned. In Ontario, natural gas is a dirty technology, as coal is often used as a fuel which is converted natural gas, giving the gas a high sulphur content. Among the problems associated with CNG buses are:

- The mean time to failure for a CNG bus is 1/2 that of a diesel bus.
- CNG fuel requires large, powerful compression/fuelling stations, such that buses can be fuelled quickly and get out of the depot and onto the road.

- Garages need extensive changes to protect against gas explosions from leaks, which includes replacement of many electrical systems and additional ventilation, as gas tends to pool in pits under the buses.
- CNG buses cannot operate in underground stations.
- The quality of manufacture of some of the component subsystems (notably the tanks) is aimed for vehicles whose expected life is less than 10 years.

The above analysis of Toronto shows how ridership has invariably improved on the newer streetcar lines, whereas boarding numbers are flat or have fallen for many of the bus routes.

*San Francisco*

San Francisco has an extensive system of streetcar lines, and has seen a major increase in ridership with the opening of its newest line, the F line (Market Street) extension, in March, 2000. This line uses historical PCC cars, and usage of the line has exceeded expectations. Projected to carry 12,000 people per day, the line is already carrying over 20,000 per day in its first year of service, creating a need to acquire more vehicles. The route is 5.8 miles long, built at a cost of $30 million per mile, and uses 24 cars (at least 12 more cars are needed). In addition, the new line



seems to be spurring new development and renewal of properties along its route. (Reference: Paul Weyrich). The original section of the F line, which started service prior to the Fisherman's Wharf extension, opened in 1995. Before the opening of this streetcar line, the existing bus carried a volume of 5,400 passengers per day. By 1996, the new F line was carrying 7,800 per day, and by 1998, it was carrying 9,700 per day. Since the new extension of the F line has opened, ridership has increased to 20,000 per day. The planned 3-rd Street line, which will replace the Rt. 15 bus, is expected to carry 75,000 to 80,000 passengers per day, in comparison to the bus line, which now carries about 28,000 passengers per day. (Reference: Peter Straus).

Otherwise, San Francisco has 5 streetcar lines: J (Church), K (Ingleside), L (Taraval), M (Ocean View), and N (Judah). The J line is 4 miles long and primarily runs in mixed traffic with headways every 6-12 minutes, using mainly 1-car consists. There are some low platform stations, but in other areas, passengers board from the street. The K line is 2.7 miles long, with about 2 miles in mixed traffic. It runs in 2-train consists every 10-12 minutes, with platforms in the middle of the street. The L line runs 3 miles in a semi-exclusive right-of-way, using 2-car consists every 6-10 minutes. Passengers board from the street. The M line extends 4 miles, with 2.5 miles in a shared right-of-way. It uses 2-car sets running every 10-12 minutes, and there are no platforms in the shared right-of-way sections. The N line runs 4.5 miles, of which 1.5 are in mixed traffic. Two-car sets run every 10-12 minutes, and platforms are located in the middle of the street. Once again, the San Francisco experience shows that running streetcars in densely populated urban neighborhoods is clearly feasible.

San Francisco's resolve to improve its transit system was manifest by its citizens approving $900 million to fund new rail corridors. The MUNI master plan calls for the following extensions: 2005 – Streetcar lines: E (Embarcadero), F (extension to Fort Mason), G (to Golden Gate Park), and light rail: J (Third Street), 2010 – Streetcar lines: E (Embarcadero, 2 extensions), F (Market St, Wharf, Presidio), and light rail: B (Geary), C (Central Subway), 2020 – Light rail: C (Geneva extension), D (downtown loop). Significant transit-oriented development is anticipated to follow these rail lines.

The recent experience of San Francisco in its opening of new streetcar lines and planning of others shows that ridership increased markedly when buses are replaced by rail. Many of the existing streetcar lines in San Francisco run along narrow rights-of-way with pedestrians, bicyclists, and parked cars sharing the route. According to MUNI, safety concerns in the form of streetcars blocking emergency vehicles have not been raised. (Reference: Peter Straus). The 20 year transit plan for MUNI includes rehabilitation and initiation of many more streetcar and cable car lines, as well as improvements in the heavy rail BART system.



***Replacement of streetcars with buses leads to declining ridership***

*Philadelphia*

There are many examples of transit systems which, over the years, have neglected of abandoned rail routes and replaced them with buses. Invariably, this has led to reduced ridership levels and transit usage. Two notable examples are Philadelphia and the Arborway case in Boston. In Philadelphia, however, a new stimulus has been generated to reverse these past trends, and one old streetcar line, the Rt. 15 Girard Avenue line, is being rehabilitated.

For Philadelphia, as in many other cities, replacement of the streetcar system with rubber-wheeled buses led to a decline in transit usage. In 1954, the PTC (Philadelphia Transportation Company) operated 46 streetcar routes using about 1500 cars, with many of them old (1000) and some of them new PCC cars (500). At that time, the entire PTC system carried 412 million base-fare passengers, about 52% of which were carried on streetcars. Between 1955 and 1957, PTC bought 1000 new buses and replaced the old-style streetcars, reducing the number of streetcar routes to 14. After this conversion (1958), PTC carried only 343 million riders, only about 20% of which were carried on streetcars, which was a decline of 17%,. From 1950 to 1960, the population of Philadelphia only fell 3%, such that the loss of transit ridership was highly disproportional to the population decline. (Reference: Chris Zearfoss).

Another example is seen in the Ardmore busway case, where a suburban trolley line near Philadelphia was replaced by a dedicated bus-only roadway. When this route was converted from old trolleys to modern, air-conditioned buses in 1967 (Rt. 103), ridership dropped 15%. (Reference: E.L. Tennyson, "North American Busway Experience, 1999). Compared to the Media and Sharon Hill routes, which remained trolley lines, the Ardmore bus line was found to attract fewer nonwork trips, result in significantly shorter distances that people are willing to walk to access public transportation, and represent a lower image to its passengers than the light rail lines. (Reference: Tennyson, 1991).

Currently, Philadelphia has 5 streetcar lines existing in its southwestern suburbs, whereas 3 lines servicing North Philadelphia were "temporarily" suspended in 1992. One of those suspended lines, the Rt. 15 Girard Avenue line, is being reconstructed. The five existing lines, which run in mixed traffic, carry about 58,000 riders per day (FY 2000). Meanwhile, the discontinued streetcar routes, which have been replaced by buses, have seen falling ridership since the conversion. The following streetcar ridership numbers reflect service just prior to discontinuation in 1992. While it ran as a streetcar line, Rt. 23 carried 30,000 riders per day, but now the



replacement bus carries 21,300 per day (a decrease of about 30%). Similarly, Rt. 15 carried 17,000 – 18,000 per day while a streetcar line, but now carries only 9,400 per day (almost a 50% drop). Meanwhile, the population of Philadelphia dropped from 1990 to 2000 from 1,580,000 to 1,505,000. Along the Girard Avenue line, the population dropped about 10%. Once again, a disproportionate decrease in transit ridership compared to population decline is evident in a situation where a streetcar route was replaced by buses.

The transportation department of the city of Philadelphia has encouraged restoration of the Rt. 15 Girard Avenue streetcar line. The Girard Avenue line travels in a right-of-way which varies from 34 ft. to 84 ft., and parts of the route have on-street parking. According to the transportation department of Philadelphia, no major safety issues exist with the currently existing streetcar lines. (Reference: Chris Zearfoss). Reconstruction of this line is expected to stimulate investment along the entire corridor, instill a sense of pride in the community, and provide a state-of-the art ADA accessible transportation option for the residents of this part of the city.

*Boston*

In Boston, major losses in ridership have occurred due to discontinuation of the Arborway streetcar line, even though the route was replaced by buses with an equivalent level of service. Since rail service was suspended in 1985, total ridership along this route has precipitously dropped. Meanwhile, this drop does not reflect a drop in ridership or transit usage in the Boston region, as many other lines have seen increases in passengers. The ridership fall along the Arborway route is most likely a result of the mode change from streetcar to bus.

During the last year of streetcar service (1985), the Arborway line carried about 50,000 passengers per day. Currently, the Rt. 39 bus, which is the bus route with the most boardings in the entire MBTA system, carries about 18,000 people per day. An argument is given that many of those “lost” passengers have actually switched their service to utilize the new Orange line, which opened in 1987. Actually, the ridership numbers show that this is not the case, as Orange line ridership on this part of the line is similar to that of the old Orange line, these numbers have remained flat since the new line opened, whereas bus ridership on Rt. 39 has continued to fall.

In 1988, one year after the new Orange line service commenced, the Rt. 39 bus carried 28,000 passengers daily and the final three stations of the Orange line (which are in Jamaica Plain) saw 16,270 boardings. In 1993, the ridership on the Rt. 39 bus had fallen to 17,167, whereas Orange line boardings on the final three stations was stable at 16,339. Overall, over 10,000 trips were lost to transit between 1988 and 1993.



It is likely that these passengers reverted to automobile driving. While transit use was declining in Jamaica Plain between 1988 and 1993, ridership levels were increasing on both the remainder of the Green line (from 157,406 to 166,862) and the Red line (from 129,386 to 139,239).

Both the Philadelphia and Boston examples show that replacing streetcar lines with buses leads to an overall decline in transit ridership in the corridors served. The San Francisco and Toronto experience presents strong evidence that new streetcar routes are more successful in gaining ridership than the bus lines they replaced. The conclusion of these studies contradicts the EOTC/MBTA conclusion that bus service will lead to a higher gain in ridership than resuming streetcar service in Jamaica Plain.

***Examples of new light rail systems inducing increased transit ridership***

Many cities have build new light rail systems over the past 25 years. In most instances, the existence of these rail systems has stimulated increased transit ridership. Some examples of new systems which have led to higher ridership figures are those of St. Louis, Los Angeles, and Denver. Although these lines run mainly on dedicated rights-of-way, describing these examples helps to confirm that a mode preference exists between rail transportation and the use of buses, with the public highly preferring rail.

In St Louis, in its last “all-bus” year of 1993, 40 million boardings and 173 million passenger-miles were recorded. By 1998, after light rail transit was introduced, St.

Louis reported 54 million boardings, up 35%, and passenger-miles were up to 246 million, or up 42%. Operating expense was $94 million in 1993, rising to $188 million by 1998, which is an increase of 25%, but which represents a fall of 7% of operating expense per boarding ($2.35 to $2.18) an a fall of 11% in operating expense per passenger-mile ($0.54 to $0.48). During the same time (1988-1996), average operating expense per bus passenger-mile rose by 8% ($0.54), while operating expense per heavy-rail passenger-mile fell by 21% (to $0.30) and average operating expense per light-rail passenger-mile fell by 6% (to $0.45 per pass-mile). (Reference: Leroy Demery). Not only has the rail system exceeded projections in terms of ridership, but it has stimulated bus ridership as well. Prior to light rail, St. Louis's bus transit system was losing about 2.4 million riders per year. Instead, total transit ridership from 1993 to 1995 climbed by 16.5 million riders, representing a 44% increase. (Reference: St. Louis Bi-State Development Agency). In St. Louis, when light rail opened, 79% of its riders were new to transit, and 9% of riders had no car while 55% owned two or more cars. (Reference: Paul Weyrich).



Between 1996 and 1998, Los Angeles has seen an increase in its annual boarding count of 14%, with average weekday ridership up by 11% while annual passenger-miles increased by 41%. Thus, the system succeeded in capturing more and longer trips, while its operating expense rose by only 3.4%. Operating expense per vehicle-mile fell by 20%, while operating expense per vehicle-hour fell by 18%. Total operating expense per boarding fell by 9.5% while that per passenger-mile fell by 25%, to $0.21. (Reference: Leroy Demery).

The power of rail to draw riders is exemplified by the opening of Denver's light rail extension to Littleton (8.7 miles), which occurred in July, 2000. During its opening, the line carried over 30,000 riders, greatly surpassing expectations. The line is projected to carry 8,500 daily riders and has parking for fewer than 2,500 cars. (Reference: Edward Ruetz, Jr.). In Sacramento, the current light rail system was instituted in 1987. Since that time, from 1987 to 1997, the systemwide boardings for both buses and trains in Sacramento grew from 14.0 million to 26.3 million (an 88% increase). Because of the attractiveness of light rail, ridership on crossways bus corridors has increased. (Reference: Sacramento RT, 2000). A study comparing light rail service to bus service in Sacramento (Thompson's TRB study) found that light rail attracted 60-70% more riders than equivalent bus service. In Portland, the MAX Eastside light rail line began service in 1986. Light rail ridership tripled between 1986 and 1999, and bus ridership went up over 35%. Since the Westside MAX opened in September, 1998, bus and MAX ridership in that corridor increased 137%. (Reference: Portland Tri-Met, 2000). The MAX system carries over 70,000 trips per day, which is an increase of 10,000 trips per day since 1999. It is estimated that this increased ridership has removed an additional 312 cars from traffic per month, in addition to the 22,000 cars the system is removing each weekday. (Reference: Lightrailnow.com).

In Perth, Australia, which is a highly automobile-dependent city of 1.1 million, transit options until the early 1990's included a series of express bus lines. Prior to its opening in 1993, it was predicted that rail would lose patronage from the already existing bus system, since people do not like to transfer from bus to rail. However, in the first year of operation, there was a 40% increase in rail-bus use over bus-only use in the rail corridor, which grew to a 56% increase a few years later. It was predicted that people would never leave their cars for the rail service, since parking and the roadways are so easy in Perth. Meanwhile, even in this auto-dependent city, 25% of the patrons of the new rail line had given up using their cars for the journey-to-work trip in the first year of its operation. (Reference: Newman and Kenworthy).

A measure of success of a transit system is how many "choice" riders it captures, compared to how many "captive" riders use the system. In Atlanta, less



than 40% of MARTA patrons are "captive" riders, compared to more than 70% in Houston, a city without a rail system. A large majority of Houston's transit passengers are from low-income households, compared to roughly 40% in Atlanta. (Reference: Leroy Demery). In Chicago, in Lake County, the mean earnings of rail commuters is greater than $76,000, double the earnings of people who drive to work. (Reference: Paul Weyrich). Fewer people who have the option of driving will choose to take a bus that is held to slow speeds on congested city streets. In Lake County, the mean earnings of rail commuters were $76,000, but the mean earnings for bus riders was less than $14,000. Similarly, in St. Louis, about 30% of transit riders earn more than $45,000, and 25% own three or more cars.

It is widely known that rail transit can stimulate economic development. According to Cervero, average office rents near stations with systemwide ridership were higher by $3 per foot, with lower vacancy rates, higher building densities, and higher overall economic activity, including jobs. In Washington DC, Metrorail is estimated to generate $2.1 billion in tax revenues, 25 million square feet of office space, and 91,000 additional jobs. From 1977 to 1995, the actual development attributable to Metrorail was 25 million square feet. In St. Louis, Metrolink has been a catalyst for economic development, especially for locations within walking distance of stations. Downtown businesses have reported increased pedestrian traffic, and abandoned land is being redeveloped. In Memphis, where a streetcar line was built in the central city, it is estimated that the line is generating an additional $1.7 million in economic benefits annually. In addition, neighborhoods with light rail tend to display a greater sense of community.

***Portland's new Streetcar service***

Portland, Oregon is about to initiate service on its Portland Streetcar (July 20, 2001). This 4.3 mile long line loops in central city streets, and is anticipated to use 5 streetcars run by 13 operators. These are low-floor 3 section articulated cars which seat 30 and are 66 feet long and 8 feet wide. The layout of the tracks is consistent with progressive traffic engineering standards, and accommodates existing curbside parking and loading. Future extensions are possible.

New ridership along this line is expected to reach 5000 rides per day once service is instituted. Implementation of the light rail system, which was done exclusively using local funding sources, has been coordinated with the police and fire departments of Portland, and standard operating procedures are in place should a safety situation arise. No adverse impacts on public safety are anticipated with opening of this line. (Reference: Vicky Diede).



Portland's rail system offers a long-term commitment to excellent transportation with consistent and reliable service, linking established areas to employment centers while attracting new economic growth. The idea is to link neighborhoods with a convenient and attractive transportation alternative while fitting into the scale and traffic patterns of existing areas. The streetcar service will reduce short inner city auto trips, parking demand, traffic congestion, and air pollution, while providing quality service to attract new transit ridership.

**Methodology showing resuming rail would increase transit usage along Arborway**

Various panels and the Federal Transit Administration forecast and measure transit usage by several parameters. One key measure is the "average distance traveled by each passenger," or "passenger-miles." Annual passenger-miles divided by annual passengers ("annual boardings") give average travel distance per boarding (ATD). For most rail lines in the U.S., this statistic falls in the range of 5 to 7 miles. Heavy rail systems tend to carry longer-distance passengers (BART, in San Fransicso, carries an ATD of 12 miles), and commuter rail services carry even longer ATD. Except for commuter buses (such as Boston's "express" buses), the ATD carried by rail is always greater than that carried by buses, as rail services tend to attract a greater proportion of longer-distance passengers. In Portland, OR, the comparative ATD is 5.3 miles for rail and 3.7 miles for buses in 1998.

Average passenger-miles divided by route length gives traffic density, expressed as "passenger-miles per mile of route per weekday." This describes the number of passengers who travel over each mile of the line every weekday. For most systems, this figure falls between 10,000 and 18,000. Portland's system had a traffic density of 12,000 in 1998, whereas heavy rail systems carry even higher traffic densities (BART has a traffic density of 36,000).

To confirm whether a transit line's ridership projections are within reasonable ranges, one can multiply the average traffic density by the route length, then divide by the ridership forecast. The result is average travel distance, which can be compared to known figures. For Arborway, assuming a traffic density of 15,000 and a route length of 5.6 miles, along with an average travel distance of 2 miles, the projected unlinked ridership would be 42,000. An average travel distance of 2 miles is a reasonable assumption, since it is known that 60% of Jamaica Plain users of bus route 39 travel short distances of less than 10 minutes, and that the bus is about 75% empty by the time it reaches Copley. Another way to estimate average weekday ridership is to multiply the route length by the traffic density, then divide by the ATD.



## Other advantages of rail transit: Environmental, Cost, Safety

### *Environmental:*

Rail technology minimizes the impact on the environment and conserves limited natural resources. For most corridors, rail offers the most efficient, safe, and environmentally sound mode of mechanized transportation. A flanged steel wheel rolling on a steel rail is 10 times more energy efficient than a rubber tire rolling on asphalt. (Reference: AORTA).

Studies show that some of the most serious health risks from rubber-based transport are from small particulate matter (PM-10). This is a byproduct of vehicle attrition, wear on tires, and road dust. Extended exposure to PM-10 (particulate matter of 10 microns or less) poses public health risks of chronic respiratory diseases as these particulates bypass the body's natural filtration system more easily than larger particulates and can lodge deeply in the lungs. (Reference: Berwick and Cervero).

Another environmental issue of rail compared to bus transit is that of the creation of petrochemical smog and greenhouse gases. Petrochemical smog is primarily a result of engine emissions including manmade hydrocarbons, nitrogen oxide emissions, and carbon monoxide. Although CNG buses emit less nitrogen oxide than regular diesel buses (16.5 vs 37.3 grams per mile), more carbon monoxide is released from a CNG bus than a diesel. Of course, light rail vehicles do not emit either gas at point of service, as they are electrically powered. Greenhouse gases are those formed by emissions of carbon dioxide and methane. Greenhouse gases are thought to induce changes in seasonal weather patterns and in precipitation that can cause crop damage and rising sea levels. According to the MBTA Booz-Allen Bus Study (April, 2000), CNG buses introduce a high level of greenhouse gases into the environment, especially carbon dioxide (2382 grams per mile), carbon monoxide (12.2 grams per mile), and non-methane hydrocarbons (1.5 grams per mile).

**Table 2: Data from Booz-Allen Bus Study (MBTA, 2000)**

| Pollutants (grams/mile) | Diesel | CNG bus |
|---|---|---|
| Carbon dioxide | 2213.0 | 2382.0 |
| Carbon monoxide | 8.9 | 12.2 |
| Non-meth. HC | 0.17 | 1.5 |



Yet another environmental/public safety issue is that of noise pollution. A CNG bus passing by or pulling away from a stop is louder than either a light rail vehicle or a diesel bus. Noise tests show that CNG buses surpass both diesel buses and industry guidelines for excessive noise (exterior pass-by = 84.5 decibels for CNG bus compared to 80.5 decibels for diesel bus) (exterior pull-away = 86.5 decibels for CNG bus compared to 79.5 decibels for diesel bus). In general, studies find that a 3.0 decibel increase in sound is perceived by humans as being twice as loud.

***Cost:***

Travel demand forecasting and cost analysis is based on passenger-miles, which measures the “work” of the transportation system. Passenger-trips are another measure of travel demand. The attached table, based on 1998 data, shows a comparison of total operating expense, boardings, and passenger-miles, and calculates the total operating expense per passenger-mile. On average, the “no-rail” operating cost per passenger-mile is around $0.60, whereas the operating cost per passenger mile for systems which have rail is about $0.40 to $0.50. Overall, this leads to an annual cost savings in cities with rail of over $800 million **(Table 3).**

The reason for the lower operating costs associated with light rail systems is that rail attracts more passengers than buses, and it provides increased capacity more cost-effectively to transport passengers expeditiously and comfortably. Light rail vehicles provide more passenger space and can be coupled in two car sets. In **Table 4,** it is apparent that in most cases, light rail systems carry a lower operating cost per passenger-mile than the cost for buses. The rail systems which tend to incur a higher costs are in cities which have generally small, stand-alone rail lines. When the line in

Denver was extended to its suburbs, these costs fell. Interestingly, the lower operating cost characteristics of light rail systems that are exhibited in real-world experience have not been well-predicted by planning studies and alternative-analysis comparisons with theoretical bus operations. Finally, according to the Federal Transit Administration, in new light rail systems, operating costs have actually been dropping **(Figure 1).**

Incidentally, according to the Mobility Planning Association of Austin, Texas, the fully allocated total cost of urban automobile transportation, including the work-commute trip and other purposes, is much higher than for bus or rail transit. In the year 2000, the cost per passenger-mile for an urban automobile was estimated to be $1.25 **(See Table 5).** The costs of providing vehicle parking represents one of the highest societal expenses of providing a system based on personal automobile use. For a typical home-to-work trip, the “home” parking cost per vehicle-mile is estimated to be $0.24 (assuming 6000 non-commuter miles per year and 6000 commuter miles per year over 250 days, averaging 12 miles per day). The “central



business district” cost, taking an average of surface and garage parking, is $0.32 per vehicle-mile. At a standard figure of 1.2 passengers per car, that equates to a total parking cost of $0.47 per passenger-mile. (Reference: Lightrailnow.com). These figures base their calculations on a value of $30 per square foot for commercial real estate, a number which is many times higher in the Boston urban core.

For the Arborway analysis, any calculation of operating costs must factor the increased capacity of two-car trains compared to single buses. The approximate maximal capacity of an articulated 60-ft. bus is 84 passengers, whereas the maximal capacity of a 2-car LRV is about 250 passengers. Ten trains per peak hour will therefore carry a maximum of 2500 passengers compared to 15 buses per peak hour, which will carry a top capacity of 1260, or approximately half the amount of the streetcars. For a bus line to handle this much capacity, many more buses would be necessary, raising both capital and operating costs. To achieve the capacity of 2-car trains, bus headways would need to be reduced to impractical levels of every two minutes!

An existing example of the comparison in operating costs between buses and trains exists in the analysis of the Los Angeles Blue Line corridor, between central Los Angeles and Long Beach. Currently, the Blue Line LRT carries 56,225 daily riders, who are served by 20 peak morning trains, 10-off peak period trains, and 19 peak afternoon trains (all are 2-car). A parallel Line 60 bus carries only 26,694 weekday riders, requiring 115 buses. Assuming equivalent ridership, the costs for the bus line were found to be 43% higher than the light rail line **(Figure 2).** To handle the current ridership, alternative bus service would require 482 buses. (Reference: Lightrailnow and LACMTA). Because of cost issues and the general operational inefficiency of buses, the Los Angeles County Metropolitan Transportation Authority voted unanimously to proceed with light rail transit over a BRT busway in the Exposition Boulevard corridor. (June, 2001). Another reason for the choice of rail over buses in Los Angeles was the tremendous number of buses that would have had an adverse impact on other roadway traffic, the risks of collisions with cars from tandem buses passing each other, and the projection that LRT will attract 51,400 daily person-trips compared to 29,000 trips by the BRT alternative. (Reference: LACMTA, Mid-City/Westside Transit/Draft EIS/EIR).

When compared to bus rapid transit (BRT), the capital costs of BRT are close or higher than those of implementing light rail. One example is in Pittsburgh, where the new West Busway was built at a cost of about $60 million per mile, which is about 1.5 to 3 times the cost of building most light rail systems. (Reference: Lightrailnow.com). Meanwhile, busways have not tended to capture or even keep their ridership. In Ottawa, which is often used as an example of a city with a successful BRT busway system, ridership on the central busway line by 1995 had



declined 10% since its opening. Ridership on this system was projected to be 95 million per year by 1991, but was actually 75 million trips in 1995. (Reference: Gow, in Tramways & Urban Transit).

***Safety:***

Surveys of all major cities with streetcar systems show that there have been no known cases of streetcars impeding passage of emergency vehicles. Although streetcar systems are inherently associated with more accidents than systems with exclusive rights-of-way (such as tunnels, reservations, etc.), the safety profile of streetcars remains 10 times safer than driving an automobile. The point-of-service health benefits of electric vehicles compared to buses which emit fumes and particulates at stops is obvious. In routes with frequent acceleration and braking, along with many stops, the safety benefits with regards to pollutants and health are greater with electric transit vehicles.

The Bureau of Transportation Statistics reports on fatality rates for surface modes of transportation. Assuming an average motor vehicle occupancy rate of 1.5, the most recent statistics confirm that light rail transit is the safest mode of travel.

**Table 4: Fatality Rates per 100 Million Passenger-Miles (1997)**

| | |
|---|---|
| **Motor vehicles** | **0.93** |
| **Rail rapid transit** | **0.55** |
| **Commuter rail** | **0.05** |
| **Bus** | **0.10** |
| **Light Rail** | **0.00** |

Fatalities are only one aspect of safety, as other injuries and property damage caused by accidents must also be factored in. For automobile accidents, many states have limits on reporting, and lower cost accidents do not require reporting. Meanwhile, transit agencies are required to report all injuries, even those which are caused by automobiles swerving into public transportation vehicles. In fact, some states require transit agencies to report all accidents on their property, whether they be caused by transit vehicles or not.

Nonetheless, data from California shows that the rate of light rail – motor vehicle accidents is has been dropping. In the 1990s, the overall light rail accident rate dropped by nearly 50% to 1.18 accidents per 100,000 train-miles. (Reference: Los Angeles to Pasadena Metro Blue Line Construction Authority). While there were 3,494 traffic fatalities in California during this time, there were six light rail related fatalities. (Reference: California Public Utilities Commission). This occurred in a



state with many street-running trains, such as those in Sacramento and San Francisco.

**The Bus vs. Rail debate**

As the previously presented information indicates, rail is clearly the preferred alternative over buses for the Arborway corridor, and experience in other cities proves that rail ridership invariably surpasses projections and that of bus systems. Cities which have removed streetcars from service have experienced a big decline in patronage, and many cities which have attempted to improve transit ridership with busways have failed. Even in Ottawa, which has the most extensive busway system in the Western world, transit use has been declining since it opted for buses. (Reference: Newman and Kenworthy).

In San Diego, the data show that many people have left their cars to use the light rail system. The previous bus system was unable to achieve this in spite of dedicated busway lanes. In the northern corridor of the line, where a bus service operates and a dedicated right-of-way exists with park and ride facilities available, the utilization rates of the park-and-ride is about 50% of the stations which have light rail. (Reference: Mills). Transportation models fail to figure the simple preference people have for rail over buses. The result is that ridership is often over-anticipated for busways and underpredicted for rail lines. There are multiple examples all over the world where new rail lines have outperformed the buses they have replaced, and are far more successful than the standard models predicted. (Reference: Newman and Kenworthy).

Some of the reasons why people seem to prefer light rail over buses include both tangible and intangible aspects of each mode:

- Rail offers greater comfort and convenience (both in vehicles and at stations), especially since passengers are more likely to get a seat in a higher capacity rail unit than a bus. (Reference: Algers)
- Rail is perceived to have better schedule reliability. (Reference: Jessiman)
- Rail offers more reliable transfer between modes (people are more likely to transfer from bus to rail at Forest Hills than from bus to bus).
- Greater inherent passenger appeal of the vehicles and stops, including width of aisles, smoothness, odor, engine noise, all-weather reliability, and other environmental factors. (Reference: Tennyson).
- Route understandibility – light rail has tracks and wires which clearly indicate where it goes and stations are generally more obvious than bus stops.



- Stronger image and identity – contributes greatly to large passenger attracting ability of rail transit.
- Rail is more attractive to economic development due to its higher patronage potential and financial performance, cementing a stronger relationship between land use opportunities and transportation.
- The "Sparks effect" – this is a term given for the increased passenger appeal of an electric system over a rubber-based system, and is observed in many electric rail systems. This is due to all the above factors, and also to the faster acceleration and deceleration of the electric drive system in electric trains.

Because of the above factors, it is often necessary to build a 20% increase in ridership for rail transit over buses when comparing passenger estimates. (Reference: Newman and Kenworthy). Rail transit ridership has climbed at a rate much higher than that of bus ridership, which has been stagnant. From 1977 to 1997, motor bus ridership increased only 5%, whereas light rail ridership rose 155%. (Reference: Lightrailnow.com).

There is a long track record of inaccurate predictions of rail ridership compared to its actual achievement, as seen in many cities. In Portland, ridership on the new Westside MAX line exceeded projections by 22%. (Reference: Tri-Met, 2000). In St. Louis, ridership on the MetroLink system exceeded its initial forecast of 12,000 daily riders by carrying 20,000 daily riders its first year, an error of 67%. In 2001, the daily ridership has reached 40,000, already exceeding its 20-year projection of 37,000. (Reference: Citizens for Modern Transit). In Salt Lake City, about 20,000 riders use the Trax light rail system on weekdays, which has exceeded forecasts by 43%. (Reference: Utah Transit Authority, 2000). Denver's new Southwest LRT extension to Littleton is carrying 14,000 people per day, which is 67% above original predictions. (Reference: Denver Business Journal). In Dallas, ridership on its new rail line missed projections by 30%. (Reference: Denver Business Journal). Also in Dallas, ridership on its rail line exceeded ridership on the express bus it replaced threefold. These figures suggest that currently available forecasting models are unrealistic towards light rail transit. Public behavior is not the same with regards to how the public views rail transit compared to bus transit.

Typically, from 30% to 50% of rail transit users are new to the transit system and they have automobiles which they could use but choose not to. These are the same people who generally shun bus service. A single light rail vehicle can remove 60 to 120 cars from the road, making the corridor safer for local traffic and pedestrians. Since light rail power can be generated from water and wind generated



power systems, pollution can be reduced both at point of service and at the power source. Areas near light rail systems generally see an increase in property values, as the entire community becomes more vibrant. Finally, light rail produces less noise than either buses or automobiles. (Reference: E.L. Tennyson).

**Conclusion**

Cities which have instituted light rail service have invariably seen an increase in ridership when these lines replaced buses, both in cases where the rail service has been a mixed-traffic streetcar system and where it has been along a dedicated right-of-way. Not only is this higher ridership evident on the route in question, but the presence of light rail increases usage of buses that access the line, leading to an overall increased ridership on the entire transit system. The evidence is apparent in many transit systems throughout the United States, and the data presented for Toronto and San Francisco, where streetcar lines have recently been expanded, is relevant for the Arborway situation.

Because of the inherent preference of passengers to ride rail over buses, as borne out by all of the comparative evidence, the EOTC/MBTA’s projections that transit ridership would be lower if a rail option were chosen for Arborway over a bus is questionable and most likely wrong. Because people ride rail more, transit usage would increase with this mode, automobile usage would be reduced, and overall regional levels of pollution would invariably decrease. The data suggests the opposite for using buses: in addition to creating obviously higher levels of pollutants at point of service all along the route from Forest Hills to Back Bay and Park Street, buses will result in lower transit ridership , greater automobile use, and worsened air quality than if rail were chosen.

**I urge the Department of Environmental Protection to carefully analyze all of the data, which strongly confirms that selection of a rail option for Arborway will lead to increased transit ridership. The light rail option is the most sound choice from an environmental and transit perspective.**

Sincerely,

Srdjan S. Nedeljkovic, M.D.

**TABLE 1: New and Existing Light Rail systems in the United States**

| | |
|---|---|
| Baltimore: | Existing: 30 miles, 32 stations, 30,000 daily riders |
| Boston: | Existing: 28 miles, 78 stations, 241,000 daily riders |
| Buffalo: | Existing: 7 miles, 15 stations, 22,000 daily riders |
| Cleveland: | Existing: 15 miles, 34 stations, 18,000 daily riders |
| Dallas: | Existing: 20 miles, 20 stations, 37,000 daily riders |
| | Planned: 23 miles, 16 stations, $992 million |
| Denver: | Existing: 14 miles, 20 stations, 28,472 daily riders |
| | Planned: 19 miles, 14 stations, $883 million |
| Houston: | Planned: 7 miles, 16 stations, $300 million |
| Kenosha: | Existing: 2 miles, 5 PCCs, ? ridership |
| Little Rock: | Planned: 2 miles, streetcars, $7.6 million |
| Los Angeles: | Existing: 41 miles, 36 stations, 89.275 daily riders |
| | Planned: 14 miles, 14 stations, $680 million |
| Memphis: | Existing: 5 miles, 14 streetcars |
| | Planned: 2.5 miles, streetcar, $69 million |
| Minneapolis: | Planned: 11.6 miles, 17 stations, $548 million |
| New Jersey: | Existing: 12 miles, 22 stations, 17,000 daily riders |
| | Planned: 3 miles, 4 stations, 16 LRV |
| Newark: | Planned: 1 mile, 5 stations, $208 million |
| South Jersey: | Planned: 34 miles, 20 stations, diesel, $600 million |
| New Orleans: | Existing: 8.6 miles, 54 streetcars, 20,000 daily riders |
| | Planned: 5.5 miles, streetcar, $139 million |
| Philadelphia: | Existing: 55.4 miles, 8 lines, 76,500 daily riders |
| Pittsburgh: | Existing: 18 miles, 3 lines, 26,000 daily riders |
| | Planned: 5.5 miles, 8 stations, $384 million |
| Portland: | Existing: 33 miles, 50 stations, 62,000 daily riders |
| | Planned: 5.5 miles, 4 stations, $180 million |
| | Planned: 5.8 miles, 1 line, $350 million |
| | Planned: 2.3 miles, 5 streetcars, $42 million |
| Sacramento: | Existing: 20.6 miles, 31 stations, 30,000 daily riders |
| | Planned: 17.2 miles, 13 stations, $367 million |
| Salt Lake City: | Existing: 15 miles, 21 stations, 26,000 daily riders |
| | Planned: 2.5 miles, 4 stations, $106 million |
| San Diego: | Existing: 46.4 miles, 45 stations, 75,000 daily riders |
| | Planned: 6 miles, 4 stations, $431 million |

| | |
|---|---|
| San Francisco: | Existing: 28 miles, 14 lines, 150,000 daily riders |
| | Existing: 5.3 miles, 3 cable car lines, 27,000 daily riders |
| | Planned: 5.4 miles, 19 stations, $500 million |
| San Jose: | Existing: 30.5 miles, 45 stations, 27,600 daily riders |
| | Planned: 10.3 miles, 25 stations, $651 million |
| St. Louis: | Existing: 34.4 miles, 27 stations, 50,355 daily riders |
| | Planned: 8.6 miles, 2 stations |
| Seattle: | Planned: 25 miles, 28 stations, $3.1 billion |
| | Existing: 2 miles, 5 streetcars |