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Related Press Coverage

The Boston Globe:

Rail Lines Boosting Home Values. January 12, 2003.
Analysis of data of home prices between 1995 and 2001 shows that the median price of single-family homes nearly doubled in 19 communities after they gained MBTA commuter rail service.

New York Times:

Service Upgrade by N.J. transit fuels gains around stations. November 3, 2002.
New Midtown Direct trains are generating growth. In Morristown for example, $1 million town houses are being built near the Morristown station, and over $200 million in private development in the town has occurred.

Charlotte Observer:

Commuter rail line drives up price of land. July 7, 2002.Land values along the South End leg of the light rail corridor due to open in 2006 have doubled, and in some cases tripled, in the past four years.

Wall Street Journal:

Railway agencies play bigger real-estate role. May 4, 2001 page B12.
Transit villages sprout around train stations as part of tranisit-oriented development in Los Angeles.

Chicago Daily Herald:

Why Metra is booming. March 20, 2001 page 1.
Residents are flocking around suburban downtowns revitalized by new rail amenities and nearby real estate development.

St. Louis Commerce:

Magnetic Metrolink February 2001.
The light rail system is attracting new investment that is reviving once faded neighborhoods while adding value to already healthy ones.

Rail Definitions

Rail transit services exist in over 50 metropolitan areas and small cities, and the number grows almost yearly.

A **mode** is the system for carrying transit passengers described by specific right-of-way, technology and operational features. The most common rail modes are:

Commuter rail (also called **metropolitan rail**, **regional rail**, or **suburban rail**) is an electric or diesel propelled railway for urban passenger train service consisting of local short distance travel operating between a central city and adjacent suburbs. Service must be operated on a regular basis by or under contract with a transit operator for the purpose of transporting passengers within urbanized areas, or between urbanized areas and outlying areas. Such rail service, using either locomotive hauled or self propelled railroad passenger cars, is generally characterized by multi-trip tickets, specific station to station fares, railroad employment practices and usually only one or two stations in the central business district. Intercity rail service is excluded, except for that portion of such service that is operated by or under contract with a public transit agency for predominantly commuter services, which means that for any given trip segment (i.e., distance between any two stations), more than 50% of the average daily ridership travels on the train at least three times a week.

Heavy rail (**metro**, **subway**, **rapid transit**, or **rapid rail**) is an electric railway with the capacity for a heavy volume of traffic. It is characterized by high speed and rapid acceleration passenger rail cars operating singly or in multi-car trains on fixed rails; separate rights-of-way from which all other vehicular and foot traffic are excluded; sophisticated signaling, and high platform loading. If the service were converted to full automation with no onboard personnel, the service would be considered an automated guideway.

Light rail (**streetcar**, **tramway**, or **trolley**) is lightweight passenger rail cars operating singly (or in short, usually two-car, trains) on fixed rails in right-of-way that is not separated from other traffic for much of the way. Light rail vehicles are typically driven electrically with power being drawn from an overhead electric line via a trolley or a pantograph.

Other modes are:

Aerial tramway is an electric system of aerial cables with suspended powerless passenger vehicles. The vehicles are propelled by separate cables attached to the vehicle suspension system and powered by engines or motors at a central location not on board the vehicle. Only two such transit operations exist in New York City and at Mountain Village, CO. All other aerial tramways are at ski areas or at tourist sites.

Automated guideway transit (**personal rapid transit**, **group rapid transit**, **people mover**) is an electric railway (single or multi-car trains) of guided transit vehicles operating without an onboard crew. Service may be on a fixed schedule or in response to a passenger activated call button. The places with automated guideways are Detroit, MI, Indianapolis, IN, Jacksonville, FL, Las Colinas, TX, Miami, FL, and Morgantown, WV. Automated guideways in non-transit settings such as airports and hospital campuses are more common.

Cable car is an electric railway with individually controlled transit vehicles attached to a moving cable located below the street surface and powered by engines or motors at a central location not on board the vehicle. Only one cable car operation exists in San Francisco, CA.

Inclined plane is a railway operating over exclusive right-of-way on steep grades (slopes) with powerless vehicles propelled by moving cables attached to the vehicles and powered by engines or motors at a central location not on board the vehicle. The special tramway type of vehicles have passenger seats that remain horizontal while the undercarriage (truck) is angled parallel to the slope. Chattanooga, TN, Dubuque, IA, Johnstown, PA, and Pittsburgh, PA (2 inclines) are the only places with inclines used in regular transit service.

Monorail is an electric railway of guided transit vehicles operating singly or in multi-car trains. The vehicles are suspended from or straddle a guideway formed by a single beam, rail, or tube. Only two transit monorails exist in Las Vegas, NV and Seattle, WA. Their most common use is in the non-transit settings of amusement parks. If the trains do not have an onboard crew, they are considered automated guideways.

Types of Service

Local service, in the rail context, means trains stop at every station on a route. For light rail and cable cars operating on city streets, local service would be analagous to local bus service, where stops are every block or two apart.

Most aerial tramway, automated guideway, inclined plane, and monorail routes are one mile or less long. New York City Transit also has a few very short heavy rail shuttle lines, and most heritage trolley lines are also only a few miles long. Some of these operations may operate in a loop and connect, often at a transfer center or rail station, to major routes for travel to more far-flung destinations

Express service speeds up longer trips, especially in major metropolitan areas during heavily-patronized peak commuting hours, by operating long distances without stopping. In New York, Chicago, and other areas, express trains even have separate tracks for at least part of their routes.

Limited-stop service is a hybrid between local and express service, where not all stations and stops are served. An example is a pair of closely-spaced trains that both stop at the most heavily-patronized stations on a line. For the other stations, the first train stops at every other station, while the following train stops at the stations missed by the first train.

Types of Vehicles

Although most service is operated with vehicles purchased new, a small proportion is operated by vehicles rehabilitated or rebuilt when they are 10 to 20 years old.

Rehabilitation is the rebuilding of revenue vehicles to original specifications of the manufacturer. **Rebuilding** may include some new components but has less emphasis on structural restoration than would be the case in a **remanufacturing** operation, focusing on mechanical systems and vehicle interiors.

An **aerial tramway car** is an unpowered passenger cabin suspended from a system of aerial cables and propelled by separate cables attached to the vehicle suspension system. Engines or motors at a central location, not on board the vehicle, power the cable system.

An **automated guideway car** is a guided passenger car operating under a fully automated system without an onboard crew. One type is a **downtown people mover**, which operates on a loop or shuttle route within the central business district of a city.

A **cable car** is a streetcar type of passenger car operating by means of an attachment to a moving cable located below the street surface and powered by engines or motors at a central location not on board the vehicle.

A **commuter rail car** is a commuter rail mode passenger car--either an unpowered **passenger coach** that is pulled or pushed by one or more locomotives, or a **self-propelled passenger car** that has an onboard power source or that draws power from overhead electric wires. A large proportion of commuter rail cars are double-decked with upper and lower seating levels.

A **locomotive** is a power unit vehicle that does not carry passengers that is used to pull or push commuter rail passenger coaches. Most locomotives use diesel fuel or are powered by overhead electric wires or an electrified third rail. A small number are dual-mode and can operate either as a diesel or electric vehicle.

A **heavy rail car** has motive capability, is driven by electric power taken from a third rail or (rarely, overhead wires), and is usually operated on exclusive right-of-way.

An **inclined plane car** is a special type of passenger car operating up and down slopes on rails via a cable mechanism.

A **light rail car** (or **streetcar**, **tram,** or **trolley car**) has motive capability, is usually driven by electric power taken from overhead lines, and usually operates much or all of its route on non-exclusive right-of-way. Sometimes older cars are refurbished (vintage trolley cars) or newer cars are built to look like older cars (heritage trolley cars).

A **monorail car** is a guided passenger car operating on or suspended from a single rail, beam or tube.

Accessibility

A **station** is a public transportation passenger facility.

An **accessible station** is a station that provides ready access, and

Transit-Oriented Development & Joint Development

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Overview

A recent study report (R-102, Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects) published by the Transit Cooperative Research Project (TCRP) defines transit-oriented development (TOD) as compact, mixed-use development near transit facilities and high-quality walking environments. The TCRP study concludes that the typical TOD leverages transit infrastructure to promote economic development and smart growth, and to cater to shifting market demands and lifestyle preferences. TOD is about creating sustainable communities where people of all ages and incomes have transportation and housing choices, increasing location efficiency where people can walk, bike and take transit. In addition, TOD boosts transit ridership and reduce automobile congestion, providing value for both the public and private sectors, while creating a sense of community and place.

The same TCRP study defines joint development as a form of transit-oriented development that is often project specific, taking place on, above, or adjacent to transit agency property. It involves the common use of property for transit and non-transit purposes. Proximity to rail transit has been shown to enhance property values and can increase the opportunity for fostering community and development partnerships.

According to the TCRP study, the most common joint development arrangements are ground leases and operation-cost sharing. Most often, joint development occurs at rail stations surrounded by a mix of office, commercial, and institutional land uses. However, examples of public-private joint ventures can be found among bus-only systems as well, normally in the form of joint intermodal transfer and commercial-retail space at central-city bus terminals.

Benefits

According to the TCRP study, the potential benefits of TOD and joint development are social, environmental, and fiscal. Focusing growth around transit stations capitalizes on expensive public investments in transit by producing local and regional benefits. The most direct benefit of TOD and joint development is increased ridership and the associated revenue gains. Other primary benefits include the vitalization of neighborhoods, financial gains for joint development opportunities, increases in the supply of affordable housing, and profits to those who own land and businesses near transit stops. Secondary benefits include congestion relief, land conservation, reduced outlays for roads, and improved safety for pedestrians and cyclists.

This Is Light Rail Transit

A Dallas light rail transit train approaching the zoo station.

Photo courtesy of Dallas Area Rapid Transit Authority

Inset: America's newest Light Rail Transit system serves downtown Jersey City across the Hudson River from Lower Manhattan.

Photo courtesy of Jack W. Boorse

This Is Light Rail Transit was prepared by the Light Rail Transit Committee of the Transportation Research Board; Jack W. Boorse acted as principal author, and E. L. Tennyson and John W. Schumann provided statistical research and analysis. This booklet was first distributed at the Eighth National Conference on Light Rail Transit in Dallas, Texas, in November 2000 on the conference proceedings CD-ROM. The conference was sponsored jointly by the Transportation Research Board and the American Public Transportation Association.

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What Is Light Rail Transit?

An aerial LRT structure in Baltimore.

Photo courtesy of Parsons Brinckerhoff

As its surname indicates, Light Rail Transit (LRT) is a transit mode. Its middle name reflects that fact that it runs on rails. Why is it called "light"? That depends on who and where you ask.

In Britain the term "light railway" is applied to any rail mode that is scaled down from the common size of incline railroads. In previous years, even some of the lines that operated short freight trains pulled by diminutive steam locomotives were classified as light railways. It was not until the 1970s that the term "light rail transit" came into use in the United States. There was no formal definition of LRT at that time, but it was generally understood to mean an urban rail transit form that was leaner and less costly than other rail modes.

A formal definition was adopted in 1989 and placed in

LRT surface trackage in San Jose.

Photo by Wm. H. Watts

An underground LRT station in Portland.

Photo courtesy of LTK

the Transportation Research Board's Urban Public Transportation Glossary: *"A metropolitan electric railway system characterized by its ability to operate single cars or short trains along exclusive rights-of-way at ground level, on aerial structures, in subways, or occasionally, in streets and to board and discharge passengers at track or car floor level."*

LRT is designed to accommodate a variety of environments, including streets, freeway medians, railroad rights-of-way (operating or abandoned), pedestrian malls, underground or aerial structures, and even in the beds of drained canals. It is this characteristic that most clearly distinguishes it from other rail modes. Because of this design flexibility, LRT generally is less costly to build and operate than other fixed-guideway modes.

The purpose of this informational booklet is to provide an understanding of this increasingly popular transit mode, with particular emphasis on its application in North American metropolitan areas, and to address the background of LRT's characteristics and capabilities.

The Origin of Light Rail Transit

In North America LRT emerged as an identified transit mode in the 1970s, but long before it existed in name it existed in fact. Its roots extend back more than a hundred years.

OMNIBUS MODE

Transit service in the larger cities of the United States and Canada began in the 19th century with the advent of the omnibus. The omnibus was an enclosed, wooden-wheeled wagon pulled by horses; it traveled on streets that were unpaved or that had, at best, a rough surface made of stones or timber. For those travelers who could not afford their own horse and buggy, the omnibus was the only alternative to walking.

HORSECARS

As the 19th century progressed, new technologies started to emerge. Metal rails were installed in the streets to provide a smooth riding surface for carriages that rolled on flanged metal wheels. These rails offered a much gentler ride for passengers and significantly reduced the effort required of the horses to move the cars. Moreover, the fixed guideway provided by the rails made it feasible to use mechanical power—in place of the horses—from a remote location.

CABLE CARS

Some of the larger cities started to develop cable car lines. The cars that served these lines were propelled by a “grip” instead of being pulled by a horse. The grip was a device placed beneath the car that protruded through a slot between the rails and into a chamber below the street surface. The chamber contained a moving cable that, when clamped by the grip, would move the car forward. It was a functional method of propulsion, but it was cumbersome. Before these cable car systems became widespread, the more advanced technology of electric traction emerged.

ELECTRIC TRACTION

Streetcars

Developed in the 1880s, electric traction technology allowed electricity—used to power onboard electric motors—to be conducted to the streetcars by means of an overhead wire. The electric streetcar proved to be so superior to its predecessors, both the horsecar and the cable car, that electric railways were constructed rapidly throughout the continent in all the large cities and even many of moderate-sized ones. As the electric rail lines grew, development of cable railways faltered while the omnibus mode moved swiftly toward extinction. The seeds of LRT had been planted.

Once the concept of electrically powered railways had been discovered, it was applied in a variety of ways. Some main line railroads electrified portions of their trackage to gain the benefits of clean and powerful electric traction. This versatile power source also made it feasible to extend local railway lines beyond urban boundaries into new and future suburbs and, in some cases, cross county to other urban areas. The resulting high-speed, interurban lines offered service that was generally cheaper and more frequent than the service

A scene in downtown Newark during the streetcar era.

Photo by Albert L. Creamer, courtesy of National Railway Historical Society, New Jersey chapter.

offered by parallel railroads with the same destinations.

Elevated Systems

In the largest cities, where major streets became congested, railways were installed on structures above the streets. New York and Chicago started to build their elevated systems—also called “L” systems—as early as the 1870s. For the most part, these systems used trains of railroad-type cars pulled by small steam locomotives, although in a few cases, by cable. These elevated lines were ideal candidates for electric traction and were quickly converted.

Subways

This new power delivery method also opened other opportunities for urban transport. As the 20th century dawned, Boston, New York, and Philadelphia began to place railway tracks and stations in enclosed subways beneath the streets—a concept that would have been unthinkable with animal or steam power.

Trolleys

The major application of electric traction, however, was on the urban street railways that had supplanted the omnibus mode. The horsecar was redesigned with electric motors beneath the floor, and a device on the roof that trolled the overhead wire and collected energy to power the motors. Early on the trolling device came to be known as the trolley, a term that eventually identified the cars, the wires, and the entire mode. In all the large cities, including the three that were developing subways, the electric trolley became the dominant transit mode and would remain so for decades.

During the second quarter of the 20th century, the internal combustion engine and the pneumatic tire were refined, and paved streets and highways were being constructed throughout the metropolitan areas with public funds. These improvements inspired a return of the omnibus and family buggy, each with much improved motive power and running gear. The electric trolley slowly forfeited to the automobile not only its dominance of the roadways but also much of its patronage. Concurrently, the bus not only became practical, but being a lower capacity conveyance it was more appropriate on the weaker lines where riding had dwindled considerably.

In the decade before World War II and in the two immediately after, it became a matter of survival of the fittest for the trolley mode. Ridership decreased as automobile use increased and many of the interurban lines were rendered unprofitable—all but a few succumbed. The majority of streetcar lines in urban areas were either converted to bus operation or simply abandoned.

The trolley lines that were least vulnerable to the erosion were those that had substantial sections of trackage that were on separate rights-of-way, free of the increasingly congested street traffic. During the early decades of the 20th century, Boston, Newark, and Philadelphia built trolley subways in their core areas. Pittsburgh and San Francisco constructed lengthy trolley tunnels under steep hills at the edge of their downtown districts to connect street trackage there with growing residential areas on the other side of the hills. In Cleveland and New Orleans the lines that survived were those which had long stretches of trackage in separate surface rights-of-way.

By the beginning of the last quarter of the 20th century only those seven cities in the United States and Toronto, Canada, had surviving trolley lines.

It was at this time that the North American public transportation community reawakened to the potential of LRT. The depletion halted and the trend reversed. New systems were initiated at an average rate of nearly one per year (Table 1). Just before the close of the 20th century two new systems—one focused on Salt Lake City and the other on Jersey City—began passenger service and brought the total number of operating systems to 23.

TABLE 1 Dates of New LRT System Openings Since 1975

City	*Date*
Edmonton	April 1978
Calgary	May 1981
San Diego	July 1981
Buffalo	October 1984
Portland	September 1986
Sacramento	March 1987
San Jose	December 1987
Los Angeles	July 1990
Baltimore	April 1992
St. Louis	July 1993
Denver	October 1994
Dallas	June 1996
Salt Lake City	December 1999
Jersey City	April 2000

LRT Today

North American LRT, as we know it today, represents a blend of design and operating practices and parallels the development of the mode in Europe, Asia, and Australia. Today's systems can be categorized into two types:

- "First Generation" systems have evolved from earlier trolley and tramway lines that remained in operation throughout their transformation.
- "Second Generation" systems were designed afresh (occasionally utilizing portions of abandoned trolley or railroad lines, or both).

In the United States and Canada there are seven First Generation systems. They operate in the metropolitan areas of Boston, Cleveland, New Orleans, Newark, Philadelphia, San Francisco, and Toronto. All of the other systems (16 at present and growing) are of the Second Generation type.

Some LRT operating agencies like to give special names to their light rail lines. For example, Portland's system is called ***MAX***, which stands for **M**etropolitan **A**rea e**X**press, and Salt Lake City's is named ***TRAX*** (**TRA**nsit e**X**press). In San Diego the light rail line is simply designated ***Trolley***, but in San Francisco riders travel on the ***Muni Metro***. St. Louis refers to their system as ***Metro Link***, and Calgary passengers jump on the ***C-Train***.

Regardless of type or name, all LRT systems have the following basic elements:

The Church Street Line of San Francisco's First Generation system.

Photo by Wm. H. Watts

- Infrastructure—composed of the trackways, stations, and storage yards, including any associated structures, such as tunnels and bridges.
- Rolling Stock—comprising one or more fleet of railcars that carry the passengers along the trackways. Generally, these cars are designed so that they can be assembled into short trains. They are sometimes referred to as vehicles, although most statutory definitions of that term, including the one contained in the *Uniform Vehicle Code*, specifically exclude railcars.
- Fixed Equipment—consisting of an operations and maintenance center, the electric power supply, signals, and communications facilities.

Each of these elements is discussed on following pages.

Infrastructure

TRACKWAYS

LRT trackways can be constructed in a variety of configurations. As with other electric railway modes, they can be placed on the surface of the ground, below the surface in an open cut or in a subway, or above the surface on an embankment or aerial structure.

A surface LRT trackway may be physically separated from vehicle and pedestrian traffic by means of bridges or underpasses. It may also cross roadways and walkways at grade, in which case the conflicting movements are temporarily separated by appropriate control devices, usually automatic crossing gates or traffic signals.

Surface LRT trackage may also be constructed along a street right-of-way, commonly in segregated lanes but occasionally within vehicle lanes used by general traffic.

Sub-surface trackways are generally positioned below streets and follow the street pattern, but they can also follow an independent alignment and pass under structures, parks, bodies of water, or other railways. Aerial trackways may also follow street patterns, but are more likely to trace a different alignment, crossing above streets, rivers, and other rail lines.

In northern climates provisions for snow and ice removal must be included in system designs and operating plans.

A crossing controlled by automatic gates on Philadelphia's LRT system.

Photo courtesy of Jack W. Boorse

A surface station in San Jose.

Photo by Wm. H. Watts

STATIONS

Stations range from simple platforms at ground level where passengers can safely board and alight from trains, to elaborate structures above or below ground, which may be accessed via stairways, escalators, and elevators.

Underground stations, even where they are far below the surface, can be served safely because electric railcars emit no harmful fumes into the air.

STORAGE YARDS

The storage yards do not need to be elaborate. Unlike buses, electric LRT cars have no engines that are temperature sensitive. They will start reliably in any ambient temperature experienced by North American cities. There is no necessity to house them in enclosed buildings, although in extreme climates simple roofing over the storage tracks is sometimes installed. Also, the cars require no fueling stations, thereby eliminating the possibility of fuel spills.

Rolling Stock

The versatility of LRT as a mode is in no small measure attributable to the capabilities of the railcars that have been developed to serve the lines. Sometimes referred to as light rail vehicles (LRVs), trolleys, or trains, LRT cars can be tailored to the needs of specific operating environments.

Where the tracks are constructed along, above, or below a public street network, the presence of adjacent buildings or other structures may necessitate track alignments that include sharp turns and steep grades. A curve radius of 25 meters (82 feet) is the customary minimum for new LRT lines, and longer radii are preferable where conditions permit. However, it is possible to design cars to negotiate curves with a radius as short as 11 meters (36 feet).

While a maximum gradient of 5 percent is considered a desirable design criterion, there has been a need on some new systems to include track segments with gradients as steep as 7 and 8 percent. The cars operating on those systems negotiate these gradients without difficulty. LRT cars could be designed to climb a slope of 12 percent and indeed some predecessor streetcar lines had such gradients. However, 10 percent is now considered the limit from the perspective of passenger comfort. Exotic technologies with rubber tires or linear induction propulsion are not needed to conquer precipitous track profiles.

The use of external electric power not only provides the cars with the muscle needed to climb steep trackage, it also gives them the ability to serve enclosed passenger stations that may be located inside buildings or, more commonly, underground where an onboard combustion engine could cause a health risk. The electric power also provides the ability to maintain air conditioning or heat in the car during layovers without wasting fuel.

Today's LRT cars come in a variety of shapes and sizes. Of those currently operating in the United States, body widths vary

A Buffalo LRT car with a one-piece body more than 20 meters in length.

Photo courtesy of Parsons Brinckerhoff

from 2.6 to 2.9 meters (8.5 to 9.5 feet). The lengths of the one-piece cars range from 15 meters (50 feet) to 20.4 meters (67 feet). When the length of the body exceeds that range it is split into two or three sections.

Those sections are hinged to each other so that the car is able to negotiate short-radius curves. These are called articulated cars and their lengths vary from 21 to 29 meters (70 to 95 feet).

Most North American LRT systems use articulated cars. Boston, San Francisco, and Toronto operate mixed fleets that include some shorter cars with traditional one-piece bodies. One-piece bodies only comprise the fleets in Buffalo, Fort Worth, New Orleans, and Philadelphia.

Individual cars of either type can be assembled into a short train that is controlled from the front car. A three-car train of articulated cars operated by a single driver can safely transport more than 400 passengers. Where conditions dictate, individual cars or multi-car trains can be and are operated in mixed traffic.

Although, to date, it has only been implemented on a test track, completely automatic operation without an onboard operator would be feasible on track segments that are fully separated from the roadway network.

An articulated car negotiates a sharp turn in San Francisco.

Photo by Wm. H. Watts

State-of-the-art electric LRT cars are neighborhood friendly. Not only are they nearly silent, but modern electronic propulsion and braking control enables them to stop very quickly when necessary. This technology allows them to run at the appropriate speed for the zone in which they operate.

This same equipment gives them the ability to move rapidly where it is safe to do so. The usual maximum speed of LRT cars is about 90 kilometers (56 miles) per hour, but some

LRT cars are part of the neighborhood in suburban Philadelphia.

Photo courtesy of Jack W. Boorse

recently produced cars travel as fast as 105 kilometers (65 miles) per hour. A few of their interurban predecessors ran at speeds as high as 145 kilometers (90 miles) per hour, and there is no technological reason why they could not be designed to operate at 160 kilometers (100 miles) per hour.

Contemporary LRT cars are also passenger friendly. Because they roll on steel rails, they furnish an especially smooth ride. They are not only immune from vertical jolting caused by paving flaws that are unavoidable in a metropolitan setting, but also from the lateral and longitudinal lurching that is common with steerable, rubber-tired vehicles. In many applications they can have a generous body width so that broader and more comfortable seats and aisles can be provided.

Their interiors are temperature controlled for all seasons—in climates as diverse as those of Dallas in the summer and Edmonton in the winter. Externally supplied electric power allows them to maintain the necessary heating and cooling continuously without any loss of performance, even while simultaneously climbing long and steep gradients. Another passenger-pleasing attribute that is inherent to electric traction is

A stationary lift at a station in San Jose.

Photo by Wm. H. Watts

its freedom from engine noise, vibration, and odor.

LRT cars can be especially friendly to passengers with disabilities. Some cars carry lifts like those in new buses to assist the boarding and alighting of mobility-impaired passengers. Others have stationary lifts at the stations.

However, an increasing number of LRT systems are being designed to provide easy access through level boarding. This type of boarding assures that the floor of the car at all or most of the doors matches the height of the station platform. Until recently, in order to achieve level boarding it was necessary to design stations with platforms about one meter above the rails because that was the traditional car floor height. These high platforms exist in two forms. The more common is a full-length version that provides level boarding at every door. The less common form is the mini-high platform (sometimes called a high block), which serves only the front door.

Today many of the new systems (and a few of the more established ones) are acquiring low-floor cars. These cars are designed with floors that are only about 35 centimeters (14 inches) high. This gives them the ability to provide level boarding at a low-platform station.

A high-platform station in Edmonton.

Photo courtesy of Jack W. Boorse

A mini-high platform in Denver.

Photo courtesy of T. R. Hickey

In addition to aiding mobility-impaired passengers, level boarding also eliminates the need for ambulatory passengers to climb steps, thereby expediting the boarding and alighting process and minimizing the station stop time. The result is shorter trip times for everyone.

A low-floor LRT car at a station in Portland.

Photo courtesy of Tri-Met

Fixed Equipment

OPERATIONS AND MAINTENANCE CENTER

The operations and maintenance center is the focal point of an LRT system. It includes a control room from where operations are coordinated, accommodations for train crews preparing for duty, and a maintenance facility where the cars are inspected, cleaned, and repaired. The center can also include administrative and management offices.

ELECTRIC POWER SUPPLY

Two basic elements comprise the electric power supply: a network of traction power substations and a distribution system. The power substations receive high-voltage commercial electrical power and convert it to medium-voltage direct current. The distribution system delivers that converted power from the substations via overhead wires to the individual LRT cars as they travel along the line.

SIGNALS

The movement of the cars or trains is guided by signals. On some systems all of the signals are located alongside the trackway. These trackside signals may include, or be coordinated with, traffic signals along the line. On other systems only certain signals are installed trackside, while others are displayed on a console in front of the train operator.

COMMUNICATIONS FACILITIES

Communications facilities link the operations and maintenance center with the train operators and other personnel. These facilities range from conventional telephone lines to the very newest wireless technologies.

Operating Experience

Since the North American resurgence of LRT a quarter of a century ago, operating experience generally has been favorable, particularly in some metropolitan areas that previously had been without rail transit service.

Adding an LRT component to a transit system does not drain passengers from the bus lines as some observers have claimed. Rather, it encourages more people to use both bus and rail transit. Adding LRT trunk lines and coordinating them with a region's buses to create a multimodal, multidestination transit system results in growth for both modes—even in the low-density, auto-oriented cities of the American West.

Sacramento provides a good example. An examination of the Federal Transit Administration (FTA) National Transit database showed that in 1987—its last year of all-bus operation—regional transit vehicles carried fewer than 14 million passengers. Eleven years later the system accommodated more than 28 million riders. The LRT trunk line attracted over 8 million passengers, while bus ridership grew to nearly 20 million. There were similar results in San Diego, Portland, and St. Louis.

Used appropriately, LRT enhances transit efficiency. By 1998 LRT trunk lines, each 23 or more kilometers in length, had opened and were providing primary rail services in San Diego, Portland, Sacramento, San Jose, St. Louis, and Dallas. Previously, only buses served these six cities. In 1998, these systems operated more than 3,000 buses in route service plus more than 500 small vehicles in demand-responsive service; there were fewer than 300 light rail cars. By providing high-capacity service on major routes, the LRT lines became highly productive, accommodating 22 percent of total system boardings and carrying 30 percent of systemwide passenger miles but consuming only 17 percent of the operating and maintenance costs.

One-person operation of trains (of up to four cars) makes it possible for an LRT line to do the work of many buses. Using LRT results in greater efficiency, even after taking into account the cost of added staff to maintain the tracks, stations, electrification, signals, and other fixed facilities. However, achieving these economies of scale requires a high level of ridership. That is why it makes sense to provide LRT service on a transit system's high-demand primary corridors and to operate buses (or even smaller vehicles in local shuttle and circulator service) where they are the better choice on secondary radial lines and crosstown and feeder routes.

Only the largest, most densely developed cities generate passenger volumes that require fully grade-separated heavy rapid transit systems. Commuter railroads are best suited to longer radial corridors linking cities with their more distant suburbs. LRT is a medium to high-capacity mode that fits well into many metropolitan areas with good productivity.

One way of measuring the productivity of a transit mode is by calculating the number of passenger kilometers produced per transit employee both onboard and for support. A productivity comparison of the measurements for five urban transit modes is shown in Table 2.

TABLE 2 Productivity Comparison of Annual Passenger Kilometers

Mode	*Annual Passenger Kilometers*
Commuter (Regional) Railroads	608,200
Rail Rapid Transit (Metros)	413,500
Light Rail Transit (LRT)	301,618
Urban Bus Transit	201,125
Automated Guideway Transit (AGT)	64,360

Another measurement of productivity is the average number of passengers carried by one vehicle. In this category LRT exceeds even that of the nation's rapid transit systems. The productivity per unit (one railcar or bus) for the three major urban transit modes is compared in Table 3.

All transit modes are basically safe. However, LRT excels in safety and has a record clearly superior to that of automobile travel. Of all of the transit modes, LRT is among the safest. Data submitted to FTA document that LRT's safety record even surpasses that of urban bus service by moving people with 47 percent fewer casualties per passenger kilometer. This is to be expected since LRT cars are reliably guided by rails and often are located in reserved lanes or exclusive right-of-ways, as compared with operator-steered vehicles maneuvering in street traffic.

TABLE 3 Productivity Comparison of Average Number of Weekday Passengers

Mode	*Average Passengers Per Unit*
Light Rail Transit (LRT)	1,134
Rail Rapid Transit (Metros)	982
Urban Bus Transit	362

New residential, retail, and office development around the Hazard Center LRT station in San Diego.

Photo courtesy of San Diego Metropolitan Transportation Development Board

Yet another attribute of LRT, which it shares with other rail modes, is its ability to stimulate growth, leading to healthy economic development in the form of private sector investment and higher real estate values. The presence of a major transit infrastructure is broadly viewed as a promise of permanence. Once a rail line is built, it is likely to remain for a long time.

LRT Tomorrow

What lies ahead for LRT? The beginning of the 21st century will see continuing expansion of the LRT mode in North America. Fifteen of the 23 systems now in operation are actively extending or upgrading their lines. There are currently eight future new systems in various stages of planning or design.

Whether you are a transportation professional, an elected official, a civic leader, or a citizen of a metropolitan area who is interested in the betterment of your community, we urge you to learn as much as you can about this fascinating and increasingly popular transit mode.

Related Transit Links

TRANSPORTATION RESEARCH BOARD

http://www.nationalacademies.org/trb/

LRT News

www.nationalacademies.org/trb/publications/LRTNews/LRTv15n1.pdf	(June 2000)
http://www.nationalacademies.org/trb/publications/LRTNews/lrtv14n2.pdf	(Dec. 1999)
http://www.nas.edu/trb/ftp/epubs/lrtv14no1.pdf	(Sept. 1999)
http://www.nas.edu/trb/publications/lrtv13no8.pdf	(Dec. 1998)

TRB Transit Cooperative Research Program

http://www4.nas.edu/trb/crp.nsf/

FEDERAL TRANSIT ADMINISTRATION

http://www.fta.dot.gov/

AMERICAN PUBLIC
TRANSPORTATION ASSOCIATION

http://www.apta.com/

Today, the City of Newton's total land area is 18.1 square miles, with a population of 83,000. In Newton Centre, there are over 2,700 households with a population of nearly 8,000 people. Within the 1/4-mile radius around the Massachusetts Bay Transportation Authority light rail stop (Newton Centre "T" stop, Riverside Branch, on the east-west Green line) there are nearly 600 dwelling units at a density of 7.4 units per acre. According to 1990 Census figures, there are 1.81 autos available per household in Newton Centre, which is higher than the 1.46 for the Boston metropolitan area, but lower than most suburban locations. Only 60 percent of the MBTA transit riders living in Newton Centre, however, have access to an automobile.

Newton Centre, compared to the Boston metropolitan area, is noticeably affluent. Only six percent of the population is below poverty level, while the average is 15 percent for the Boston metro area. The median household income in Newton Centre ranges from $52,000 to $82,000, as compared to $30,000 for metro Boston. The Newton Centre village of Newton is also largely homogenous, with 92 percent of the population white, as compared to 87 percent in the metro area.

Transit and Land Use at Newton Centre

Though many definitions of transit-oriented development include mixed-use development that follows the siting of a transit stop, Newton Centre as a community was around more than two hundred years before the MBTA light rail stop was constructed. Newton Centre can be classified as a transit-oriented development, however, based on the village's relationship to the stop, and based on the fact that the stop has both created and changed patterns of development and resident mobility patterns directly adjacent to the stop since its opening.

The transit stop lies near the end of the Riverside "D" line in a primarily suburban region of Greater Boston. Bus service is on the "52" route that travels north-south above and below Newton Centre in the Newton area. The City of Newton also has a relatively new shuttle bus service providing service between the city's villages. The service connects the villages to existing MBTA bus and light rail stops. Additionally, Boston College runs buses through Newton Centre for its students, faculty, and staff.

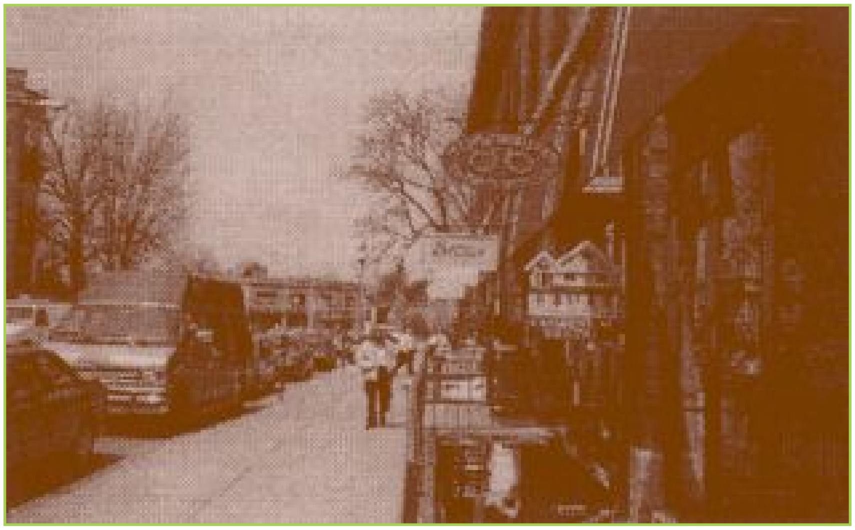
Light rail service is regular, running every five minutes during peak commuting times, and about every ten minutes at non-peak times. Bus service is less frequent, running every thirty minutes weekly, and up to every hour on weekends.

Union Street in Newton Centre.

Ridership from Newton Centre averages just under 1,100 riders per day on the MBTA Green line. While there are peak commutes in the morning and evening, the valley of ridership between peaks is not as low in Newton Centre as in other nearby locations. Seventy percent of Newton Centre transit commuters walk to the transit stop, twelve percent park and ride, eleven percent are dropped off, and only seven percent take the bus. No riders indicated that they ride a bicycle to the transit stop. More than half of those who walk to the transit stop can do so in less than five minutes, and another forty percent in under fifteen minutes.

A recent survey of transit riders arriving in Newton (though not necessarily Newton Centre) from other locales indicated that 41 percent arrive for work, twelve percent for personal business, and 3 percent for social or recreational purposes. Only six percent of riders indicated that they use Newton for shopping.

While overall usage numbers for all types of trips is not available, U.S. Census Journey to Work data shows that Boston is the most frequent work destination for commuters coming from Newton Centre's transit stop. Newton is a distant second, and Cambridge is farther still in third. The data confirms the function of Newton Centre as a point of origin for Boston commuters, also affirming the transit-oriented development as a point of origin for residents who work in close proximity to their homes.



Wide sidewalks and interesting street facades enhance the pedestrian orientation of this street in Newton Centre.

While the majority of Newton Centre residents do drive to work, it is significant that thirteen percent walk and fourteen percent take public transportation on a regular basis. Over a quarter of the residents, then, either use the centrally located transit or walk to their work destinations, an essential characteristic of a transit-oriented development. Of those who work in Newton Centre but live outside of the village, fourteen percent walk and nine percent use existing transit.

Newton Centre's central core area is comprised primarily of retail and office uses intermingled with residences. Surrounding neighborhoods are comprised largely of residences, small retail, and large institutions. Residential uses make up over 3.3 million square feet, while commercial is over 582,000 square feet.

Of the commercial square footage, retail comprises over half, office over 30 percent, and restaurant uses the remaining share. Newton Centre's retail shops serve as a destination for many, though are not a large draw for those outside of Newton itself according to studies by the city's Economic Development Commission. In fact, the Newton Centre Merchants Association is working to change the character of the Centre from a commuter point of origin to a commercial destination. The Association does not necessarily see eye-to-eye with proponents of reduced automobile use and increased transit, viewing parking spaces as the keys to local commercial success. The Association does not believe the transit stop is a significant enough mode of transportation for incoming retail and other users.

Impacts Of Rail Transit On Property Values

Roderick B. Diaz
Booz•Allen & Hamilton Inc.
Mclean, VA

ABSTRACT

Introducing rail transit into a region often creates expectations about the impact of the rail project on property values. Information on the impact of rail on property values is often incomplete and limited to anecdotal evidence, leaving regions planning for rail investments without a firm basis to judge the future impact of such an investment. In addition, this lack of complete information limits the extent to which transit agencies can develop strategies to maximize positive property value impacts. This paper summarizes a comprehensive survey of recent research on the impact of rail transit and property values. The impact of twelve rail projects (including both heavy rail and light rail) throughout North America is compared to develop general conclusions about the impact of rail on property values. In general, proximity to rail is shown to have positive impacts on property values. This conclusion is based on several measures of property value such as sales prices of single-family homes, apartment rents, and median home value. This survey of recent experience also reveals that the relative impact of rail transit is affected by a number of factors. The relative increase in accessibility provided by the new transit investment is the primary factor in increasing property values. In addition, some studies show that such factors as proximity to industrial uses or to highway facilities may limit the extent to which property values are increased. These conclusions suggest a number of strategies that transit agencies can undertake to ensure maximum property value benefit for land along future rail alignments.

INTRODUCTION

The introduction of a rail transit investment brings benefits to the transportation system and to the accessibility of the population to employment, retail, and recreation activities. Rail transit investments also introduce a variety of impacts to the area around the rail alignment. One of the most significant impacts of a rail transit project is the impact on property values. Numerous accounts of recent experiences with the impact of rail transit on property values have surfaced within the past two decades with varied results and general conclusions based on the local conditions of the rail transit systems studied. These numerous accounts often appear as isolated anecdotes in documenting the impact of rail transit on property values.

This paper presents a summary of the recent studies that examine the impact of rail transit on property values. It synthesizes the research in order to draw general conclusions and to place the various experiences in the context of one another. The summary begins with an enumeration of impacts of rail on single family homes. It continues with a discussion of additional studies that suggest that there are disparate property value effects based upon other factors. This discussion identifies various variables associated with a rail transit investment that contribute to positive and negative changes in property values. Finally, the summary ends with a suggestion that the primary positive impact of rail on property values is the impact due to accessibility.

The latter half of the paper speaks generally about another way that rail transit can affect property values, through new development. Because the documentation on the actual value increase is not as well documented as the value difference due to accessibility differences, the discussion focuses on general principles associated with the increased ability to develop land and the factors that contribute to intensification and changes in use. The paper concludes with a general discussion of strategies transit agencies can take to ensure maximum property value benefit.

IMPACTS ON PROPERTY VALUES

Positive Impacts of Rail on Residential Property

One of the more prominent ways that people understand the value of property is through the price or value of a home that they own or in the rent that they pay. Generally, individuals working in an office building or purchasing goods in a retail store do not readily know the rents charged for office space or retail space. In addition, the amount of space devoted to residential property is generally greater than that devoted to other uses. Given that the number of residential property owners or of residential renters is greater that the number of consumers of other types of real estate, the effects of rail transit on rail transit are most acutely felt in the residential sector. For these reasons, much of the research performed on the impact of rail transit on property values focuses on the impact on residential property values.

The analysis of residential property impacts begins with a study on apartment rentals around stations on the Bay Area Rapid Transit (BART) system. The Bay Area Rapid Transit system in the San Francisco Bay Area is a transit system with the most well-documented impacts in the United States. Recent studies associated with the twentieth anniversary of the regional heavy rail system have detailed the impact of BART on property values. In a study to examine the potential for housing near transit, comparisons were made between the property values of new housing developments around several transit stations (many of them newly constructed) and developments well outside of BART station areas. Rental housing units near BART were found to enjoy higher rents over those away from the BART system. For example, one bedroom apartment units within a quarter-mile of the Pleasant Hill BART station in suburban Contra Costa County, east of San Francisco, rented for approximately 10% more per square foot than one bedroom units away from BART. Following a similar pattern, two bedroom units near the station rented at approximately 16% more per square foot than comparable units in the same general area but farther from BART. Another suburban area encompassing the cities of Union City and Freemont experienced a similar pattern of higher rents for transit-proximal locations.

This pattern was not widely felt, however, throughout the BART service area. For example, in northern Alameda County area encompassing the communities of Albany, El Cerrito, and Richmond, apartment unit rents exhibited no significant difference based on the distance from the BART station. This helps to highlight that different communities experience property value benefits differently. In some communities, transit options and transit accessibility play a larger role in housing prices than in others. Examining the difference even further with tests that hold other variables constant, such as the number of bedrooms, the age of the unit, and the presence of amenities such as playgrounds or weight rooms on the site of the housing complex, the rent premium for being within one quarter-mile of BART was found to be $34 more per month. (1)

A separate study of the impacts of the BART system examined the impact on home values. Statistical models developed to analyze the impact of proximity to rail on property values showed that for every meter a house in Alameda County was located closer to the nearest BART station, its sales price in 1990 increased by $2.29. For every meter a house was closer to the nearest BART station in Contra Costa County, the sales price increased $1.96. According to the models, a house immediately adjacent to BART would sell for close to 38% more than an identical house not near any BART service (35 kilometers away). (2) Effectively, this comparison may represent the difference between the sales price of the home near a station of a mature rail system and the sales price of a home in a region without a mature rail system.

Another heavy rail system experienced mixed results with respect to the impact on property values. An analysis of single family home prices near the 21-mile heavy rail Metrorail system in Miami-Dade County, Florida revealed mixed results. In an analysis of comparing home price sales from 1971 (13 years before the 1984 opening of the heavy rail line) to 1990 (6 years after opening), property values near Metrorail stations experienced at most a 5% higher rate of appreciation in sales value compared to the rest of the City of Miami. The Miami study also found varying effects of proximity to rail. Housing prices in some neighborhoods also varied. Interestingly, the study attributed these variations to neighborhood type. For example, the introduction of Metrorail weakly increased the value of existing properties near transit stations in higher priced neighborhoods experiencing growth. Properties in neighborhoods experiencing decline showed almost no relative benefit to property values.(3)

An examination of areas near commuter rail systems in suburban Philadelphia confirms that there is a similar effect associated with commuter rail service. For two separate commuter rail systems, there are proven premiums for being near commuter rail. In suburban New Jersey, for example, the median home price for census tracts immediately served by the rail line operated by PATCO was generally 10% higher that the median home price in census tracts located away from the rail line. This differential was evident in the same direction for the Philadelphia suburbs within Pennsylvania. The average median home price for census tracts served by SEPTA commuter rail enjoy a 3.8% premium over the average median home price for census tracts not directly served by commuter rail.(4)

The Potential for Negative Impacts

Given the positive nature of the correlation between rail transit service and property values, is there any potential for negative effects caused by new transit infrastructure? Can factors such as noise, traffic, safety, or aesthetics negatively affect property values? Two recent experiences – one with light rail and one with heavy rail – place the potentially negative effects in perspective.

A 1993 study of the Eastside Metropolitan Area Express (MAX) light rail transit line reviewed the impacts of rail transit to property values in suburban Portland. In general, Portland's experience is generally consistent with the results of the studies in other areas. Within the 2 years after the 1986 beginning of operation of the rail line, residential properties in the East Burnside area within 500 meters of the transit were, on average, 10.6% greater in value than homes outside of 500 meters. Properties within the 500 meter walking distance generally experienced higher property values the closer a property was to the station. Within the immediate station area, however, nuisance effects such as noise and increased traffic reduce the potential property value impacts of those properties closest to the station area. Nevertheless, that there is a net benefit shows that, at least in the case of this particular area within metropolitan Portland, the benefit of rail transit overshadows the nuisance effects.(5)

In Atlanta, the impacts of rail transit were tested in an area of DeKalb County along the East Line of the Metropolitan Atlanta Rapid Transit Authority. This study area was chosen because the neighborhood types served by the line to the north and south of the line are dramatically different enough to demonstrate if there are relative differences due to neighborhood types. The east line follows the right of way of freight railroad tracks stretching to the east from downtown Atlanta. As such, industrial uses lie on both sides of the rail transit line, generally adjacent to the right-of-way. These industrial uses, the railroads, and the MARTA East Line form a buffer between the neighborhoods to the north and south of the right-of-way. The areas to the north of the line comprised predominantly middle class neighborhoods with some prominent affluent sections. The areas to the south of the line are predominantly lower income, lower middle class neighborhoods. In 1980, the average value of housing on the north side of the tracks were more than twice the value on the south side of the tracks. At the same time, the mean family income on the north was close to twice that on the south side. The fact that these two dramatically different neighborhood types were served by the same transit line presented the opportunity to examine if the impacts of rail transit on property values depend upon the characteristics of the neighborhood.

Examination of the effects of proximity to rail transit for these two neighborhoods showed that proximity to rail showed a positive effect on property values on the south side, but a negative effect in the neighborhood on the north side. In the neighborhood on the south side, property values increased close to $1045 for every 100 feet a property was closer to the East Line. The opposite occurred on the north side. For every 100 feet a property was closer to the East Line, property values dropped by $965. This negative effect may be due to such factors as noise, perceptions of crime, and visual intrusion. The pattern of rising property values as one travels to the north of rail tracks may also have to do with the general pattern of rising incomes as one travels to the north. In addition, proximity to the industrial uses and the freight railroad right-of-way were may also be deterrents to high property values. In the case of the south side, the value of accessibility provided by the rail line more than compensated for these nuisance effects. On the north side, the value accessibility was not enough to compensate for the nuisance effects. (6)

While the Atlanta experience appears to demonstrate the opposite effect of that shown in Miami, these differences can be explained by the assertion that rail transit imparts value to residential property in districts where the population values the access provided by that transit service the most, regardless of the income of the district. In Miami, higher growth, higher priced neighborhoods experienced a greater positive effect than stagnant, lower priced neighborhoods. In Atlanta, it appears that the opposite may be the case. The higher income neighborhoods did not appear to show value associated with being near rail while lower income neighborhoods did show positive value with that association. While this may appear to be a contradiction, these facts highlight one of the primary reasons why rail transit imparts value to properties. Rail transit shows positive correlation to property values to areas where the access provided by the transit service is valued. This is the case for both the high growth, higher valued districts in Miami and the lower income groups in suburban Atlanta.

Factors Affecting The Magnitude Of Property Value

Impact

Access to Employment

These studies all suggest that there are generally positive impacts of proximity to rail transit on property values, although some experience more pronounced increases than others. This leads to the following question. What is it about a rail transit system increases the value of property? And why do property values increase more in some cases than in others? The comparison of the Atlanta experience and the Miami experience highlight that the value of accessibility provided by rail transit accounts for a significant part of the impact on property values. The experience around the Philadelphia to Lindenwold High Speed Line supports this notion. In studying the impacts around this heavy rail connection between Philadelphia and suburbs in Southern New Jersey, is was found that there was an increase in value of $149 (in 1971 dollars) in the price of a single family home for each dollar value of time savings to the Philadelphia central business district.(7) A similar effect was felt in the Toronto area. The average premium for the average home served by the new Spadina heavy rail line was found to be C$2,237. Commute time savings contributed most to these premiums. (8) Effectively, individuals are capitalizing the time savings they receive by a lower priced commute into a higher priced home purchase.

Another study conducted in the Philadelphia area, examined the impact of commuter rail service on property values. Regional census tracts with commuter rail services averaged 12% more of their residents working in downtown Philadelphia than surrounding census tracts. Census tracts in suburban Philadelphia near Southeastern Pennsylvania Transportation Authority commuter rail lines generally had a median home price 3.8% above the median home price of census tracts not near commuter rail. Census tracts in Philadelphia suburbs in New Jersey near commuter rail lines operated by the Port Authority Transit Corporation (PATCO) demonstrated a median home price of 10% above those not near commuter rail. (4)

This experience suggests that the primary advantage of properties near rail over those not near rail transit is the additional accessibility that the rail transit line brings to those properties near transit. The added convenience of accessibility manifests itself to different types of properties. Residential properties become more attractive because residents near rail more convenient access to regional employment, retail, and cultural opportunities. Properties holding employment uses such as offices and industrial sites experience higher property values because such properties have increased access to a larger labor market. In fact, office properties demonstrate a larger property value increase compared to industrial sites because office buildings tend to cluster in more dense concentrations, allowing for the benefit of rail to be more acutely felt. Finally, retail properties often benefit from the fact that rail transit contributes to the concentration of activity and increases in pedestrian traffic in transit-accessible, pedestrian-oriented districts.

Pedestrian Accessibility

Most of the tests of the impact of rail on property values showed that the positive effects of rail transit on property values were most prominently felt within a very limited distance from transit stations. This distance is determined by the distance of a reasonable walk from the station, generally one quarter mile to one-half mile. Beyond this zone, the effect of the proximity to rail on property values is neglible. Easier automobile access to stations, therefore, has limited appreciable effects on property values. This highlights the importance of creating more the pedestrian connections to rail transit stations and the enhancing the pedestrian environment around stations.

Market Penetration

The extent of property value increase appears to be affected by the market penetration of transit in the respective area. A comparison of various California rail systems confirms this. Statistical analyses compared 5 rail systems in California – the CalTrain commuter rail line connecting San Mateo County to San Francisco and San Jose, BART in the San Francisco Bay Area, the light rail systems Sacramento, San Jose, and San Diego. The study confirmed that the that those systems with the highest rates of ridership and that reached more locations within their respective regions, such as BART and the San Diego Trolley experienced the most significant association between distance from transit stations and property values. Property values in the regions these systems serve increased more than $2 per meter the closer the property was to the transit alignment. This effect was stronger and more significant in some portions of these regions than in others. Proximity to the CalTrain commuter rail service, and the Sacramento light rail system and the San Jose light rail transit system exhibited a negative relationship between proximity to the line and property values. The study suggested, however, that this negative effect may have been due to proximity to heavy industry and freeways near the light rail tracks. (9) This comparison suggests that rail systems that enjoy the highest rates of usage enjoy the greatest property value increases. This reinforces the notion that rail transit accessibility is one of the strongest determinants of property value increases.

Development Impacts

As the summary of studies shows, research on the impact of rail on property values has focused primarily on comparing the effect of distance from the rail system on property values. As just mentioned, this comparison suggests that the primary influence on property values is the improvement in regional accessibility that a rail transit investment brings. However, measuring the effect of proximity to rail at one point in time fails to capture the second major effect of rail on property values. Rail transit may make locations near transit more valuable as sites for potential development, thus increasing the value of property at those locations.

Second, rail transit can make a property a more attractive site for a higher level of development. Often, property owners decide they can develop their vacant parcels in order to capitalize on the proximity to transit. In other cases, an existing low density use can be converted to a higher density use or another type of use altogether. The conversion of properties from previously vacant sites to developed sites imparts additional value to the property. An informal survey of properties in Hillsborough County in Florida suggested that the average appraised value of developed parcels within the urbanized core was approximately $19,000 greater per acre than that of undeveloped parcels in the same urbanized core. A review of the BART system 20 years after the beginning of revenue operation revealed that there were more significant changes in land use and density around the rail transit stations than near nearby highway intersections. Such change, however, has depended on the willingness of local jursidictions to accommodate such development growth. (Cervero and Landis 1995, unpublished)

Policies to Maximize Positive Impacts of Rail on Property Values

Given that there are proven positive impacts of rail on property values because of new accessibility and the because of the ability to attract new and more intense development, how best can transit agency maximize the potential for a property value increase? This section presents several strategies that transit agencies can undertake to maximize the positive impact on property values of a rail transit investment. As discussed earlier, there are two primary ways that property values can increase due to a rail transit investment. This section, therefore, groups the strategies into ways to improve accessibility and ways to improve the possibility of new development. In addition, this section briefly mentions strategies to minimize the potential negative impacts of a rail transit system.

Improving Accessibility

Plan for Regional Accessibility

Improving accessibility provided by rail requires that the rail line or rail system be planned to reach regional accessibility centers quickly. When planning rail transit alignments, it is important, therefore, to place the rail line within a reasonable walking distance of current and planned regional employment centers, cultural centers, and retail opportunities. In fact, locations with high levels of employment accessibility, either through highways or through transit, generally have higher housing prices and rents that locations with less employment accessibility. (10) Any factor that increases the length of travel time to other locations near the rail system will unnecessarily reduce the accessibility provided by the rail transit investment. This reduction in the value of rail transit will result in lower than potential property value increases. Placing a rail transit station at locations far from strong centers of development will limit the accessibility provided by rail transit and therefore limit the impact on property values.

Maximizing the accessibility provided by the rail is also impacted by the plan for operations. Strategies to increase speed such as providing separate right-of-way to improve running speeds can reduce travel time to locations along the line. Increasing frequencies also increases the level of service provided by a rail line. In addition, providing some limited service by skipping stops at times of the day or by building fewer stops can improve accessibility in the region.

Table 1: SUMMARY OF THE IMPACT OF RAIL TRANSIT FACILITIES ON PROPERTY VALUES

AUTHORS	RAIL MODE	LOCATION (TRANSIT FACILITY)	EXTENT OF PROPERTY VALUE IMPACT	MAJOR CONCLUSIONS
Boyce, David et al. (1972)	Heavy Rail	Southern New Jersey (Philadelphia – Lindenwold High Speed Line)	positive increase of $149 (1971 $) in the price of a home for each dollar of value in time savings	• Property values incorporate travel time to major employmen centers.
Bajic, Vladimir (1983)	Heavy Rail	Toronto (Spadina Line)	$2,237 premium for the average home	• Commute time savings contributes most to home value premiums
Voith (1991)	Commuter Rail	Southern New Jersey (PATCO) Suburban Philadelphia (SEPTA)	+10% premium for median home price in census tracts served by rail line +3.8% premium for median home price in census tracts served by rail line	• Proximity to commuter rail service has some minor positive median home values
Nelson, Arthur (1992)	Heavy Rail	Atlanta, Georgia (MARTA East Line)	+$1,000 on home prices for each 100 feet a house is closer to a rail station in low-income transit adjacent census tracts; a slight negative effect in high income tracts (although this may be due to proximity to industrial uses or to low income neighborhoods)	• For lower income neighborhoods, the benefit effects of accessibility more than offset any nuisance effects. • Higher value homes may be more sensitive to nuisance effe than by improvements in accessibility.
Al-Mosaind, Musaad, et al. (1993)	Light Rail	Portland, Oregon (MAX Eastside line)	+10.6% for homes within 500 meters	• Where transit plays a minor role, transit's impact on propert values is minimal. • Positive effects of accessibility are stronger than the negativ nuisance effects.
Gatzlaff, Dean and Smith Marc (1993)	Heavy Rail	Dade County, Florida (Miami Metrorail)	at most a 5% higher rate of appreciation in real estate sales value compared to the rest of the City of Miami	• Residential values were, at most, only weakly impacted by t announcement of the new rail system • Higher priced neighborhoods have experienced greater increases in property values near Metrorail stations while declining ones have not
Landis, John et al. (1994)	Heavy Rail, Light Rail, and Commuter Rail	San Mateo County (CalTrain) San Francisco Bay Area (BART) Sacramento (Light Rail) San Jose (Light Rail) San Diego (The Trolley)	negative effect on proximity to Caltrain +$2.29 per meter closer to BART in Alameda Co.; +$1.96 per meter in Contra Costa Co. no discernable positive or negative impact -$1.97 per meter closer to light rail (but negative effect may be due to proximity to industrial and commercial uses) +$2.72 per meter closer to the Trolley	• The extent to which a rail system captures ridership from its market area affects the extent to which property values are increased • Frequency of service and regional accessibility affect the amenity of a rail system
Cervero, Robert (1996)	Heavy Rail	San Francisco Bay Area (Bay Area Rapid Transit)	+10-15% in rent for rental units within 1/4 mile of BART	• Units within a quarter-mile of the Pleasant Hill Bart station rented for around $34 more per month than comparable unit farther away.

Improve Pedestrian Station Accessibility

Positive property value impacts are primarily felt within a limited zone around transit stations, generally a reasonable walking distance of up to one-quarter or one-half mile. Enhancing pedestrian accessibility from the station to the surrounding area can thus increase the likelihood that properties will fall within a reasonable walking distance of the station and therefore experience a benefit to the their value. Improvements to station area accessibility can take the form of increasing the density of streets and pedestrian paths, improving safety, lighting, and other pedestrian amenities, and by providing additional station entrances and portals to allow direct access to the station from more locations.

Minimize Negative Impacts of the Rail Investment

Although the exact impact of nuisance variables such as noise, and visual obstruction caused by at-grade and elevated rail guideways has not been extensively reviewed, several studies at least suggest that such nuisances do lessen the amount of property value benefit that properties near the rail alignment and rail stations experience (6). Rail investment planning thus should seek to mitigate these types of effects through effective design and engineering.

The examination of the impact of proximity to the MARTA east line in Atlanta may have also suggested that proximity to industrial uses often has a negative effect on property values. Because the most available railroad rights-of-way for developing rail transit investments often occur in industrial districts, it is important to plan for a conversion of uses to more transit-compatible uses. Transit agencies can help local municipalities and jurisdictions plan for appropriate buffer uses between the remaining industrial land and the transit station area. In the longer term, plans can potentially incorporate the eventual conversion of uses to more transit-compatible ones such as housing or commercial space. Recent experiences with joint development indicates that industrial sites often provide for attractive opportunities for redevelopment.

Improving Potential for New Development

Assemble Development Sites

Transit agencies are often left with surplus sites after completion of a rail transit investment. Often, these sites are no longer necessary for the operation of the transit system. Surplus sites, however, are often characterized by irregular shapes and small size. These constraints limit the attractiveness of these properties as locations for development. Partnerships with adjacent property owners and with local jurisdictions can, however, enable the assembly of these sites can facilitate the assembly of these sites into larger, more flexible sites that allow for a broader range of development options. The federal government has historically allowed lease of property to private developers as long as revenues were used for transit purposes. Recently, the federal legislation has permitted the sale of property for limited purposes.

Introduce Incentives and Reduce Regulation for Development Near Stations

Often, developers are hesitant to be the first to enter a particular market niche. Development to capitalize on rail transit is often a new phenomenon to read estate developers in a given region because rail is often new to certain regions. Therefore, assorted incentives, both with increased financial incentives and decreased regulation may provide the jump start necessary to attract more developers to take advantage of transit-adjacent sites. Such incentives may include low-cost financing, mortgage guarantees, waivers or reductions in impact fees, and incentives to promote mixed uses.(11)

Support Joint Development

Developers in cities with new rail transit systems often have little experience with developing around transit stations. Transit agencies can perform a role as a catalyst by partnering with private developers to jointly develop property adjacent to transit stations. Activities that support joint development can include providing information on available sites for development, by establishing a process to receive, evaluate, and approve development proposals, and by providing assistance in the public outreach during the development review process. Joint development also has the additional benefit of increasing the attractiveness of the station area. Coordinated planning around stations for property around station

CONCLUSIONS

Rail transit investments have proven positive effects on property values. In fact, the effect of a new fixed guideway transit investment is two-fold. First, transit investments improve the convenience of accessing other parts of a region from station locations. Second, rail transit accessibility enhances the attractiveness of property, increasing the likelihood that the property can be developed or redeveloped to a more valuable and more intense use. Documentation of the impact of rail transit on property values primarily focuses on the first effect. Property value premiums due to increases in accessibility range between 3% and 40%. Property value premiums due to increases in the ability to develop or redevelop property depend on the land use and amount of development allowed on the property. Slight negative impacts of rail on property values are generally attributed to noise, visual intrusion, and the association of the rail right-of-way with industrial uses.

Transit agencies can undertake a number of strategies to increase the potential to increase property values with fixed guideway investments. To increase the effect of improved accessibility, transit agencies can plan rail lines to be serve the most prominent existing and planned development clusters. It can also orient the operating plan to provide for the maximum accessibility benefit by limiting the number of stops and planning for higher speed services. In addition, a transit agency can work with local jurisdictions to enhance pedestrian accessibility in station areas. Enhancements such as increased density of streets and walkways and safety improvements, and can make the positive impacts of rail transit on adjacent properties more apparent. To increase the positive impact of rail transit through new development, transit agencies can work to assemble development sites and undertake joint development activities. It can also work to enable development and redevelopment of station sites through support of development incentives and enhanced zoning.

ENDNOTES

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7. David E. Boyce et al., Impact of Rapid Transit on Suburban Residential Property Values and Land Development, U.S. Department of Transportation, 367 pp, 1972.
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9. John Landis, Subrajit Guhathakurta, Ming Zhang , "Capitalization of Transit Investments into Single-Family Home Prices," Working Paper, University of California Transportation Center, 38pp, 1994.
10. Kara Maria Kockelman, "Effects of Location Elements on Home Purchase Prices and Rents in San Francisco Bay Area," Transportation Research Record 1606, pp. 40-50, 1997.
11. Elizabeth Deakin, Tilly Chang, and Michael Bernick, Implementation of Residential Development at Rail Transit Stations in California: Case Studies and Policy Options, California Department of Transportation, 70 pp., 1992.

Table 1: SUMMARY OF THE IMPACT OF RAIL TRANSIT FACILITIES ON PROPERTY VALUES

AUTHORS	RAIL MODE	LOCATION (TRANSIT FACILITY)	EXTENT OF PROPERTY VALUE IMPACT	MAJOR CONCLUSIONS
Boyce, David et al. (1972)	Heavy Rail	Southern New Jersey (Philadelphia – Lindenwold High Speed Line)	positive increase of $149 (1971 $) in the price of a home for each dollar of value in time savings	• Property values incorporate travel time to major employmer centers.
Bajic, Vladimir (1983)	Heavy Rail	Toronto (Spadina Line)	$2,237 premium for the average home	• Commute time savings contributes most to home value premiums
Voith (1991)	Commuter Rail	Southern New Jersey (PATCO) Suburban Philadelphia (SEPTA)	+10% premium for median home price in census tracts served by rail line +3.8% premium for median home price in census tracts served by rail line	• Proximity to commuter rail service has some minor positive median home values
Nelson, Arthur (1992)	Heavy Rail	Atlanta, Georgia (MARTA East Line)	+$1,000 on home prices for each 100 feet a house is closer to a rail station in low-income transit adjacent census tracts; a slight negative effect in high income tracts (although this may be due to proximity to industrial uses or to low income neighborhoods)	• For lower income neighborhoods, the benefit effects of accessibility more than offset any nuisance effects. • Higher value homes may be more sensitive to nuisance effe than by improvements in accessibility.
Al-Mosaind, Musaad, et al. (1993)	Light Rail	Portland, Oregon (MAX Eastside line)	+10.6% for homes within 500 meters	• Where transit plays a minor role, transit's impact on propert values is minimal. • Positive effects of accessibility are stronger than the negativ nuisance effects.
Gatzlaff, Dean and Smith Marc (1993)	Heavy Rail	Dade County, Florida (Miami Metrorail)	at most a 5% higher rate of appreciation in real estate sales value compared to the rest of the City of Miami	• Residential values were, at most, only weakly impacted by t announcement of the new rail system • Higher priced neighborhoods have experienced greater increases in property values near Metrorail stations while declining ones have not
Landis, John et al. (1994)	Heavy Rail, Light Rail, and Commuter Rail	San Mateo County (CalTrain) San Francisco Bay Area (BART) Sacramento (Light Rail) San Jose (Light Rail) San Diego (The Trolley)	negative effect on proximity to Caltrain +$2.29 per meter closer to BART in Alameda Co.; +$1.96 per meter in Contra Costa Co. no discernable positive or negative impact -$1.97 per meter closer to light rail (but negative effect may be due to proximity to industrial and commercial uses) +$2.72 per meter closer to the Trolley	• The extent to which a rail system captures ridership from its market area affects the extent to which property values are increased • Frequency of service and regional accessibility affect the amenity of a rail system
Cervero, Robert (1996)	Heavy Rail	San Francisco Bay Area (Bay Area Rapid Transit)	+10-15% in rent for rental units within 1/4 mile of BART	• Units within a quarter-mile of the Pleasant Hill Bart station rented for around $34 more per month than comparable uni farther away.

3

Existing Conditions

This chapter provides information on the existing conditions of the study area neighborhoods in East Cambridge, Somerville, Medford Hillside, and West Medford. It includes information on demographics, travel behavior, roadways and congestion management areas, development patterns and study area projects.

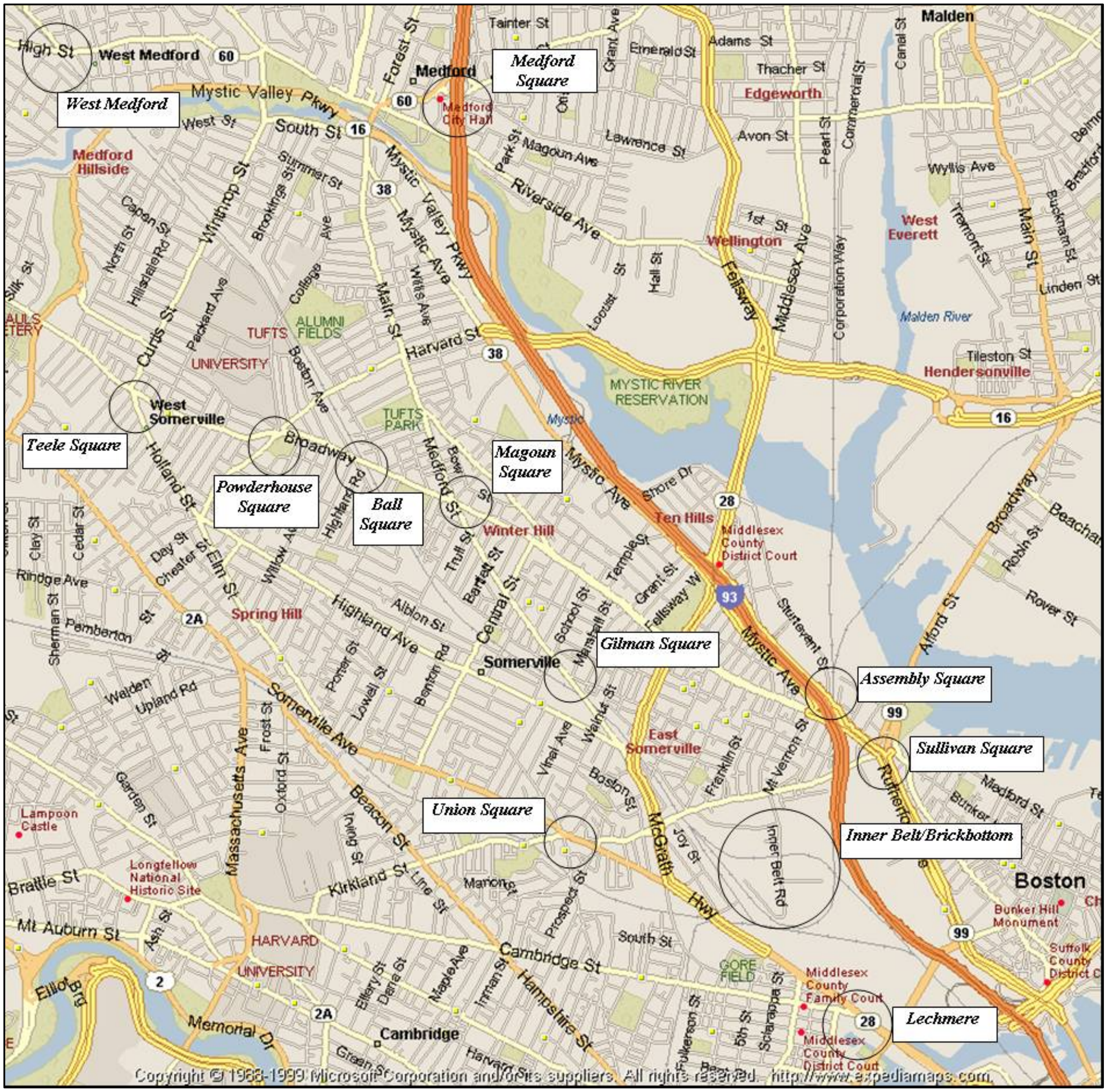
3.1 Description of Study Area

The study area for the Beyond Lechmere Northwest Corridor Study is bounded by Interstate 93 and the Orange Line to the east, the Somerville/Cambridge Line to the west, Lechmere Station on the south and the West Medford Commuter Rail Station to the north. Many of the neighborhoods in East Cambridge, Somerville, and Medford Hillside, and West Medford are focused on neighborhoods or "squares", where commercial activity serving surrounding residential areas is concentrated. Residents often walk to and from these commercial areas to meet their daily commerce needs. Neighborhoods and squares within the study area include:

- Lechmere
- Inner Belt/Brickbottom
- Union Square
- Gilman Square
- Magoun Square
- Ball Square
- Powderhouse Square
- Medford Hillside/Tufts
- Teele Square
- West Medford

Figure 3-1 shows the locations of neighborhoods and squares within the study area.

Figure 3-1 – Study Area Neighborhoods and Squares



3.2 Overview of Transportation Facilities and Service in Corridor

Travel in the study area is oriented towards downtown Boston and neighboring urban centers. On the southern end of the study area, transit markets are served by the Green Line Light Rail Transit service at Lechmere Station. On the eastern and western edges of the study area, transit markets are served by rapid transit facilities (Red and Orange Lines). The Red Line also serves intermediate stations at Porter Square in Cambridge and Davis Square in Somerville. Within the study area, local buses provide connections to the Red, Orange and Green Lines.

The MBTA operates fifteen bus routes that serve the study area. Fourteen of the fifteen services require passengers destined to/from Boston employment centers to transfer at least once during their trip. The quality of the existing bus service in the study area generally meets the MBTA's Service Delivery Policy for loading. However, schedule adherence is a problem in the study area, as only one route, the Route 85, meets the Service Delivery Policy's standards for schedule adherence. This is a typical problem for surface bus routes in areas with traffic congestion as is found in Union Square, Davis Square, Medford Hillside and West Medford Square, among other locations in the project area. The traffic congestion at these locations often leads to service delays on the entire route.

Commuter rail service in the study area is provided in West Medford via the MBTA's Lowell Line, also known as the New Hampshire Main Line. There are no commuter rail stops in Somerville on the Lowell Line. Commuter rail service is provided on the western edge of the study area via the MBTA's Fitchburg Commuter Rail Line at Porter Square. Guilford Rail System (GRS) operates freight service over both the Fitchburg and Lowell Lines. The community of Somerville has voiced concerns that there are four transit rail lines (two commuter rail and two rapid transit lines) running through the city with one subway stop at the western periphery and no commuter rail stops. The community of Medford has expressed concerns about the physical condition of West Medford Station.

3.3 Source Documents

In compiling the information provided in this document a number of sources were utilized. The following is a brief summary of the source documents:

- Assembly Square Mixed-Use District, City of Somerville Office of Housing and Community Development , 2004
- Beyond Lechmere Alternatives Evaluation Report, MBTA/Lane, Frenchman, and Associates/Fay Spofford and Thorndike, Inc., 1984
- Boston Region MPO: Regional Transportation Plan 2004-2025, Boston Metropolitan Planning Organization Region, 2003
- Changes to Service Delivery Policy, Massachusetts Bay Transportation Authority, Adopted December 2002.
- Circumferential Transportation Improvements in the Urban Ring Corridor - Expanded Environmental Notification Form (ENF), Earth Tech, 2001
- Circumferential Transportation Improvements in the Urban Ring Corridor - Phase Two Draft Environmental Impact Report/Statement (DEIR/S) Scoping Summary Report, EarthTech, 2001

- Evaluation of Transit Alternatives Beyond Lechmere Station, MBTA, 1981
- Inner Belt Planning Study - Technical Memorandum I: Existing Conditions, City of Somerville Office of Housing and Community Development, 2001
- Load Profiles, MBTA Comprehensive Ridecheck Program, Winter 1997/1998 through Winter 2003.
- MassHighway Accident Database, 1998 - 2002
- MassHighway 2002 Traffic Volume Database
- MBTA Bus and Train Service Schedules, www.mbta.com, June 2004.
- MBTA Commuter Rail Train Audit, Massachusetts Bay Commuter Railroad Company, December 2003.
- MBTA Reverse Commuting Study, Central Transportation Planning Staff, 2001.
- McGrath Highway Corridor - Technical Memorandum 1: Existing Conditions, City of Somerville Office of Housing and Community Development, 2002
- North Point Somerville - Planning Study, ICON Architects/FMX Associates/Bruce Campbell and Associates/City of Somerville Office of Housing and Community Development, 2003
- Preliminary 2004 Service Plan: Proposed Bus Service and Service Policy Modifications, Massachusetts Bay Transportation Authority, 2004.
- Ridership and Service Statistics, Eighth Edition, Massachusetts Bay Transportation Authority, 2001.
- Service Delivery Policy, Massachusetts Bay Transportation Authority, Sept., 1996
- Somerville Community Path Feasibility Study, Rizzo Associates/ICON Architecture, 2001
- Streetcar Lines of the Hub, Clarke, Bradley H., Boston Street Railway Association, 2004
- Streetcar Suburbs, Warner, Samuel, Harvard University Press, 1962
- Transportation Element for the Somerville Community Development Plan: Crashes 1995-1999, Central Transportation Planning Staff.
- Truck Traffic Study in the City of Somerville for the Department of Traffic & Parking, Bayside Engineering, 2001
- Union Square Master Plan, Bluestone Planning Group, 2003
- Union Square Transportation Plan, Executive Summary City of Somerville Office of Housing and Community Development/Edwards and Kelcey

3.4 Demographics and Travel Behavior

Data from the 1990 and 2000 U.S. Census were reviewed to identify population, employment, and travel behavior within the study area. These characteristics are summarized in the following sections.

3.4.1 Population

According to the U.S. Census, the 2000 population in the study area communities at the municipality level were: 55,765 in Medford; 101,355 in Cambridge; and 77,478 in Somerville. The study area has been further broken down to reflect the individual census tracts for the purpose of summarizing demographics and travel behavior. Figure 3-2 delineates the census tracts included within the study area.

Figure 3-2 – Study Area Census Tracts

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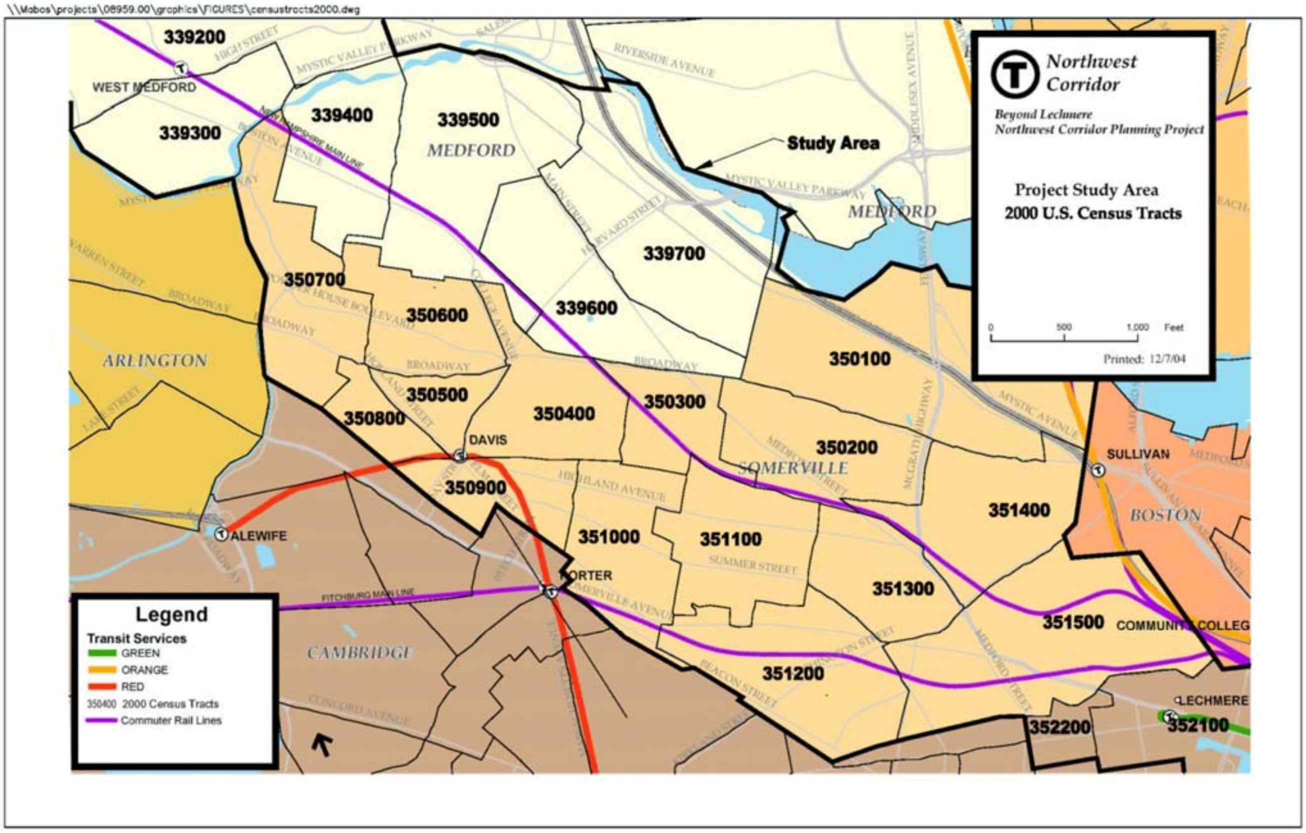


Table 3-1 shows the relationship between population, land area and population density for the census tracts contained within the study area. Median age, housing values and household income are also provided.

Table 3-1 – Population and Demographics by Census Tract

By Census Tract	Total Population	Land Area (square miles)	Population Density (population/ square mile)	Median Age	Median Housing Values	Median Household Income
Medford Tracts						
Tract 3392	5,883	1.0	5,794	41.9	$280,800	$71,295
Tract 3393	3,017	0.3	11,189	38.6	$194,000	$51,352
Tract 3394	3,512	0.2	14,396	33.8	$238,100	$48,607
Tract 3395	5,702	0.5	12,112	25.6	$230,500	$56,477
Tract 3396	5,042	0.3	15,842	34.5	$249,200	$51,681
Tract 3397	4,039	0.5	8,632	35.9	$230,300	$45,149
Somerville Tracts						
Tract 3501	8,964	0.7	12,934	31	$244,600	$40,436
Tract 3502	6,806	0.3	25,208	33	$244,800	$45,326
Tract 3503	2,457	0.2	16,213	33.2	$191,500	$46,610
Tract 3504	5,921	0.2	25,128	30.9	$313,900	$56,643
Tract 3505	1,639	0.1	18,572	31.3	$340,400	$60,700
Tract 3506	4,665	0.2	23,390	22.1	$332,000	$56,094
Tract 3507	6,096	0.3	19,398	31.2	$313,100	$44,766
Tract 3508	1,743	0.1	21,222	30.3	$311,900	$54,457
Tract 3509	3,106	0.2	20,331	30.6	$339,600	$54,799
Tract 3510	6,395	0.3	25,064	29.5	$277,800	$53,563
Tract 3511	5,932	0.3	22,622	32.9	$251,500	$50,465
Tract 3512	8,451	0.4	22,329	29.8	$231,700	$48,452
Tract 3513	4,336	0.2	22,196	33.7	$260,200	$33,516
Tract 3514	8,881	0.3	28,860	31	$219,700	$36,113
Tract 3515	2,086	0.5	3,982	34.4	$167,200	$36,516
Cambridge Tracts						
Tract 3521	3,079	0.3	9,910	31.8	$356,100	$48,529
Tract 3522	1,974	0.1	32,950	35.6	$205,400	$23,750
Overall Study Area	**109,726**	**7.3**	**15,100**			

Sources: Data from 2000 United States Census

3.4.2 Population and Health

On the following page, Table 3-2 summarizes data gathered from the Massachusetts Department of Public Health's (DPH) Mass Community Health Information Profile (MassCHIP) for Cambridge, Medford, and Somerville, as well as statewide. Also included in the table are key chronic disease objectives (target rates) set forth by DPH. Each community's current rate can be compared to the target rate.

Table 3-2 – Population and Health Status Indicators

		Statewide	Cambridge	Medford	Somerville
Demographic Indicators*					
Per Capita Income		$25,952	$31,156	$24,707	$23,628
Population below 100% of poverty level (%)		9.3	12.9	6.4	12.5
Population below 200% of poverty level (%)		21.7	27.8	18.7	26.6
Children less than 18 years of age living below 100% of poverty line (%)		12.0	15.6	6.1	15.2
Unemployed Person age 16 and older (%)		5.3	3.8	4.6	4.5
White non-Hispanic persons (%)		83.9	67.9	87.2	77.7
Black non-Hispanic persons (%)		5.3	12.1	6.2	6.6
Hispanic persons (%)		6.8	7.4	2.6	8.8
Asian persons (%)		3.9	12.4	4.0	6.8
		Actual			
	Target Age-adjusted Rate**	**Statewide Age-adjusted Rate****	**Cambridge Age-adjusted Rate****	**Medford Age-adjusted Rate****	**Somerville Age-adjusted Rate****
Chronic Disease Indicators					
Total cancer deaths	------	202.4	186.4	215.4	233.9
Cardiovascular disease deaths	-----	284.2	270.8	259.3	253.5
Hospital Discharges for Primary Care Manageable Conditions					
Asthma	-----	130.8	123.1	126.6	137.7
Chronic Disease Objectives					
Reduce the overall cancer death rate. (All types of cancer)	44.9	202.4	186.4	215.4	233.9
Reduce asthma deaths - under 5 years of age. ***	0.1	0.3	0.0	0.0	0.0
Reduce asthma deaths - ages 5 to 14 years.***	0.1	0.4	0.0	0.0	0.0
Reduce asthma deaths - ages 15 to 34 years.***	0.2	0.5	2.1	0.0	0.0
Reduce asthma deaths - ages 35 to 64 years.***	0.9	1.3	6.3	4.9	0.0
Reduce asthma deaths - ages 65 years or older.***	6.0	4.5	10.8	0.0	0.0
Reduce hospitalizations for asthma - under 5 years of age.****	250.0	346.1	290.3	404.7	400.7
Reduce hospitalizations for asthma - age 5 to 64 years.****	77.0	105.6	71.8	87.7	88.0
Reduce hospitalizations for asthma - 65 years and older.****	110.0	173.6	162.8	165.6	233.3
Chronic obstructive pulmonary diseases - ages 45 years and older.	60.0	121.7	95.3	116.5	116.1

Notes:

*2000 Census Counts or Sampling Data - most recent population estimates

Denominator for persons age less than 18 and living in poverty is all persons age less than 18.
Unemployment rate: all unemployed persons in labor force divided by all persons in labor force.
AFDC recipients percent denominator is persons age less than 65 (eligible population based on age)
Multiple Assistance Unit recipients percent denominator is persons less than age 25 (eligible population based on age)

**Age adjusted rates: A procedure for adjusting rates, designed to minimize the effects of age differences in age distributions when comparing rates for different populations. Age-adjusted rates are expressed per 100, 000 persons. For standardization within Mass Community Health Information Profile (MassCHIP) the standard population used is the 2000 US population.

***Objective has been reworded, but it maintains its meaning. Objectives seek a rate of death per 1.0 million. The modified definition converts the rate of deaths per 100,000.

****MassCHIP can only approximately measure the objective. Hospital discharges data set does not include emergency room visits, where many cases of asthma are seen. Objectives have been reworded, but maintain the same meaning. The objectives seek a rate of hospitalizations per 10,000. The modified definition converts the rate to deaths per 100,000.

3.4.3 Population and Employment

Table 3-3 shows the relationship between population and employment for the cities that will be served by improved transit in the study area. Journey to work information for 2000 currently is only available at the municipality level. Based on journey to work information, a resident to job ratio by municipality is shown to give an indication of whether the city is a net importer or exporter of workers. These data consider only the existing flows of commuters between the cities.

Table 3-3 – Population and Employment

	Municipality of Residence			
Category	**Cambridge**	**Medford**	**Somerville**	**Boston**
Population*	101,355	55,765	77,478	589,141
Employment**	113,500	19,000	23,000	578,500
Resident to Job Ratio	0.89	2.93	3.37	1.02

Sources:
* Data from 2000 Census Minor Civil Division (MCD) Journey to Work Tables
** Data from the Mass Division of Employment and Training (DET) for 2001

From this table, the following is indicated:

- Boston and Cambridge are regional job centers. Both cities nearly double their population in the daytime because of job supply.
- Somerville and Medford have populations about three times greater than their job supply.

3.4.4 Travel Behavior for Residents

Table 3-4 presents the travel characteristics of residents at the municipality level. This information was obtained from 2000 Census Minor Civil Division (MCD) Journey to Work Tables.

Table 3-4 – Commute Travel Behavior for Residents

	Municipality of Residence			
Category	**Cambridge**	**Medford**	**Somerville**	**Boston**
Population*	101,355	55,765	77,478	589,141
Percent of Resident Labor Force Working in Cambridge*	46 %	11 %	20 %	6 %
Percent of Resident Labor Force Working in Medford*	1 %	17 %	4 %	0 %
Percent of Resident Labor Force Working in Somerville*	2 %	5 %	16 %	1 %
Percent of Resident Labor Force Working in Boston*	27 %	25 %	28 %	66 %
Percent of Residents who Work in Study Area	76 %	58 %	68 %	73 %
Percent of Residents who Work Beyond the Study Area	24 %	42 %	32 %	27 %

Sources:
* Data from 2000 Census Minor Civil Division (MCD) Journey to Work Tables

Table 3-4 indicates the following travel behaviors for residents in the study area, based on municipality level data:

- **Medford** - Medford has the highest proportion of people who work outside the study area (42%). Within the study area, the largest concentration of employment for Medford residents is in Boston (28%). A modest number of Medford residents also work in Medford (17%) and in Cambridge (11%). The smallest work location percentage for Medford residents is Somerville (5%).
- **Somerville -** A large portion of Somerville residents work in Cambridge (20%) and Boston (28%). Interestingly, Somerville has the smallest percentage of residents who work in their city of residence (16%). A small percentage of Somerville residents work in Medford (4%).
- **Cambridge** – 46% of Cambridge residents also work in Cambridge, while a small portion of Cambridge residents work in Medford (1%) or Somerville (2%). Overall, 76% of Cambridge residents work within the study area.
- **Boston** - Data shows that a relatively small portion of Boston residents commute to Medford and Somerville (1%). Employment for Boston residents is concentrated in Boston; although, a moderate portion of Boston residents commute to Cambridge (6%).

3.4.5 Travel Behavior for Workers

The previous section evaluated the work commute travel behavior of residents in the study area. This section provides an employment-based perspective of travel patterns. The data indicate how each municipality functions in the Boston metropolitan regional economy. Table 3-5 presents the travel characteristics of workers employed in each of the municipalities.

Table 3-5 –Travel Behavior Data for Workers

	Municipality of Workplace			
Category	**Cambridge**	**Medford**	**Somerville**	**Boston**
Employment**	113,500	19,000	23,000	578,500
Percent of Workers who Live in Cambridge*	22 %	2 %	6 %	3 %
Percent of Workers who Live in Medford*	3 %	25 %	6 %	1 %
Percent of Workers who Live in Somerville*	8 %	8 %	31 %	2 %
Percent of Workers who Live in Boston*	14 %	7 %	9 %	36 %
Percent of Workers who Live in the Study Area	47 %	42 %	52 %	42 %
Percent of Workers who Live Beyond Study Area	53 %	58 %	48 %	58 %

Sources:
* Data from 2000 Census Minor Civil Division (MCD) Journey to Work Tables
** Data from the Mass Division of Employment and Training (DET) for 2001

Table 3-6 presents the travel mode to work of employed residents within the study area, based on 2000 U.S. Census Tract data. As shown in this table, 27% of employed residents take public transportation to work in the study area census tracts. Forty-nine percent of employed residents drive alone to their jobs, and 10% of employed residents reported carpooling as their means of transportation to work.

Table 3-6 –Travel Modes to Work by Census Tract

Census Tracts	Mode of Transportation to Work											
	Drive alone		Carpool		Public Transportation		Bicycle		Walk		Other/ Work at Home	
	Pop.	%	Pop.	%	Pop.	%	Pop.	%	Pop.	%	Pop.	%
Medford Tracts												
Tract 3392	2,269	73%	202	6%	531	17%	29	<1%	23	<1%	72	2%
Tract 3393	957	60%	76	5%	465	29%	18	1%	24	2%	50	3%
Tract 3394	1,082	58%	168	9%	396	21%	27	1%	155	8%	28	2%
Tract 3395	1,508	54%	183	7%	515	18%	5	<1%	500	18%	90	3%
Tract 3396	1,924	66%	231	8%	586	20%	14	<1%	76	3%	70	2%
Tract 3397	1,154	55%	410	20%	397	19%	25	1%	72	3%	29	1%
Subtotal	**8,894**		**1,270**		**2,890**		**118**		**850**		**339**	
Average		**62%**		**9%**		**20%**		**<1%**		**6%**		**2%**
Somerville Tracts												
Tract 3501	2,201	51%	855	20%	904	21%	29	<1%	246	6%	61	1%
Tract 3502	2,061	53%	594	15%	922	24%	63	2%	162	4%	118	3%
Tract 3503	805	56%	125	9%	358	25%	62	4%	47	3%	50	3%
Tract 3504	1,620	44%	234	6%	1,365	37%	48	1%	263	7%	153	4%
Tract 3505	482	43%	26	2%	505	45%	13	1%	74	7%	34	3%
Tract 3506	942	37%	139	5%	605	24%	63	2%	701	27%	108	4%
Tract 3507	1,870	53%	195	6%	1,054	30%	25	<1%	259	7%	123	3%
Tract 3508	475	42%	66	6%	513	45%	19	2%	36	3%	24	2%
Tract 3509	840	37%	97	4%	1,033	46%	50	2%	174	8%	66	3%
Tract 3510	1,793	41%	255	6%	1,635	37%	202	5%	458	10%	70	2%
Tract 3511	1,822	51%	278	8%	915	26%	125	4%	308	9%	123	3%
Tract 3512	1,833	35%	556	11%	1,278	25%	372	7%	921	18%	205	4%
Tract 3513	1,096	46%	279	12%	621	26%	80	3%	232	10%	69	3%
Tract 3514	2,095	47%	756	17%	1,175	27%	59	1%	234	5%	108	2%
Tract 3515	428	40%	193	18%	246	23%	41	4%	131	12%	28	3%
Subtotal	**20,363**		**4,648**		**13,129**		**1,251**		**4,246**		**1.340**	
Average		**45%**		**10%**		**29%**		**3%**		**9%**		**3%**
Cambridge Tracts												
Tract 3521	593	39%	105	7%	380	25%	23	2%	314	21%	89	6%
Tract 3522	317	35%	62	7%	229	25%	21	2%	269	30%	11	1%
Subtotal	**910**		**167**		**609**		**44**		**583**		**100**	
Average		**38%**		**7%**		**25%**		**2%**		**24%**		**4%**
Overall Total	**30,167**		**6,085**		**16,628**		**1,413**		**5,679**		**1,779**	
Study Area Average		**49%**		**10%**		**27%**		**2%**		**9%**		**3%**

Note:
The Other/Work at Home category includes the U.S. Census Bureau categories Other, Motorcycle, and Work at Home.

Table 3-7 summarizes the auto availability by census tract within the study area. As shown in this table, 21% of the households within the study area do not own a vehicle.

Table 3-7 –Auto Availability by Census Tract

	Occupied Housing Units	Occupied Housing Units with No Vehicle Available	% of Occupied Housing Units with No Vehicle Available
Medford Tracts			
Tract 3392	2,196	135	6%
Tract 3393	1,248	197	16%
Tract 3394	1,500	296	20%
Tract 3395	1,631	161	10%
Tract 3396	2,097	311	15%
Tract 3397	1,603	189	12%
Subtotal	**10,275**	**1,289**	
Average			**13%**
Somerville Tracts			
Tract 3501	3,343	745	22%
Tract 3502	2,653	525	20%
Tract 3503	1,020	166	16%
Tract 3504	2,522	348	14%
Tract 3505	734	141	19%
Tract 3506	1,090	123	11%
Tract 3507	2,783	811	29%
Tract 3508	768	148	19%
Tract 3509	1,492	286	19%
Tract 3510	2,964	570	19%
Tract 3511	2,539	536	21%
Tract 3512	3,579	1,009	28%
Tract 3513	2,006	677	34%
Tract 3514	3,111	779	25%
Tract 3515	951	310	33%
Subtotal	**31,555**	**7,174**	
Average			**23%**
Cambridge Tracts			
Tract 3521	1,524	397	26%
Tract 3522	1,124	547	49%
Subtotal	**2,648**	**944**	
Average			**36%**
Overall Total	**44,478**	**9,407**	
Study Area Average			**21%**

Table 3-8 demonstrates the average times it takes for residents to travel to work. The travel times are based on the number of workers over the age of 16 in each census tract and broken down into the mode by which they travel either using public transportation or other means. The percentage of workers and the time it takes to travel to work were calculated for each community, and for the overall study area using this 2000 U.S. Census data.

Tables 3-5, 3-6 3-7, and 3-8 indicate the following travel behaviors for workers in the study area:

- **Medford** – Almost six out of ten employment positions in Medford are held by people commuting from outside the study area communities. One-quarter of Medford's labor force lives and works in Medford. A modest number of Medford workers live in Somerville (8%) and in Boston (7%). In terms of work commute mode choice, Medford residents within the study area have the highest reliance on the automobile for commuting trips (62%) and the lowest walk/bike (7%) and transit (20%) mode shares. For those who take public transportation, travel times to work between 30 and 44 minutes are the most common. The most common travel time to work for those commuting by means other than public transportation is less than 30 minutes.
- **Somerville –** One-third of Somerville's employment base consists of jobs filled by Somerville residents. In terms of work commute mode choice in the study area census tracts, Somerville residents rely more heavily (29%) on public transit than their counterparts in Cambridge (25%) or Medford (20%). The most popular commuting mode for Somerville residents is the single-occupant automobile, which accounts for 45% of trips. Together, walking and bicycling are the travel mode choice of 12% of Somerville commuters. For those who take public transportation, travel times to work between 30 and 44 minutes are the most common. The most common travel time to work for those commuting by means other than public transportation is less than 30 minutes.
- **Cambridge** – A smaller portion of people employed in Cambridge live in the same community (22%) than in any of the other study area communities. Overall, less than half (47 %) of Cambridge workers live in Cambridge, Somerville, Medford or Boston. In terms of work commute mode choice, only 38% of study area Cambridge residents drive to work. Walking and bicycling are important modes, accounting for 26% of commuting trips, which is significantly higher than in other areas. Public transportation carries 25% of commuting trips from the study area. For those who take public transportation and those who take means other than public transportation, the most common travel time to work is less than 30 minutes.

Table 3-8 –Travel Times to Work by Census Tract

	Travel Time to Work											
	Less than 30 minutes			30 to 44 minutes			45 to 59 minutes			60 or more minutes		
Census Tracts	Total	Public Transportation	Other Means	Total	Public Transportation	Other Means	Total	Public Transportation	Other Means	Total	Public Transportation	Other Means
Medford Tracts												
Tract 3392	1694	64	1630	969	244	725	268	149	119	131	74	57
Tract 3393	689	90	599	448	118	330	245	150	95	158	107	51
Tract 3394	897	56	841	604	159	445	219	101	118	108	80	28
Tract 3395	1577	70	1507	799	270	529	226	102	124	135	73	62
Tract 3396	1585	119	1466	795	191	604	244	131	113	217	145	72
Tract 3397	1181	88	1093	564	159	405	206	122	84	113	28	85
Subtotals	7623	487	7136	4179	1141	3038	1408	755	653	862	507	355
% of Total		**4%**	**51%**		**8%**	**22%**		**5%**	**5%**		**4%**	**3%**
Somerville Tracts												
Tract 3501	2369	251	2118	1071	356	715	274	113	161	521	184	337
Tract 3502	1914	150	1764	1272	415	857	381	202	179	257	155	102
Tract 3503	726	56	670	473	185	288	123	69	54	92	48	44
Tract 3504	1659	280	1379	1169	671	498	458	277	181	251	137	114
Tract 3505	617	235	382	332	178	154	104	78	26	61	14	47
Tract 3506	1541	110	1431	573	286	287	256	176	80	96	33	63
Tract 3507	1545	172	1373	1160	480	680	402	214	188	327	188	139
Tract 3508	439	104	335	443	279	164	146	79	67	81	51	30
Tract 3509	1186	386	800	687	420	267	250	191	59	77	36	41
Tract 3510	2210	383	1827	1428	806	622	441	295	146	275	151	124
Tract 3511	1731	206	1525	1089	319	770	390	222	168	251	168	83
Tract 3512	2796	288	2508	1599	609	990	414	284	130	187	97	90
Tract 3513	1116	66	1050	646	226	420	337	199	138	248	130	118
Tract 3514	2531	356	2175	1270	447	823	278	145	133	295	227	68
Tract 3515	607	82	525	325	122	203	54	22	32	53	20	33
Subtotals	22987	3125	19862	13537	5799	7738	4308	2566	1742	3072	1639	1433
% of Total		**7%**	**45%**		**13%**	**18%**		**6%**	**4%**		**4%**	**3%**
Cambridge Tracts												
Tract 3521	949	204	745	370	129	241	52	8	44	81	39	42
Tract 3522	552	98	454	227	90	137	74	33	41	50	8	42
Subtotals	1501	302	1199	597	219	378	126	41	85	131	47	84
% of Total		**13%**	**51%**		**9%**	**16%**		**2%**	**4%**		**2%**	**3.6%**
Overall Total	39734	4401	35333	22492	8300	14192	7250	4117	3133	4927	2700	2227
% of Study Area Total		**6.5%**	**47%**		**12%**	**19%**		**6%**	**4%**		**4%**	**3%**

3.4.6 Environmental Justice

Environmental Justice is an important element of policy making in transportation planning. Environmental Justice efforts focus on improving the environment in under served communities, specifically minority and low-income communities; addressing disproportionate adverse environmental impacts that may exist in those communities; and providing opportunities for racial and ethnic minorities to participate in the decision making process.

The federal government has identified Environmental Justice as an important goal in transportation. Local and regional governments are also incorporating Environmental Justice into transportation programs.

3.4.6.1 EJ Guidelines

The study area for the Beyond Lechmere Northwest Corridor Project includes a number of Environmental Justice (EJ) Populations. The following sections and figures describe the guidelines for Environmental Justice from the federal, state and local perspectives, and depict graphically the EJ populations within the study area.

Federal

Environmental Justice is concerned with the impacts of services and Federal funding on defined minority and low-income populations. The US DOT Order (5610.2) on Environmental Justice defines a disproportionately high effect on minority and low-income populations as: an adverse effect that is predominately borne by minority population and/or a low-income population; or will be suffered by the minority population and/or low-income population and is appreciably more severe or greater in magnitude than the adverse effect that will be suffered by the non-minority population and/or non low-income population.

The data used to analyze EJ compliance are generally based on 2000 U.S. Census data. The “Block Group level” is the smallest geographic area for which income, race, and ethnicity data are available from the U.S. Bureau of the Census. The characteristics of the population within the study area are compared to thresholds established by the state, municipality, or Metropolitan Planning Organization. The analysis identifies minority population, Hispanic population and low-income populations.

State

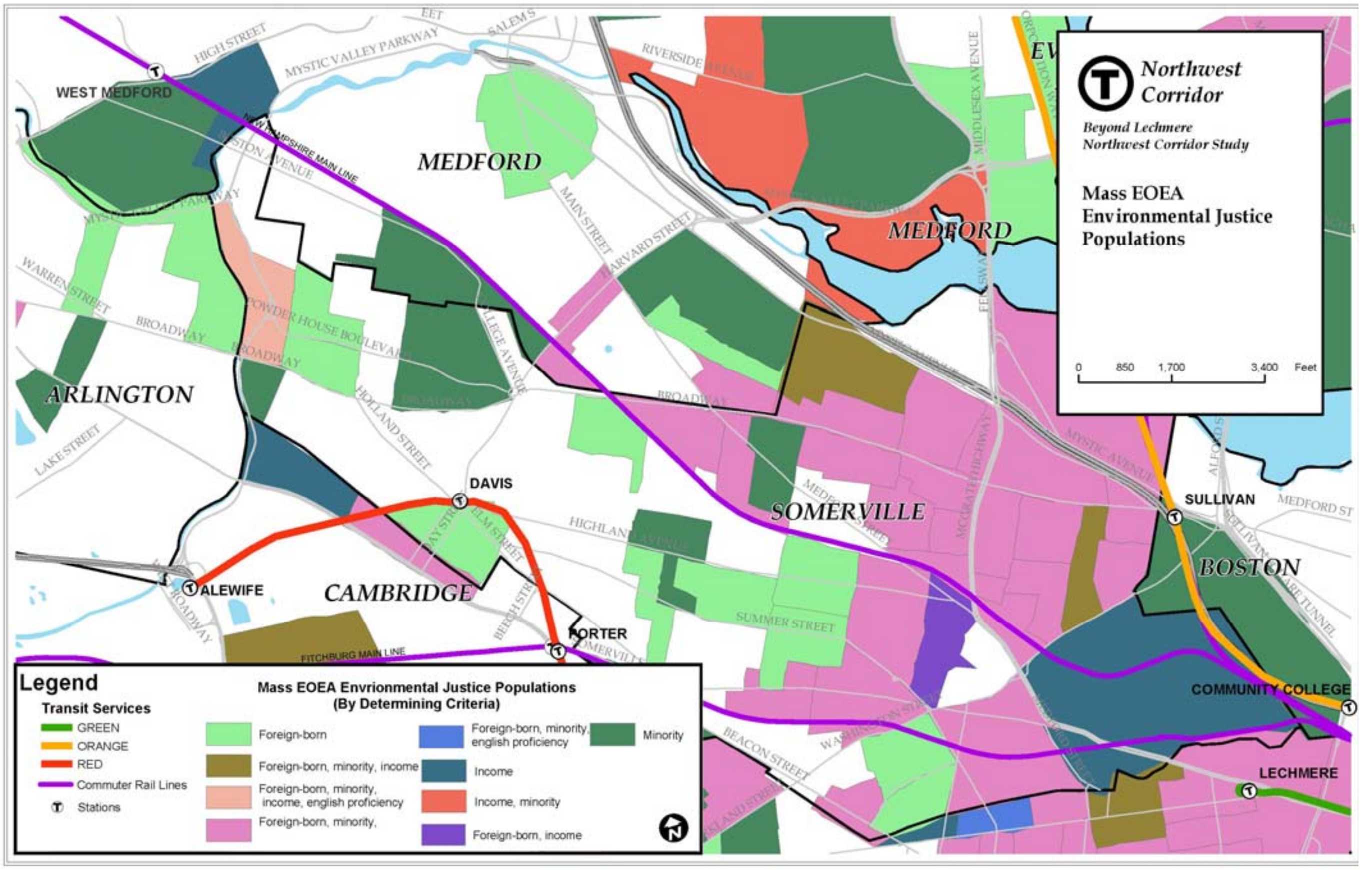
The Environmental Justice Policy of the Executive Office of Environmental Affairs (EOEA) is an effort to protect the environment and public health in the Commonwealth of Massachusetts. EJ is based on the principle that all people have the right to be protected from environmental pollution and to live in and enjoy a clean and healthful environment. EOEA’s EJ Policy makes

Environmental Justice an integral consideration in the implementation of all state environmental programs, including but not limited to, the grant of financial resources, the implementation and enforcement of laws, regulations and policies, and the provision of access to both active and passive open space.

The policy focuses attention on the high-minority/low-income neighborhoods in Massachusetts where residents are likely to be unaware of or unable to participate in environmental decision-making or to gain access to state environmental resources. The policy defines EJ populations as neighborhoods, defined by the US Census Bureau, that meet one of the following criteria: median annual household incomes are at or below 65% of the statewide median; 25% of the residents are minority; 25% of the residents are foreign born; or 25% of the residents are lacking English language proficiency. EJ populations are generally located in densely populated urban neighborhoods. These neighborhoods are generally smaller in area, with larger populations and are located in close proximity to contaminated and abandoned sites and large sources of air emissions. MASSGIS mapping developed by the EOEA is used to determine if an area meets the criteria of an EJ Population.

MASSGIS mapping developed by the EOEA indicates that portions of Cambridge and Medford and a significant area of Somerville include EJ populations. Figure 3-3 indicates those neighborhoods that are categorized as EJ populations according to Massachusetts EOEA guidelines.

Figure 3-3 – Mass. EOEA Environmental Justice Populations



Boston Region MPO

The Boston Region Metropolitan Planning Organizations (MPO), working with the Environmental Justice community, has developed methodologies to assess the impacts of their transportation plans and planning processes on low-income and minority populations. According to the guidelines established, Environmental Justice requires the MPO to:

- Examine the allocation of benefits and burdens, currently and in the planned future,
- Ensure that minority and low-income communities are treated equitably in the provision of transportation services and projects, and
- Provide full participation for minority and low-income communities to advise the MPO during its planning and decision-making process.

Performance measures used by the Boston Region MPO include:

- Mobility and congestion
- Environment
- Access to needed services and jobs

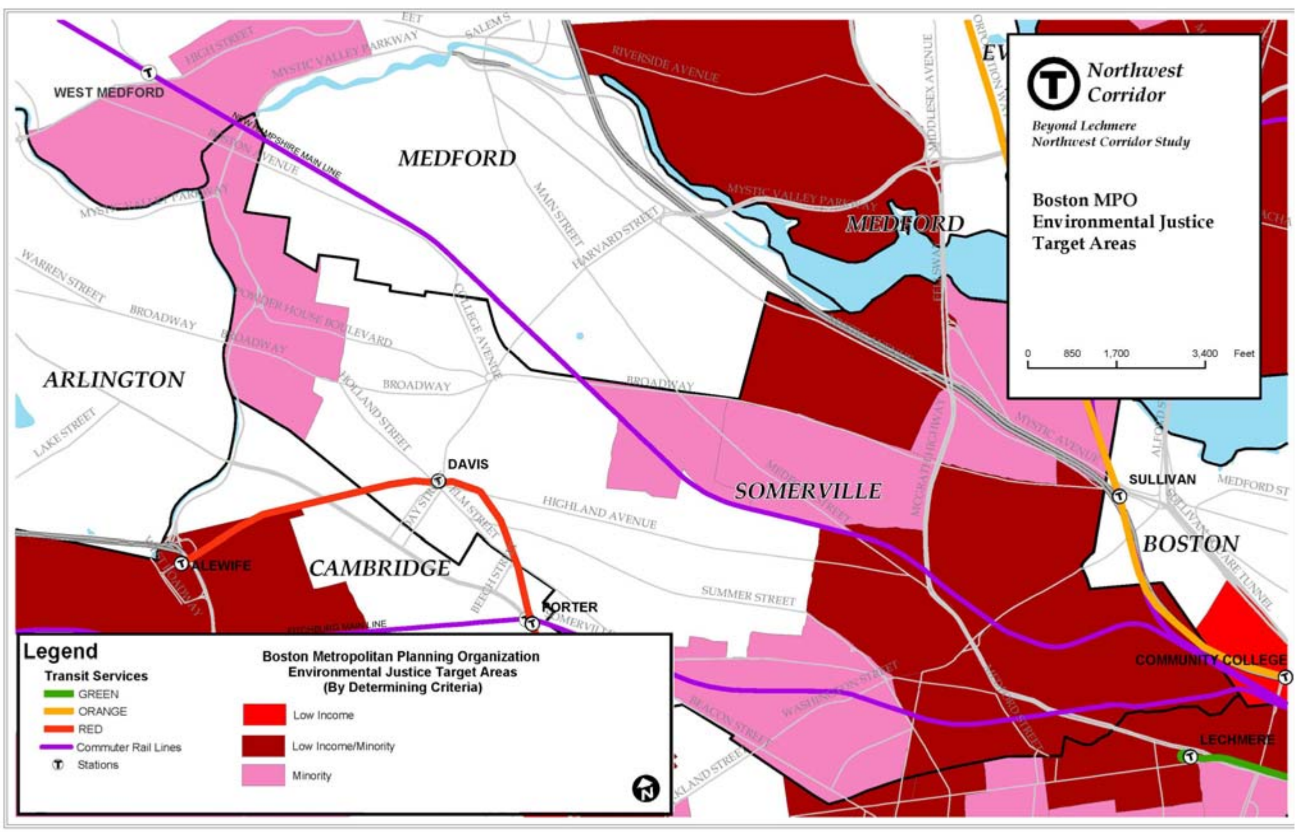
The Boston Region MPO has compiled profiles of the Environmental Justice Communities of Concern as part of the Regional Transportation Plan 2004-2025.

Sections of Cambridge, Somerville and Medford have been identified as populations of concern, or target populations. Target populations are based on traffic analysis zones (TAZs), which is an aggregation of census geography based on population and number of trips. Target populations are defined as:

- Low income – A low-income TAZ was defined as having a median household income at or below 75% of the MPO's median household income in 2000 (≤ $41,850).
- Minority – A minority TAZ was defined as having a percentage of minority population greater than 21.4%.
- Not fluent in English – These TAZs were defined as areas in which over 4.1% of the residents five years and older were unable to speak English fluently.
- Zero-vehicle households – A zero-vehicle household TAZ was defined as an area in which more than 15.4% of all households were without autos.

Several target neighborhoods based on the density of low-income and minority populations residing in them were identified. These target areas are shown in Figure 3-4.

Figure 3-4 – Boston MPO Environmental Justice Target Areas



3.4.6.2 Study Area EJ Communities

It is the goal of this study that improvements to transit services not burden and, to the greatest extent possible, provide benefits to these environmental justice populations in terms of air quality, mobility, and improved regional access. By applying the criteria established by both EOEA and the Boston MPO to the 2000 U.S. Census tract data, Table 3-9 demonstrates how the EJ criteria relate to the study area.

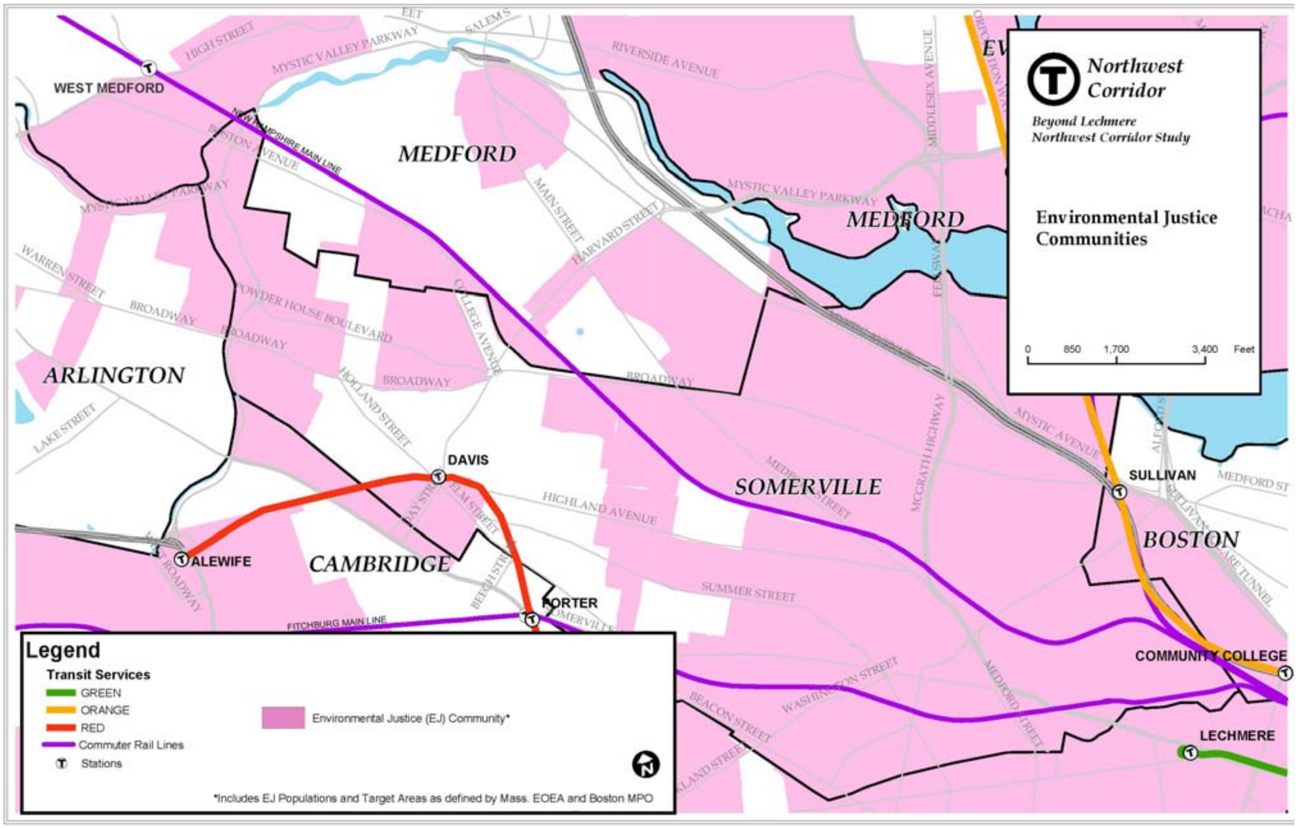
Table 3-9 – Environmental Justice Criteria Applied by Census Tract

Census Tract	Percent Minority Population	Percent Foreign Born Population	Percent of Population 5 Years and Over Not Fluent in English	Median Household Income in 1999	Percent of Occupied Housing Units with No Vehicle Available
Medford Tracts					
Tract 3392	5.3%	6.2%	0.1%	$71,295	6.1%
Tract 3393	**46.9%**	18.8%	3.2%	$51,352	**15.8%**
Tract 3394	14.7%	17.5%	3.3%	$48,607	**19.7%**
Tract 3395	16.8%	17.9%	3.7%	$56,477	9.9%
Tract 3396	17.9%	20.4%	3.3%	$51,681	14.8%
Tract 3397	20.5%	**25.6%**	**7.3%**	$45,149	11.8%
Somerville Tracts					
Tract 3501	**42.4%**	**40.1%**	**16.4%**	**$40,436**	**22.3%**
Tract 3502	**28.3%**	**32.6%**	**6.7%**	$45,326	**19.8%**
Tract 3503	**28.5%**	**27.7%**	**7.2%**	$46,610	**16.3%**
Tract 3504	12.7%	14.9%	**4.3%**	$56,643	13.8%
Tract 3505	12.9%	13.8%	1.7%	$60,700	**19.2%**
Tract 3506	**22.6%**	15.9%	1.6%	$56,094	11.3%
Tract 3507	**21.8%**	**25.0%**	**6.0%**	$44,766	**29.1%**
Tract 3508	**22.2%**	18.1%	1.0%	$54,457	**19.3%**
Tract 3509	16.0%	16.9%	1.0%	$54,779	**19.2%**
Tract 3510	17.5%	20.2%	2.4%	$53,563	**19.2%**
Tract 3511	18.4%	**26.3%**	3.6%	$50,465	**21.1%**
Tract 3512	**27.4%**	**32.5%**	**7.3%**	$48,452	**28.2%**
Tract 3513	**25.5%**	**28.1%**	**8.1%**	**$33,516**	**33.7%**
Tract 3514	**47.7%**	**48.5%**	**19.0%**	**$36,113**	**25.0%**
Tract 3515	**35.2%**	**42.6%**	**20.1%**	**$36,516**	**32.6%**
Cambridge Tracts					
Tract 3521	**31.9%**	**28.2%**	1.7%	$48,529	**26.0%**
Tract 3522	**31.1%**	**31.9%**	**10.6%**	**$23,750**	**48.7%**

Bold indicates meets or exceeds EOEA and/or MPO EJ threshold

Additionally, the environmental justice populations defined by the EOEA and the Boston MPO have been consolidated onto one plan. Figure 3-5 shows each of the neighborhoods that have been categorized as environmental justice populations.

Figure 3-5 – Study Area Environmental Justice Communities



3.5 Roadways

As mentioned previously, a network of arterial and local roadways serves the study area. In general, the arterial roadways provide connections between the key activity centers within and beyond the area. Many of these arterial roadways also serve as commuter routes between more distant suburbs and the core business districts of Cambridge and Somerville. Intersections of these major arterial roadways often form the major commercial centers. Local roadways link residential areas to the arterials, and sometimes serve as cut-through routes to avoid traffic congestion during peak periods. Major roadways and the connections they serve are described in the next section.

3.5.1 Major Roadways

This section presents brief descriptions of major roadways within the study area. Where available, MassHighway traffic and accident data is provided. Supplemental traffic information and truck volumes were also provided by the City of Somerville.

- **Interstate 93** is the only interstate highway near the study area, running from the Massachusetts/New Hampshire border near Methuen to

Canton where it terminates at I-95. I-93 forms the southeastern boundary of the study area and serves as a major commuting route from the northern suburbs to downtown Boston. The only access to I-93 inbound near the study area is at the Route 28/38 intersection, adjacent to the Assembly Square Mall. Access from I-93 northbound is also possible at the Route 28/38 intersection and at a recently completed exit ramp to Cambridge Street/Washington Street near Sullivan Square on the Boston/Somerville city line. Access to and from I-93 north of the study area is available at the Mystic Avenue interchange on the Somerville/Medford city line. Supplemental connections between the study area and I-93 are also possible via Rutherford Avenue in Charlestown and via Leverett Circle in Boston. In the study area, I-93 carries nearly 150,000 vehicles per day with an average of 125 auto accidents per year.

- **Route 28/McGrath-O'Brien Highway** is a major multilane arterial that provides alternative connections from I-93 to Cambridge and downtown Boston. To the north of the study area, Route 28 is known as the Fellsway, which traverses Medford. To the south of the study area, Route 28 travels though Leverett Circle where connections are possible to the interstate system and Storrow Drive. Route 28 also provides important circulation functions within the study area linking Medford and the Assembly Square neighborhood to Winter Hill, East Somerville, and East Cambridge. Near Lechmere Station, Route 28 carries over 40,000 vehicles per day with 65,000 vehicles per day between Medford/Highland and Washington Streets. Approximately 170 auto accidents occur along this corridor annually. Observed truck volumes on Route 28 south of Medford Street are between 500 and 1000.

- **Route 38/Mystic Avenue** parallels I-93 offering access to commercial areas in Somerville and Medford and providing links to I-93 entrance and exit ramps. Mystic Avenue begins near Medford Square and ends near Sullivan Square in Charlestown. Mystic Avenue is generally a four-lane arterial carrying approximately 35,000 vehicles per day. Approximately 205 auto accidents occur annually along this corridor.

- **Route 16/Mystic Valley Parkway** travels through the northern section of the study area in an east-west direction linking Wellington Station and Alewife Station. Route 16 is generally a four-lane arterial roadway carrying approximately 20,000 vehicles per day. The corridor averages 236 auto accidents annually.

- **Route 60/High Street** travels through the northern section of the study area in an east-west direction linking Medford Square and Winthrop Square to West Medford. Route 60 is two-lane arterial roadway carrying approximately 18,000 vehicles per day with approximately 90 auto accidents a year.

- **Broadway** crosses the study area in a northwest-southeast direction linking Powderhouse Square near Tufts University to East Somerville and Sullivan Square via the Winter Hill neighborhood. Between Powderhouse Square and Sullivan Square, Broadway is generally a four-lane arterial roadway carrying between 20,000 and 30,000 vehicles per day. The corridor averages approximately 195 auto accidents a year. Truck volumes on sections of Broadway can be up to 499 trucks per day.
- **Washington Street** runs in an east-west direction across the southern portion of the study area, linking Union Square to Sullivan Square. In general, Washington Street is two-lane arterial roadway carrying approximately 11,000 vehicles per day and averaging 120 auto accidents a year. East of Route 28, there are 29,000 vehicles per day on this segment of Washington Street. Observed truck volumes on Washington Street range between 1000 and 2500 trucks per day.
- **Medford Street** crosses the study area in a north-south direction beginning in Medford Square as Main Street and crosses Harvard Street where it becomes Medford Street. Medford Street then enters Somerville as it crosses Broadway at Magoun Square and continues behind the Somerville City Hall/High School complex where it crosses the MBTA's Lowell Line at Gilman Square. Medford Street continues to the south and runs parallel with Route 28 to the east of Union Square. South of Somerville Avenue, Medford Avenue separates from Route 28, crossing the MBTA's Fitchburg Line and the Grand Junction Branch where it enters Cambridge and becomes Gore Street behind the Twin City Shopping Plaza. Gore Street terminates at Route 28 and the northwest corner of the existing Lechmere Station. In general, Medford Street is a two-lane arterial roadway carrying approximately 21,000 vehicles per day. On an annual average, 80 auto accidents occur along the Medford Street corridor through the City of Somerville. Observed truck volumes on sections of Medford Street can range from 0 to 499 trucks per day.
- **Highland Avenue** crosses the study area in an east-west direction, beginning at Davis Square, passing by Somerville Hospital and the Somerville City Hall/ High School complex and ending at Medford Street near its intersection with Route 28. Highland Avenue serves a critical function in connecting the primary commercial district of Somerville (Davis Square) with its government and medical centers. In many ways, Highland Avenue is a symbolic "Main Street" for Somerville. Highland Avenue is a two-lane roadway carrying approximately 13,000 vehicles per day, with approximately 90 auto accidents a year. Observed truck volumes on sections of Highland Avenue can range from 1000 to 1499 trucks per day.
- **Somerville Avenue** runs in an east-west direction along the MBTA's Fitchburg Commuter Rail Line, beginning at Porter Square and continuing through Union Square. The land uses fronting Somerville

Avenue are generally commercial or light industrial with residential neighborhoods located to the north of the roadway. Somerville Avenue ends at Route 28, approximately one mile west of Lechmere Station. Somerville Avenue is a two-lane roadway carrying approximately 8,000 vehicles per day, with approximately 18,000 vehicles per day at Bow Street and Somerville Avenue. Approximately 140 auto accidents occur annually on Somerville Avenue. Observed truck volumes on Somerville Avenue can range from 1000 to 2499 trucks per day in the vicinity of Union Square, and range from 1000 to 1999 trucks per day near Davis Square.

- **Elm Street** begins at Davis Square and connects to Somerville Avenue just to the east of Porter Square. Elm Street provides an important connection between Davis Square and Union Square via Somerville Avenue. Elm Street generally forms the southwestern edge of the study area and is a two-lane arterial carrying approximately 11,000 vehicles per day, with approximately 40 auto accidents a year. In the vicinity of Porter Square, there are approximately 15,900 vehicles per day. Observed truck volumes on Elm Street in the vicinity of Porter Square can range between 0 and 499 trucks per day.
- **College Avenue** begins at Davis Square and traverses the study area in a southwest-northeast direction. Approximately one-half mile northeast of Davis Square, College Avenue enters Powderhouse Square and turns to the north, traveling through the Tufts University campus crossing Boston Street and ending at Summer Street in the Medford Hillside neighborhood in Medford. College Avenue is generally a two-lane arterial carrying 11,000 vehicles per day. The auto accident rate along this corridor in Somerville is approximately 40 accidents per year.
- **Boston Avenue** enters the study area from West Medford and continues across Somerville and Medford in a northwest-southeast direction. Boston Avenue parallels the MBTA's Lowell Commuter Rail Line and passes near Tufts University at its intersection with College Avenue. Boston Avenue then continues to an intersection with Broadway at Ball Square, where its character changes to that of a neighborhood residential street. Boston Avenue is generally two lanes and carries between 11,000 and 18,000 vehicles per day. Approximately 20 auto accidents occur along the Boston Street corridor within the City of Somerville.
- **Curtis Street/Winthrop Street** begins with Curtis Street at Teele Square to the northwest of Davis Square in Somerville and continues in a north-south direction to the Somerville/Medford City Line on the west side of the Tufts University campus. In Medford the roadway is named Winthrop Street and continues across the Mystic River into West Medford. Curtis Street/Winthrop Street is a two-lane roadway that carries between 8,000 and 10,000 vehicles per day. Approximately 15

auto accidents occur along this corridor annually. Curtis and Winthrop Streets generally form the northwestern boundary of the study area.

3.5.2 Congestion Management Areas

There are several locations within the study area that exhibit recurrent peak hour traffic congestion. In many cases, this traffic negatively impacts mobility for automobile traffic, truck traffic, and public transit operations. These locations are described qualitatively in the following sections. In many cases, these congestion management areas also correspond to locations with a high frequency of vehicle/pedestrian conflicts. Although the locations listed below are congestion points, many of the roadways within the study are characterized by narrow cross-sections, on-street parking, and high traffic volumes. All of these factors can contribute to traffic congestion.

- **Winthrop Square-** Winthrop Square is the intersection of High Street (Route 60/Route 38) and Winthrop Street (Route 38) and it is located along the northern edge of the study area. This intersection is controlled by a small rotary with all approaches yielding when entering the intersection. Moderate traffic congestion in this area can delay traffic flow along Winthrop Street, which connects to the Mystic River Parkway (Route 16).
- **West Medford Square -** West Medford Square is the intersection of High Street (Route 60), Playstead Road, and Harvard Avenue and it is located along the northern edge of the study area. This intersection is controlled by stop signs on the approaches from Playstead Road and Harvard Avenue. The MBTA Lowell Line railroad crossing is also located at the intersection. The railroad crosses High Street between Playstead Road and Harvard Avenue. The railroad crossing in this area can delay traffic flow along High Street, Playstead Road, and Harvard Avenue. Turns from the stop-controlled approaches on Playstead Road and Harvard Avenue can also be difficult during peak hours.
- **Main Street at South Street -** South Street carries traffic from Winthrop Street and Mystic Valley Parkway (Route 16) eastbound. South Street is a one-way roadway connecting to Main Street (Route 38) at a flashing signal. Directly across from South Street is the on-ramp to Route 16 eastbound. Moderate traffic congestion in this area can often delay traffic flow along South Street.
- **Mystic Avenue at Main Street -** Mystic Avenue (Route 38) intersects Main Street under stop control. The intersection is also controlled by a flashing traffic signal with pre-emption for the fire department located at the intersection. Moderate traffic congestion in this area can often delay traffic flow and bus operations along Main Street and impact emergency response vehicles.

- **Magoun Square -** Magoun Square is located on the northwestern edge of the study area and is formed by the intersection of Broadway, Medford Street, and Dexter Street. The intersection is controlled by a traffic signal with two-lane approaches along Broadway and one-lane approaches along Medford Street. Moderate traffic congestion in this area can often delay traffic flow and bus operations along Broadway and along Medford Street.
- **Teele Square -** Teele Square is the intersection of Broadway, Holland Street, and Curtis Street and is located along the western edge of the study area. This intersection is controlled by a traffic signal with pre-emption for the fire department located in the square. Moderate traffic congestion in this area can often delay traffic flow and bus operations along Broadway and along Holland Street.
- **Powder House Square-** Powder House Square is a complicated intersection of Broadway, College Avenue, Powder House Boulevard, and Warner Street near Tufts University. The intersection operates as a rotary with occasional traffic signal control on some approaches. Other approaches are controlled by STOP signs. Moderate traffic congestion is experienced in Powder House Square with delays to the Broadway approaches generally being more substantial than the other, lower volume approaches. Traffic flow and bus operations are often delayed at this intersection due to the unusual geometrics and traffic control, and high traffic volumes.
- **Davis Square -** Davis Square is the principal commercial center in Somerville. The square is characterized by a one-way circulation pattern along Elm Street (eastbound), Cutter Avenue (northbound), and Highland Avenue (westbound). Highland Avenue and Elm Street intersect with Holland Street, College Avenue, Dover Street, and Day Street at a signalized intersection. The MBTA Red Line Station is also located adjacent to this intersection. Traffic congestion in Davis Square is often moderate to severe during peak periods. Generally, the longest delays are along Elm Street westbound during the evening peak hour and on College Avenue southbound, entering Davis Square. These delays can influence transit connections to the Davis Square Red Line Station.
- **Temple Street and School Street at Broadway -** Temple Street and School Streets intersect Broadway at two closely spaced traffic signals. Temple Street carries traffic from the Mystic Avenue interchange along I-93 into Somerville. Much of this traffic then uses School Street to continue in a southerly direction across the City. The interaction of these two traffic signals, coupled with higher traffic volumes along Broadway and short queue storage distances can lead to some traffic congestion along this segment of Broadway.

- **McGrath Highway/Fellsway (Route 28) at I-93 -** Traffic congestion is common at this complicated interchange along I-93. The most common point of congestion is the Fellsway southbound approaching the intersection.
- **McGrath Highway at Broadway -**Although the traffic signals at this intersection along McGrath Highway are currently being reconstructed, the intersection can lead to traffic congestion on these major travel corridors. Congestion is especially prevalent when an incident on I-93 causes traffic diversions to the McGrath Highway. Similar conditions can occur many of the intersections along McGrath Highway such as the Pearl Street intersection located just to the south.
- **McGrath Highway at Medford Street/Highland Avenue -** Medford Street and Highland Avenue intersect McGrath Highway at a traffic signal. The geometric conditions at this intersection are complex given the acute intersecting angles of these roadways. In most cases, traffic congestion is more pronounced on Medford Street and Highland Avenue than on McGrath Highway. Much like the previous intersections along McGrath Highway, increased congestion can occur when traffic congestion on I-93 results in diversions to McGrath Highway. Recent improvements have been implemented in this area with three intersection projects, providing geometry improvements and interconnection between signals.
- **Union Square -** Many roadways intersect to form the Union Square area. These roadways include Washington Street, Prospect Street, Somerville Avenue, Webster Street, Newtown Street, Stone Avenue, Warren Avenue, and Bow Street. On the west side of Union Square, Bow Street (westbound) and Somerville Avenue (eastbound) form a one-way loop. The eastern end of this one-way loop is a signalized intersection with Washington Street and Webster Avenue, which is one way southbound. East of this signalized intersection, Somerville Avenue intersections Washington Street and Prospect Street at another signalized intersection. Both of these signalized intersections can be severely congested during peak periods. This congestion is most prevalent on Washington Street eastbound and westbound and Prospect Street northbound approaching the square. At many times of the day, Somerville Avenue is also very congested between the two traffic signals.
- **McGrath Highway at Washington Street -** Although the mainline of McGrath Highway passes over Washington Street, the surface intersection of ramps leading to and from Washington Street can be severely congested. The intersection is controlled by a system of traffic signals and has a very complicated geometry due to the space limitations imposed by the McGrath Highway overpass. Connections to several other roadways such as Medford Street, Linwood Street, and Somerville Avenue further contribute to traffic congestion at this location.

Additionally, traffic congestion from Union Square sometimes contributes to congestion at this location.

- **Sullivan Square -** Sullivan Square is located in Charlestown and is the intersection of Broadway, Mystic Avenue, Route 99, Main Street, Rutherford Avenue, and Cambridge Street (Washington Street). The square operates as a large rotary for most approaches although a traffic signal controls the westernmost intersection where Cambridge Street enters the rotary. Sullivan Station on the Orange Line is located adjacent to this intersection and an off-ramp from I-93 northbound provides access to Cambridge Street just to the west of the intersection. Until recently, an overpass provided expedited access I-93 from Sullivan Square. Recently this overpass was demolished, increasing the number of traffic movements made via the rotary. Traffic congestion at Sullivan Square is especially prevalent along Cambridge Street as it approaches Sullivan Station and the rotary. This congestion is influenced by the coordination of traffic signals at the I-93 ramp and at the eastern end of the rotary and can result in delays to traffic and transit operations. Congestion in this area could influence the viability of potential connections to the Orange Line and Commuter Rail at Sullivan Square.
- **O'Brien Highway at Land Boulevard/Charlestown Avenue (Gilmore Bridge) -** This intersection is located to the east of Lechmere Station on Route 28. Traffic congestion at this intersection is common, often resulting in substantial traffic delays on the Gilmore Bridge and Land Boulevard northbound. Traffic congestion is less frequent on O'Brien Highway and generally is associated with severe congestion on I-93 resulting in diversions to Route 28. Currently, this congestion management area does not impact transit operations since no bus routes travel beyond Lechmere Station on Route 28 or on Land Boulevard and the Gilmore Bridge. Travel through this area may be necessary if improved connections to North Station or Community College Station are developed as alternatives for this study.
- **Leverett Circle -** Although improvements are under construction by the Central Artery/Tunnel Project, recurrent congestion is expected to remain at this location and could impact the viability of bus route extensions to downtown that may be considered as part of this study.

3.6 Transit Services

This section provides an overview of the present-day routes, facilities, service patterns and ridership characteristics of the rapid transit, commuter rail and bus systems in the project area. Within the project study area, these facilities consist of three rapid transit lines, two commuter rail lines and many feeder bus routes.

3.6.1 Bus Service

The MBTA operates 15 bus routes in the study area. The following is a listing and description of the various bus routes provided by the MBTA.

No. 69: Harvard/Holyoke Gate – Lechmere Sta. via Cambridge St. – Route 69 is a local route that connects Harvard Square, Inman Square and Lechmere. The route travels up and down Cambridge Street between the two terminal stops. This route is located on the southern periphery of the study area connecting to Lechmere Station.

No. 80: Arlington Center – Lechmere via Powder House Square - The Route 80 is a local route connecting Arlington Center, Medford Hillside, Powder House Square, Magoun Square, Gilman Square and Lechmere Station. Most of this route is within the project study area, traveling along Boston Ave., College Ave., Broadway, Medford St., Pearl St., and the McGrath/O'Brien Hwy.

No. 85: Spring Hill – Kendall / MIT - Route 85 is a local route connecting Spring Hill, Summer Street, Union Square and Kendall / MIT. This route northern section, serving Spring Hill and Summer Street is within the project study area before traveling to Union Square where it runs along the same route as the CT2 to Kendall / MIT.

No. 86: Sullivan Square Station – Cleveland Circle via Harvard / Johnson Gate - This route connects Sullivan Square to Union Square, Harvard Square, Allston, Brighton and Cleveland Circle. The bus travels along Cambridge Street and Washington Street through the project study area providing service between Sullivan Square and Union Square. The MBTA's Preliminary 2004 Service Plan contains a recommendation to split this into two routes, each one starting or ending at Harvard Square to minimize schedule adherence problems. This change would not significantly affect the schedule of the route through the project study area.

No. 87: Arlington Center / Clarendon Hill – Lechmere Station via Somerville Avenue - This route connects Arlington Center, Clarendon Hill, Davis Square, Union Square, and Lechmere Station along Broadway, Elm Street and Somerville Avenue.

No. 88: Clarendon Hill – Lechmere Station via Highland Avenue - This route connects Clarendon Hill, Davis Square, Somerville High School, and Lechmere Station along Broadway, Holland and Highland.

No. 89: Clarendon Hill – Sullivan Square Station via Broadway - This route connects Clarendon Hill and Sullivan Station via Powder House Square and Winter Hill. The MBTA's Preliminary 2004 Service Plan contains a recommendation to split this route by alternating the northerly terminating stop between Davis Square and Clarendon Hill. The new diversion to Davis Square, called 89D, would travel between Sullivan Square and Powder House Square, as it currently does along Broadway, and then turn onto College Ave. to make the trip to Davis Square. This would improve the connection between Winter Hill and the Red Line.

No. 90: Davis Square – Wellington Station via Sullivan Square Station & Assembly Mall - This Route provides service between Davis Square and Wellington Station via Union Square and Sullivan Square.

No. 91: Sullivan Square Station – Central Square Cambridge via Washington Street - Route 91 connects Sullivan Square with Central Square (Cambridge) via Union Square and Inman Square.

No. 94: Medford Square – Davis Square Station via W, Medford & Medford Hillside - This route provides service from Medford Square to Davis Square. This route travels through the project study area along Boston Street and College Ave.

No. 95: West Medford – Sullivan Station via Mystic Ave. – The route 95 bus operates between West Medford and Sullivan Square serving the West Medford Commuter Rail Station and Medford Square. The route originates at the corner of Playstead Road and Winthrop St. and travels through the study area along Playstead Road, High Street and Mystic Avenue in Medford before serving the Sullivan Square Orange Line Station.

No. 96: Medford Square – Harvard Station via George Street & Davis Square Station - Route 86 operates between Medford Square and Harvard Square with an intermediate stop at Davis Square Station. This route utilizes Boston St. and College Ave. through the project study area just like Route 94, however the trip to Medford Square is much shorter since it travels along Winthrop Street and Main Street in Medford.

No. 101: Malden Station – Sullivan Sq. Station via Salem St., Main St. & Broadway - Route 101 connects Malden Center to Sullivan Square Station via Medford Square and Winter Hill. This route travels along Broadway and Main Street in the project study area.

No. 134: North Woburn - Wellington Station via Woburn, Winchester, Winthrop St., Medford Sq., Riverside Ave. & Meadow Glen Mall - Route 134 provides service between the three towns of Woburn, Winchester and Medford. In the study area the route travels through the community of West Medford along Winthrop Street, but does not serve the West Medford Commuter Rail Station.

No. CT2: Sullivan Square Station - Ruggles Station via Kendall / MIT -The CT2 Route is a limited stop, cross-town route that operates between Sullivan Square and Ruggles Station. This route utilizes Cambridge Street and Washington Street to travel between Union Square and Sullivan Square in the project study area.

Bus service frequencies and daily ridership on the project study area bus routes are shown in Table 3-10.

Table 3-10 – Bus Service Frequency and Ridership

Route	Daily Ridership	Number of Weekday Inbound Bus Trips 5-9:30am	9:30am-4pm	4-7pm	after 7pm	Total
No. 69	3,388	15	20	9	13	57
No. 80	1,872	13	13	8	7	41
No. 85	402	7	9	4	0	20
No. 86	5,139	17	18	8	7	50
No. 87	3,720	14	15	11	11	51
No. 88	4,299	18	16	11	12	57
No. 89	3,586	21	17	6	9	53
No. 90	1,280	5	9	5	4	23
No. 91	1,482	11	15	6	6	38
No. 94	1,343	11	9	9	10	39
No. 95	1,679	13	13	9	7	42
No. 96	1,458	12	10	9	10	41
No. 101	4,323	21	14	13	7	55
No. 134	1,605	11	14	7	7	39
No. CT2	1,192	9	13	9	0	31

3.6.1.1 Bus Safety and Comfort

The MBTA has a Service Delivery Policy to "ensure that the MBTA provides quality transit services that meet the needs of the riding public." The 2004 Service Plan updates and revises the 1996 Service Delivery Policy and incorporates changes that were approved in 2002 and 2004.

A portion of the Service Delivery Policy identifies Service Objectives and Standards used to evaluate the MBTA's service performance. The Service Standard for Safety and Comfort is vehicle loading. The average load standard for Bus Service is shown in Table 3-11. These standards are calculated using an average maximum vehicle load per trip over any 30 to 60 minute period.

Table 3-11 – MBTA Bus Loading Standards

Time Period	Passengers/Seat
Early AM, AM Peak, Midday School & PM Peak	140%
Midday Base, Evening, Late Evening, Night/Sunrise &Weekends	
Surface portions of routes	100%
Tunnel portions of routes	140%

3.6.1.2 Loading Evaluation

The 2004 Service Plan contains a Summary Analysis of Routes and Proposed Changes (Appendix A) that notes which routes meet or fail to meet each standard in the Service Delivery Policy. Of all the bus services that are included in the study area only the Route 86 service does not meet the Bus Load standard, according to this summary. However, the peak load route segment of concern on Route 86 is between Brighton Center and Harvard Square, which has loads about 45% greater than those experienced on the segment between Sullivan

Square and Harvard Square. The traffic congestion along the entire route results in delay to the service and limits the ability to add significant capacity. In addition this route has one of the most frequent headways of those operating in the study area.

3.6.1.3 Service Reliability Standards

The portion of the Service Delivery Policy that deals with on-time performance or reliability includes a Schedule Adherence Standard that is used to quantify the performance of each service and how well it adheres to the published schedules. The goal is to identify services that do not meet the standard, identify the problem and to take some corrective action, where possible. The specific standards vary by the scheduled frequency of the route. Routes are divided into walk-up service, where the service operates more frequently than every 10 minutes, and scheduled departure service, where headways are greater than 10 minutes. Until early this year, schedule adherence on buses was measured according to a standard in the 1996 Service Delivery Policy, as amended in 2002. In late 2004, the MBTA adopted a new Service Delivery Policy intended to make the bus schedule adherence standard more sensitive to variations between routes. Table 3-12 provides a summary of the current and former standards.

Table 3-12 – Summary of Bus Schedule Adherence Standard

Standard in 2004 Service Plan (adopted September 2004)			
Trip Test	**Beginning of Route**	**Mid-Route Time Point(s)***	**End of Route**
Scheduled Departure Trips (Headways ≥10 min.)	Start 0 min. early to 3 min. late	Depart 0 min. early to 5 min. late	Arrive 3 min. early to 5 min. late
Walk-up Trips (Headways <10 min.)	Start within 25% of scheduled headway	Leave within 50% of scheduled headway	Running time within 20% of scheduled running time
Route Test	For any given bus route to be in compliance with the Schedule Adherence Standard, 75% of all trips on must adhere to the above measures over the entire service day.		

*For Schedule Adherence, mid-route time points will be used only for routes on which the on-time performance data has been collected using CAD/AVL equipment.

Standard in 1996 Service Plan (as amended in 2002)	
Adherence Standard	
Headways >= 10 minutes	75% of all trips departing and arriving 0-5 minutes late at both terminals over an entire day
Headways < 10 minutes	85% of all trips within 1.5 headways over an entire day
Trip Time Standard	95% of all trips no more than 5 minutes greater than scheduled trip times by time period and duration

3.6.1.4 Schedule Adherence Evaluation

According to the summary in the 2004 Service Plan, all study area bus routes except Route 85 failed to meet the schedule adherence standard from the 1996 Service Plan (as amended in 2002). Systemwide, only 11% of the MBTA's weekday bus routes met this schedule adherence standard. While no data are available yet about how routes are performing in relation to the new schedule adherence standard, this new standard should help the MBTA focus efforts on improving routes that have problems running significantly late. The new standards also anticipate the implementation of Computer-Aided Dispatch/Automated Vehicle Location (CAD/AVL) as new buses are added to the fleet. This new technology will allow the MBTA to verify the accuracy of the mid-route time points on the schedule cards, and once the Bus Central Dispatch system has been fully implemented, it will be possible to track real time schedule adherence and to instruct drivers to make headway adjustments if needed.

3.6.1.5 Bus System Improvements

In the 1990s and until this past year, the MBTA bus fleet that operated in the project study area was composed mostly of 40 foot, high-floor, diesel powered transit buses from various manufacturers dating back to the mid 1980's. However that has changed as the MBTA has embarked on an aggressive fleet modernization program. Ongoing improvement initiatives include:

- A large-scale upgrade of the MBTA bus fleet, with the recent procurement of 546 new buses with either CNG or Emissions Control Diesel (ECD) engines. The new buses are of a low floor configuration. With the recent and planned bus procurements the average age of the MBTA bus fleet has been reduced from 13 years in 2003 to just 4 years in 2005.
- Many of these buses will collect data that can be used to set better schedules and make route changes when congestion is a problem.
- All of the existing buses manufactured since 1990 are being overhauled, to accommodate use of low emission diesel.
- Many of the MBTA's bus maintenance garages have reached their capacity. The MBTA has plans to expand existing facilities and/or construct garages to provide additional capacity. In the Beyond Lechmere study area, all of the study area bus routes are operated out of the MBTA's Charlestown Garage, with the exception of Routes 94 and 96 which operate out of the Fellsway Garage in Medford on weekdays and out of Charlestown on weekends (when the Fellsway facility is closed). The MBTA is planning for a new bus garage and maintenance facility to be constructed at Wellington Station within the next decade. This facility is intended to provide additional capacity and replace older garages such as the Fellsway facility

In the near term, the MBTA's standard bus fleet will consist of approximately 300 CNG vehicles manufactured by North American Bus Industries and New Flyer Industries in 2001-2004; 175 ECD buses manufactured by Neoplan in 2004; and 396 conventional diesel buses manufactured by TMC and Nova between 1994 and 1995, which are being overhauled in the 2004-2007 time frame. An additional fleet of 44 articulated buses manufactured by Neoplan with CNG propulsion are in service on selected high-volume routes. A decision on the use of ECD or CNG technology in future bus procurements will depend on the performance of the vehicles now being operated by the MBTA.

Based on the bus assignments by garage as of April 15, 2005, approximately 20 percent of the fleet available for service on the study area routes is comprised of new low floor ECD buses manufactured by Neoplan. The balance of the available fleet for the study area consists of conventional diesel buses manufactured by Nova/TMC, which are being put through the overhaul program.

In addition to the fleet modernization and maintenance facility improvements described above, the MBTA is also working to improve schedule adherence on Route 86, which experiences significant problems with schedule adherence. It appears that the schedule adherence problem is a result of the route's length and heavy congestion. These factors, coupled with heavy boardings and alightings at the mid-point in Harvard Square, result in significant delay problems. In the 2004 Service Plan, it was recommended that Route 86 be split into two routes at Harvard Square. These routes would operate at the same frequency at all times of day. They would be interlined, so customers riding through Harvard Square would find it easy to continue doing so. The bus would arrive at Harvard Square as one route, remain there for about thee minutes to assure schedule adherence, and then continue on as the next route. In the service changes adopted with the 2004 Service Plan, a less extensive change to the route was adopted in which a three-minute hold time was added at Harvard Square to allow for schedule correction.

3.6.2 Green Line (Rapid Transit / Light Rail)

Lechmere Station, situated in Cambridge at the southern periphery of the project study area, serves as the northern terminus for the MBTA's Green Line light rail system. In its existing configuration Lechmere Station is an at-grade facility located immediately west of the Msgr. O'Brien Highway. This is essentially a "turnback" facility equipped with loop tracks, limited storage capacity for light rail cars and no maintenance facilities. Developers of the North Point complex, located east of the Msgr. O'Brien Highway, have committed to participate in the construction of a new Lechmere Station within the development complex. This would provide a modern terminus, well positioned to access the nearby commuter rail rights-of-way. The conceptual plans in the project's Environmental Impact Report included layover space at or near the station for approximately 24 cars, an increase over the layover capacity of the existing Lechmere Station of approximately 20 cars. South of existing Lechmere Station, the alignment of the Green Line crosses over to the east side of the Msgr. O'Brien Highway on an elevated causeway, extending south to Science Park and North Station. The MBTA in 2004 completed the new Green Line – Orange Line

Station located underground at North Station, and demolished the elevated Green Line structure on Causeway and Nashua Streets.

South of North Station, the Green Line operates through a series of downtown tunnels termed the "Central Subway." Once through the Central Subway, the Green Line branches into four separate routes that emerge from underground in the vicinity of Kenmore Square (Boston College, Cleveland Circle and Riverside Lines) and at Northeastern University on Huntington Avenue (Heath Street Line). These southern branches have been variously through-routed to terminal points at Park Street, Government Center, North Station and Lechmere. At present, the designated terminal points are:

- Route B Boston College – Government Center
- Route C Cleveland Circle – Government Center
- Route D Riverside – Lechmere
- Route E Heath Street – Lechmere

The Route A designation is vacant, having been assigned to the now-discontinued Oak Square / Watertown Line. The Boston College, Cleveland Circle and Heath Street branches operate at-grade in mid-street reservations and in mixed traffic. This results in the service being subjected to traffic-generated delays. Such delays are often mitigated by turning the northbound trains around prior to reaching their northern destinations (i.e. at Park Street or Government Center instead of Government Center or Lechmere, respectively). The Riverside – Lechmere route (D Line) is the longest on the Green Line, encompassing 13.4 miles.

Daily ridership on the Green Line, as measured by passenger boardings, is 225,200 passengers.[1] The afternoon west-bound peak hour load volume of approximately 5,000 passengers, which occurs between Arlington and Copley Stations, represents approximately 82% of existing Green Line system capacity.[2] This is in contrast to the east-bound morning peak hour load volumes between Copley and Arlington which run at or over capacity. Combined, on a typical weekday the central subway portion of the Green Line operates at 81% of capacity during the peak 30 minutes.[3] Table 3-13 shows typical weekday boardings at stations on the central subway portion of the Green Line for the most recent reporting year.

[1] MBTA website (www.mbta.com)
[2] Source data: 1997 Passenger Counts: MBTA Rapid Transit and Green Line Central Subway Volume I and Volume II, Central Transportation Planning Staff.
[3] Mobility in the Boston Region, Existing Conditions and Next Steps, Central Transportation Planning Staff, December 2004.

Table 3-13 – Green Line Typical Weekday Boardings (1997)

Station	Boardings
Lechmere	5,421
Science Park	1,360
North Station	4,906
Haymarket	4,465
Government Center	14,263
Park Street	10,445
Boylston	5,934
Arlington	8,790
Copley	13,777
Hynes	8,759
Kenmore	7,610

Source: MBTA Ridership & Service Statistics, Ninth Ed. (2003-04)

Green Line trains are comprised of three types of equipment: Light Rail Vehicles (LRVs), Type 7 cars and Type 8 cars. LRVs were built by Boeing Vertol in 1976-1978. Presently, 40 of these cars remain in service, used primarily in peak periods. The bulk of the fleet consists of so-called Type 7 cars built in 1984-1988 by Kinki-Sharyo. This fleet consists of 111 active vehicles. The LRV and Type 7 cars require the use of multiple steps to board the vehicle, since the Green Line operates with low-level platforms. Platform heights are being increased at key stations to enable wheelchair passengers to access the low floor section by means of a short ramp. The Green Line vehicles are powered by an overhead electrified trolley wire and catenary system energized at 600 volts. The total active fleet as of April 2005 was 175 cars cars, with 144 cars being required for the afternoon peak period. The Green Line's primary maintenance, repair and storage facility is located at Riverside. Additional storage yards and light maintenance facilities are located at Reservoir (end of the Cleveland Circle Line) and Lake Street (end of the Boston College Line). At the north end of the Green Line, Lechmere provides overnight storage capacity for 21 cars. No maintenance or repair work is performed at Lechmere.

Green Line trains typically consist of one and two cars, although a few three car trains have been operated during peak periods, subject to equipment availability. The three vehicle types are not interchangeable, and multiple car trains must be comprised of like equipment. As part of the Type 8 Breda car procurement, the MBTA is modifying propulsion and control systems on the Type 7 cars so that the two equipment types can operate together in multiple car trains.

Peak period schedules provide for service frequencies (headways) of five minutes on both the Boston College and Riverside Lines, six to seven minutes on the Cleveland Circle Line and seven minutes on the Riverside Line. As these services meet in the Central Subway, the result is a peak hour combined service volume of 43 trains per hour in each direction in the Central Subway, or headways of approximately 90 seconds. Green Line car requirements and headways are summarized in Table 3-14 (where **T** = Number of trains, L=Cars per train and *H* = headway in minutes):

Table 3-14 – Green Line Car Requirements and Headways

Route	AM Peak T	L	H	Am Base T	L	H	PM Base T	L	H	PM Peak T	L	H	Late T	L	H
Boston College	**20**	2	*5*	**12**	2	*8*	**12**	2	*8*	**20**	2	*5*	**11**	1	*8*
Cleveland Circle	**13**	2	*6/7*	**13**	1	*6*	**13**	1	*6*	**13**	2	*6/7*	**7**	1	*10*
Riverside	**24**	2	*5*	**12**	2	*10*	**12**	2	*10*	**25**	2	*5*	**11**	1	*10*
Heath Street	**12**	2	*7*	**8**	2	*9*	**8**	2	*9*	**12**	2	*7*	**8**	1	*10*
Run as Directed	**4**	1					**1**	1		**4**	1				
Total Cars Required	**142**			**77**			**78**			**144**			**37**		

3.6.3 Red Line (Rapid Transit / Heavy Rail)

From downtown Boston the Red Line extends northwest to a terminus at Alewife Station, passing through Cambridge and the western portion of Somerville. In the project study area, stations are located at Davis Square and Porter Square. A station is also located nearby in Cambridge at Kendall Square. Daily boardings at each of these stations are as follows: Davis-10,695, Porter - 7,355, and Kendall – 11,218. The Porter Square station includes a commuter rail connection to the Fitchburg Line. Davis Square includes a number of feeder bus routes and is located at the west end of a linear park / pedestrian path, which is intended to extend east towards Lechmere.

The Red Line is a heavy rail, high platform, grade separated operation, powered by a third rail system. Trains consist of multiple cars (six cars during peak periods and four cars during the off-peak). The active fleet consists of 218 cars. The oldest group of cars, totaling 74, was constructed in 1969-70 and was rebuilt in 1985-88. An additional 58 cars of similar design were constructed in 1987-89. A newly designed fleet of 86 cars was procured in 1993-94. South of downtown Boston, the line splits into two branches terminating at Braintree and Ashmont stations. The distance from Alewife to Braintree is 17.7 miles; from Alewife to Ashmont the distance is 11.9 miles. Service frequencies on each branch are approximately eight minutes during the peak periods and twelve minutes during the off-peak. From downtown Boston north to Cambridge and Somerville this results in a combined service frequency of four minutes during the peak period and six minutes during the off-peak. The line was extended north from Harvard Square through Porter and Davis Squares to Alewife during the early 1980's. The subsequent commercial and residential development in the areas surrounding these locales is considered indicative of the economic and social benefits that can accrue from such transit facilities.

Daily ridership on the Red Line is 214,200 passenger boardings. The morning peak hour passenger load volume is 9,500 passengers occurring between South Station - Broadway - Andrew Stations. Table 3-15 summarizes typical weekday station entrances at key Red Line stations for the most recent reporting year.

Table 3-15 – Red Line Typical Weekday Station Entrances (1997)

Station	Entrances
Alewife	9,409
Davis Square	10,695
Porter Square	7,355
Harvard	20,212
Kendall	11,214
Charles/MGH	7,855
Park Street	6,535
Downtown Crossing	12,381
South Station	20,778

Source: MBTA Ridership & Service Statistics, Ninth Ed. (2003-04)

3.6.4 Orange Line (Rapid Transit / Heavy Rail)

The Orange Line extends from Forest Hills in Jamaica Plain to Oak Grove in Malden, a distance of 10.8 miles. Within downtown Boston, the line operates in a subway. South of downtown Boston, the line is located in an open cut alongside the commuter rail and Amtrak Northeast Corridor right-of-way. North of Boston, the line is located in a grade separated right-of-way alongside the MBTA's Haverhill/Reading commuter rail line. At the eastern periphery of the project area, the Orange Line provides service parallel to the Green Line between North Station and Sullivan Square Station. Wellington Station, the next station north beyond Sullivan Square, is a major park-and ride facility, with over 1,300 spaces. Although Wellington is located beyond the project area, the parking facilities are large enough to serve a regional market, so that some project area residents may use them.

The Orange Line includes three tracks between Community College and Wellington stations. When the reconstruction of the northern portion of the Orange Line was designed in the late 1960's, it was intended that the two outside tracks would be the normal northbound and southbound tracks while the inside track would be a reverse express track. MBTA long-range planning at that time envisioned extension of the various rapid transit lines outwards to the Route 128 corridor, and this track configuration anticipated the eventual extension of the

Orange Line to Reading. However, the line has never been operated with an express track service. Instead, the third track has been used for testing of vehicles, signals and train control equipment.

The City of Somerville is examining the feasibility of constructing a new Orange Line station at Assembly Square, located mid-way between Wellington and Sullivan Square Stations. The Assembly Square station is intended to serve as an important adjunct to the re-development of the Assembly Square by facilitating commercial and residential development at the site. The positioning of a new station at an intermediate location on the Orange Line raises issues pertaining to train travel times, passenger volumes and the impact on capacity at peak load points on the line. These issues are being investigated by the City of Somerville in consultation with the MBTA.

The Orange Line is a high platform, third rail operation that uses a fleet of 120 cars constructed in 1979-81. Service frequencies range from five minutes during the peak hour to a range of eight to thirteen minutes during off-peak periods. All trains are scheduled to operate the entire length of the line. Trains consist of six cars at all times. The MBTA is currently upgrading the signal system on the northern portion of the line, with the intent of improving service reliability. Daily ridership is 160,900 passengers with the morning peak hour load volume of 8,200 passengers occurring between North Station and Haymarket Station. Table 3-16 summarizes typical weekday station entrances at key Orange Line stations for the most recent reporting year.

Table 3-16 – Orange Line Typical Weekday Station Entrances (1997)

Station	Entrances
Oak Grove	4,582
Malden Station	10,335
Wellington Station	7,078
Sullivan Station	8,667
Community College	3,663
North Station	8,312
Haymarket	4,162
State	11,249
Downtown Crossing	13,102

Source: MBTA Ridership & Service Statistics, Ninth Ed. (2003-04)

3.6.5 Commuter Rail Services

3.6.5.1 New Hampshire Main Line

The New Hampshire Main extends northwest from Boston's North Station through Somerville and Medford to Lowell, which is the present terminal for commuter rail service on the line. The MBTA identifies the route as the "Lowell Line" in its published schedules. The route continues northwards into New Hampshire. The Boston – Portland intercity passenger rail service operated by Amtrak as the "Downeaster" also uses this route. Freight service is operated by Guilford Transportation Industries. The State of New Hampshire, in cooperation with the Massachusetts Executive Office of Transportation & Construction, is proceeding with the initial design and operations planning for an extension of commuter rail service to Nashua, New Hampshire. From Boston through Lowell to the New Hampshire state line, the line is owned by the MBTA.

The route is also used by a few trains operating on the MBTA's Haverhill / Reading Line. Due to track capacity considerations, these trains are routed over the New Hampshire Main Line between North Station and Wilmington as non-stop trains.

Current Lowell Line commuter rail service consists of 21 inbound and 21 outbound weekday trains. Weekend and holiday service consists of eight inbound and eight outbound trains. In 2001, the MBTA opened a large intermodal station on the line in Woburn, the Anderson Regional Transportation Center, which provides parking and Logan Express Bus connections for passengers in the vicinity of Route 128 / I-95. A passenger station at Tufts University was closed in the early 1980's due to low passenger volume and the desire to reduce travel time to Boston for passenger from outlying areas. At the northern end of the study area, the West Medford station is served by all of the scheduled commuter rail trains. Travel time from Lowell to Boston is approximately 50 minutes. Travel time between West Medford Station and Boston is approximately 12 minutes. Daily ridership generated by the West Medford Station is 478 passenger boardings.

In keeping with MBTA operating standards for its "North Side" commuter rail lines, all trains consist of single level commuter rail coaches operated in push – pull configuration with the locomotive typically located at the outbound (or northern) end of the train. Maximum train lengths typically are six cars. Additional train capacity could be achieved in the near to mid term by increasing train lengths to nine cars, subject to equipment availability. Long-term MBTA capital improvement plans call for the replacement of the single level coaches with higher capacity bi-level coaches.

Daily weekday ridership on the Lowell Line service is approximately 10,000 passenger boardings, based on December 2003 ridership counts. Table 3-17 shows typical weekday inbound boardings at each Lowell Line Station.

Maximum train capacity, based on the use of six-car trains, is 825 passengers. The greatest ridership on a morning peak period train is 795 passengers representing 96 percent of train capacity.

Table 3-17 – Lowell Line Daily Weekday Boardings by Station

Station	Daily Weekday Inbound Boardings
Lowell	1,341
North Billerica	737
Wilmington	450
Anderson	832
Mishawum	22
Winchester	677
Wedgemere	454
West Medford	478

Source: MBCR 12/03

Although the focus of the MBTA's commuter rail service is toward Boston as an employment center, the Lowell Line experiences some reverse commuting. The primary destination for any reverse commuter on the Lowell line is Woburn. In the Spring of 2000, approximately 80 riders used the commuter rail service to travel on the 4 peak period trains to the Mishawum station. In addition, 10 passengers utilized the Lowell Line to travel between North Station and West Medford.

From Boston through Somerville the line was originally constructed with multiple tracks (three and four tracks in some locations). Reconstruction of the trackage by the MBTA has resulted in a double track route, albeit with sufficient right-of-way being available for the installation of additional trackage or other transit services. Recent overhead highway bridge construction at some locations has resulted in some side clearance limitations due to bridge abutments, and these will need to be investigated in conjunction with the project's proposed alternatives. In Somerville, all roadways, which cross the right-of-way, are grade separated from the tracks. Within the study area in Medford, only two at-grade crossings exist at Canal Street and at High Street adjacent to the West Medford Commuter Rail Station.

3.6.5.2 Fitchburg Division

The Fitchburg Division extends from North Station through Cambridge, Somerville and then westward to Fitchburg. Within the project area the route passes along the west side of the MBTA's Commuter Rail Maintenance Facility in Somerville, continuing west through Union Square, paralleling Somerville Avenue. The route then passes through Porter Square in Cambridge, Waltham, Concord and South Acton with a terminus in Fitchburg. Commuter rail service on this route consists of 18 inbound and 18 outbound trains on a weekday. Of these 18 trains, five inbound and outbound trains originate / terminate at South

Acton. Travel time between Boston and Fitchburg is approximately 1 hour and 20 minutes. Travel time between Boston North Station and Porter Square is 11 minutes.

The MBTA in February 2004 inaugurated express service on this route, with trains operating non-stop between South Acton and Porter Square, thereby reducing travel time by approximately 10 minutes. Sunday and holiday service consists of seven inbound and outbound trips, with reduced frequencies between South Acton and Fitchburg. Eight inbound and outbound trips are operated on Saturdays.

Daily weekday ridership is approximately 8,000 passenger boardings. Trainset capacity, based on a six-car train, is 825 passengers. Table 3-18 shows typical weekday inbound boardings at each Fitchburg Line Station. The greatest ridership on a morning peak period train is 563 passengers (based on December 2003 counts) representing 68 percent of the train's capacity. The Porter Square Station generates approximately 143 daily inbound boardings.

Table 3-18 – Fitchburg Line Daily Weekday Boardings by Station

Station	Daily Weekday Inbound Boardings
Fitchburg	155
North Leominster	172
Shirley	139
Ayer	233
Littleton/495	154
South Acton	560
West Concord	437
Concord	426
Lincoln	262
Silver Hill	5
Hastings	55
Kendal Green	111
Brandeis/Roberts	449
Waltham	488
Waverley	131
Belmont Center	113
Porter Square	143

Source: MBCR 12/03

Although the focus of the MBTA's commuter rail service is toward Boston as an employment center, the Fitchburg Line does experience some reverse commuting. The primary destination for any reverse commuter on the Fitchburg line is Waltham. In the Spring of 2000, approximately 75 riders used the commuter rail service to travel on the 3 peak period trains to the Waltham and/or Brandeis/Roberts stations. In addition, 25 passengers utilized the Fitchburg Line to travel between North Station and Porter Square.

Within the project area, this route was constructed as a multiple track right-of-way, with many freight sidings in the industrial area of Union Square. Many of the sidings have been removed and the line operates as a double track rail corridor with sufficient right-of-way available for additional track or other transit services.

Within the project area the tracks are grade separated. Freight service on this MBTA-owned route is operated by Guilford Transportation Industries. Train configuration and equipment is the same as for the New Hampshire Main Line.

3.7 Development Patterns

3.7.1 Economic Development/Land Use

Understanding the urban setting in which the transit system functions beyond Lechmere is crucial in defining the goals and the realistic alternatives to consider. Any extension would need (1) to fit into the existing land use of the area, (2) comply with local land use development plans, (3) accommodate an established street network and defined open spaces, with real dimensions and physical constraints, (4) serve activity areas and (4) provide connections to riders' origination points.

3.7.1.1 Existing Land Use Patterns

The topography of the study area is hilly (including Prospect Hill, Central Hill, Winter Hill, and the Medford Hills). The area also features a ridge that is oriented approximately west-east and runs along Highland Avenue. Street alignments roll down to the north and to the south from the ridge. The high ground areas around Prospect and Central Hills offer glimpses of Downtown Boston's high-rise structures.

The study area is a typical dense early 20th-century urban setting. Double and triple-deckers are distributed around urban centers that attract city activities, and a number of main avenues collect and funnel the vehicular traffic. The urban centers or activity areas that must be considered in their proper context are:

- **Davis Square,** in 1997, was declared one of the 15 "hippest" neighborhoods in the United States, a designation inconceivable without the 1984 arrival of MBTA's Red Line. While this square resides outside the study area of this project, it is a model for coordination of transit investment and urban economic revitalization initiatives. Since the opening of the Red Line station in 1984, the station has seen increased activity with station entrances rising from 6,565 in 1988 to 8,377 in 1992 and the most recent counts conducted in 2001-2003 being 10,695. During this same period, station entrances at other area Red Line stations remained relatively steady. This increase in station entrances is likely an indicator of the increased commercial activity in the Davis Square area.

- **North Point** is the 45-acre area located south of the Fitchburg commuter rail line and north of the serpentine boundary line that separates Somerville and Cambridge. North Point has been part of a planning initiative undertaken by the City of Cambridge to promote a new dense urban neighborhood in the city of Cambridge. The area is within the Charles River Basin area between the Charles River Esplanade and Boston's Harbor Park Envisioned is mixed-use development that includes 2,700 housing units, 2.1 million square feet of commercial space for office laboratory and retail uses, and a 90-room hotel.
- **Union Square** bears striking similarities to, and has the potential to become if served by transit, another Davis Square. While presently developed with a lower-intensity mix of small businesses, restaurants, and housing, it has considerable potential in the eyes of the City of Somerville officials to become an economic catalyst, given its proximity to Inman and Harvard Squares in Cambridge. Union Square plays the role of a hinge between a light industrial area that lies along the eastern end of Somerville Avenue, the commercial establishments at the intersection of Prospect, Bow and Washington Streets, and the residential areas north of Bow and Summer Streets. Union Square connects with the Central Hill area via Walnut Street. The City in conjunction with the community has recently completed several major planning documents for future investment in the square, including a Master Plan, Transportation Plan, and the establishment of a Neighborhood Revitalization Strategy Area.
- **Inner Belt Industrial Park/Cobble Hill/Brickbottom** is the area between Washington Street and Lechmere Station bound by the Lowell Line and the Fitchburg Line. The Inner Belt is the closest commercial area in Somerville to Lechmere Station and Boston. The Industrial Park is accessible only from Washington Street via an underpass below the Mystic Piers Branch Railroad. This connection does not provide easy roadway, pedestrian or transit access to this development area. The Industrial Park is also separated from the emerging North Point District of Cambridge by the Fitchburg Line and the Grand Junction Branch. The area is further separated from the Hood Industrial Park and Sullivan Square Orange Line in Charlestown by the I-93 and the Orange Line and commuter rail tracks. The Brickbottom area is approximately 40 acres located west of Route 28 and east of the Inner Belt.
- **City Hall Square/Gilman Square** is the civic center of Somerville and lies at the intersection of Highland Avenue and School Street, extends along Highland Avenue to Walnut Street and then wraps around the high school complex to Medford Street across the bridge over the MBTA right-of-way to Gilman Square, behind City Hall. It appears that, for

reasons of location and importance to the city, this site could be a prime candidate for a transit station.

- **Ball Square** is located at the important intersection of Broadway and the Lowell Line right-of-way. Ball Square would be well suited as a stop on any transit service from Lechmere to Medford Hills. The Square is healthy commercial center with retail, stores, cafes and restaurants.
- **Medford Hillside** is the area extending north from Powderhouse Square through Tufts University and over the Mystic River into West Medford. With its residential, educational and commercial land uses, it is an important center in the study area that could support improved transit service. Boston Avenue is a primary roadway through Medford Hillside that has urban centers and activity centers at the intersection of Winthrop Street and along the section from College Avenue to Arlington Street.
- **West Medford Square** is a business district in close proximity to residential areas. The intersection of Route 60/High Street and Playstead and Harvard Avenues is a congested area. Surrounding West Medford Square, there exist businesses, restaurants, churches, schools and residences, as well as the MBTA's West Medford Commuter Rail Station.

3.7.1.2 Economic Development Initiatives

As alluded to above, the introduction of public transit has resulted in substantial economic development in the Davis Square area. Although the majority of the study area is densely developed, expansion of public transit to new areas could have positive effects on economic development, if done in concert with local planning efforts and land use regulations. This economic development could result from redevelopment of underutilized parcels, such as former industrial properties and surface parking lots, or from renovation and reuse of existing buildings.

Most of the study area consists of high-density urban neighborhoods which are established yet experiencing growth pressures and demographic change. Given that roadway expansion is not possible and space for cars is extremely limited, it will be difficult if not impossible to meet the goals of regional housing affordability and concentrated mixed-use development while relying on an auto-dependent transportation system. Therefore, there is a need to strengthen and expand transit options for economic development to occur.

Two areas have been identified by the City of Somerville as high priority areas for economic development:

- **Union Square**. Substantial development opportunities exist near Union Square. Underutilized industrial properties are located on the southeast side of the square adjacent to the Fitchburg Branch railroad corridor.

Additional development opportunities exist in the square itself through renovation of existing buildings, renovation of existing buildings. Similar potential exists both to the east and west of the square along Somerville Avenue.

- **Inner Belt Industrial Park/Cobble Hill/Brickbottom**. To the east of Union Square, the mixed-use district east of Route 28 could exhibit substantial economic development with the addition of improved transit service. The Inner Belt Industrial Park could be transformed into a prime location for additional light industrial, research & development, office, or mixed use development. Additional development opportunities are also possible in the Brickbottom area.

In addition to these primary redevelopment areas, additional opportunities exist throughout the study area:

- Gilman Square could provide mixed-use development opportunities near a potential transit station. Such development could help to address the topographic challenges of the area and improve access to the City Hall/ High School complex from the potential station area are points to the north.
- The area between the Lowell Line and the former railroad right of way to Alewife (Somerville Community Path Alignment) contains abandoned industrial properties which could serve as prime residential development sites.
- The area along Boston Avenue between Ball Square and Winthrop Street could hold some redevelopment potential for institutional, residential, or mixed uses.
- Increased residential and commercial activity is also possible near a number of locations along the Lowell Line, including Magoun Square, Medford Hillside, Ball Square, Winthrop Square and West Medford.

3.7.2 Transportation Corridors

As described earlier in this document, a variety of roadway corridors provide vehicular circulation. For the most part, however, these corridors have limited capacity to accommodate a large volume of additional bus service, or to provide improved service reliability and quality due to their narrow right-of-way, high traffic volumes, and on-street parking. Notable exceptions to this condition are the McGrath Highway, Somerville Avenue between McGrath Highway and Union Square, and Broadway between Ball Square and Sullivan Square.

Railroad corridors in the study area include the Fitchburg Line, the Lowell Line, and the Somerville Community Path right-of-way (among others in East Somerville). These rights-of-way provide the opportunity for off-road transit service and access to the main economic development areas described in the previous section. There are constraints on the ability of these rights-of-way to provide increased transit service. These constraints include:

- The right-of-way is used for both commuter rail and freight services. Impacts on existing services need to be minimized and consideration needs to be made for the requirements of sharing the right-of-way with different transportation mode types.
- Some segments are narrow and may not be able to accommodate new facilities without modifications. The Lowell Line right-of-way, which is typically at least 80 feet wide, narrows to 50 feet in some sections between Harvard Avenue and Broadway and north of College Avenue. Additionally, the area north of the Mystic River contains at-grade highway-railroad crossings at Canal Street and High Streets, which will need to be addressed.
- There are 17 bridges on the New Hampshire Main Line and four bridges on the Fitchburg Line. At the time that these structures were originally built, these bridges were wide enough to accommodate up to four commuter rail tracks. However, over time several of these bridges have been rebuilt and the locations of the abutments were narrowed. Adjustments will be necessary to several of these bridges if additional modes of transportation will be provided within the right-of-way.
- A Community Path that is proposed along a portion of the Lowell Line. The project envisions the use of the abandoned segment of the Lexington & Arlington Railroad between Cedar and Lowell Streets. Heading southeast, it would extend along the MBTA's New Hampshire Main Line railroad right-of-way from Somerville Junction (near Lowell Street) to Washington Street. The alignment would then extend south to Lechmere area. Coordination with the community path is necessary to minimize impacts.
- There is currently inadequate layover space for expansion of transportation services. The ability to store and maintain vehicles at practical locations near the study area will be necessary for any expansion of service. As noted earlier in this chapter, the reconstruction of Lechmere Station presents an opportunity to increase the storage capacity in the area. However, even with the anticipated storage capacity expansion, additional layover space would be needed to expand Green Line service. Determining a location to provide sufficient storage and maintenance capacity for the service will be a necessary part of this study.

Even though these issues are constraints, design solutions can be examined to take advantage of the available right-of-way. The extent to which they are possibilities needs to be analyzed. For example, one of these constraints, the community path, could be an opportunity to improve pedestrian and bicycle access to the proposed transit systems and may help leverage multimodal/intermodal funding for transit development.

3.7.3 Environmental Considerations

Environmental considerations for the development of new transit facilities in the study area are both opportunities and constraints. There are several key environmental opportunities associated with the potential project. These include:

- Improved mobility to existing urban neighborhoods,
- Opportunity for Smart-Growth, Transit-Oriented Development,
- Reduced traffic congestion,
- Reduced automobile emissions, and
- Opportunity for cleanup and reuse of contaminated urban land.

Other potential negative environmental impacts that may require mitigation are:

- Additional noise in residential areas from construction and transit operations.
- Vibration caused by construction and transit operations.
- Wetland/Resource Area impacts associated with expanded infrastructure.
- Layover facilities.
- Transit vehicle emissions from fossil-fuel powered vehicles.
- Traffic impacts for in-road operations and at station sites.

3.8 Coordination with Other Projects

The communities in the study area are pursuing a number of transportation and development projects that are of importance to the project study area. Descriptions of the key features of these undertakings are provided as follows.

3.8.1 North Point Area

As noted previously, the North Point development promises to transform a formerly underutilized area of land straddling Cambridge, Somerville and Boston into a vital mixed-used, transit-oriented neighborhood. The groundbreaking for the North Point development occurred in March 2005, and marked the start of Phase 1 construction on two residential buildings totaling 329 condominiums, and half of the 10-acre Central Park green space. The North Point project will require continuing coordination among the private developer, the communities, and the MBTA, particularly as the Lechmere Station relocation is undertaken.

Adjacent to North Point, the Charles E. Smith residential development is a planned residential community. The project is proposed to redevelop and existing warehouse and retail operation into an apartment complex consisting of approximately 750 housing units in two buildings. A parking structure for approximately 900 spaces is also proposed.

3.8.2 Twin City Plaza Expansion

The proposed project will modernize the existing Star Market supermarket and add approximately 37,000 square feet to the existing store. The project will also provide general benefits to Twin City Plaza by improving site circulation for pedestrians and vehicles, increasing available parking by 100 spaces and improving landscaping.

3.8.3 Assembly Square

Immediately south of the Mystic River and directly west of the MBTA's Orange Line and Commuter Rail right-of-way is the City of Somerville's Assembly Square Planning District, a large triangular area bounded on the east by the MBTA right-of-way, on the north by the Mystic River, on the west by Route 28 and on the southwest by the I-93 on viaduct. The District has large retail facilities such as Home Depot, K-Mart and Circuit City as well as a Tage Hotel, a "99" Restaurant, a Loews Cinema complex, the Somerville District Court House and other retail, commercial and industrial facilities. Despite this mix of uses, the site appears underused and run down due to large vacant parcels, vast paved parking lots and vacant buildings.

The City has devoted extensive planning resources in developing a community development blueprint for Assembly Square that would accommodate more urban, transit-supportive uses and densities. Specific study efforts include:

1. *Assembly Square Planning Study: A Vision and Implementation Plan for the Future*, prepared by the Cecil Group, Inc. with others, October 2000;
2. *Assembly Square: Unifying Design Guidelines for the Public Realm* by Von Grossman & Company, March 2002
3. *Assembly Square Revitalization Plan: 2002 Major Plan Change*, prepared by OHCD, May 2002
4. *Assembly Square Transportation Plan*, prepared by Rizzo Associates, May 13, 2003

In addition to these study efforts, significant development proposals for the Assembly Square site have been submitted to the City:

- *Assembly Square: Proposal for the Redevelopment of Yard 21 and Neighboring Parcels*, *Design Concept*, submitted by The Sturtevant Partnership, August 15, 2001; and
- *IKEA at Assembly Square, A Mixed Use Development, Preliminary Master Plan, Planned Unit Development*, prepared by Arrowstreet and Vanasse Hangen Brustlin, Inc., submitted by IKEA Property, Inc., May 3, 2002

3.8.3.1 Yard 21

The Sturtevant Partnership Proposal proposes creation of a significant mixed-use district on Yard 21 and adjacent parcels. The Partnership controls approximately 10 acres adjacent to the MBTA right-of-way. The development program includes a mix of office (2,039,800 square feet), retail (327,800 square feet) and 860 residential units. Of specific interest is the Partnership's plan to physically connect the station access with the mixed-use development by means of a "Draw 7 Park Arcade." Equally of interest is its development density objective of generating sufficient ridership to justify a new Orange Line station.

Within the Assembly Square District, Yard 21 is directly west and adjacent to the MBTA ROW between Foley Street Extension on the north and Tenney Court Extension on the south. The Somerville Redevelopment Authority owns the 9.79-acre triangular shaped parcel, having acquired it in September 2000 from the MBTA for redevelopment purposes. The eastern portion of the parcel nearest to the MBTA ROW was a former railroad yard and is currently unused, overgrown with weeds and unsightly. The western portion of the Parcel is occupied by Central Steel, Spaulding Brick Company and Petrolane Company.

In 1997, Rizzo Associates, Inc. performed a Phase 1, Initial Site Investigation for the MBTA. Petroleum related compounds were detected in the soil and groundwater by the MA Department of Environmental Protection. The City has plans to redevelop the parcel and adjacent parcels into a mixed-use residential urban village centered on a new Orange Line Station. The Sturtevant Partnership has been designated by the City as developer of the parcel. Yard 21 is the most critical parcel for station siting purposes since access to the station will be through the parcel or adjacent to it.

3.8.3.2 Assembly Square Mall

The Assembly Square Mall is located on a 26.0-acre parcel of land. The redevelopment of this property will total nearly 690,000 gross square feet of buildings, including retail, office, and residential uses. The residential apartment building is reported to contain 184 studio, one-bedroom, and two-bedroom apartment units.

3.8.3.3 Stop & Shop Supermarket

A new Stop & Shop supermarket and an office building are being proposed for the former Somerville Lumber site and the adjacent Sherman Guber site on the southeast corner of the McGrath Highway/Mystic Avenue intersection. The site is approximately 7.1 acres. The proposed new facilities consist of a 73,133 square foot supermarket, an additional 7,340 square foot non-sales mezzanine area, and a 25,000 square foot office building, for a total of 105,473 square feet. The site will have 353 on-site parking spaces.

3.8.3.4 Winter Hill Yacht Club

Directly west of the MBTA ROW is a thin sliver of land owned by the MDC and occupied by the private Winter Hill Yacht Club. The Winter Hill site and the Draw 7 Park are linked by the two-lane roadway, described above, under the Dana Bridge.

3.8.3.5 IKEA Site

Directly west of the Winter Hill Parcel is a parcel owned by IKEA, the Swedish furniture retailer. The parcel is bounded by the Winter Hill parcel (MDC) and a thin sliver of riverfront land owned by the MDC. IKEA plans a major retail furniture store with underground parking. Additional planned uses include a riverside park, office space, and ground floor restaurants and retail. Currently the site is vacant. The development site is within walking distance of the potential site for the Orange Line Station.

3.8.4 Somerville Community Path

The City of Somerville is pursuing the construction of a bicycle / pedestrian facility linking the existing linear park at Davis Square to Lechmere. The project envisions the use of the abandoned segment of the Lexington & Arlington Railroad between Cedar and Lowell Streets. Heading southeast, it would extend along the MBTA's New Hampshire Main Line railroad right-of-way from Somerville Junction (near Lowell Street) to Washington Street. The alignment would then extend south to Lechmere area. The City completed a Feasibility Study in May 2001 and is presently undertaking initial design on the segment from Cedar Street to Central Street. Conceptual planning continues on the project.

Where the path is located at-grade along the MBTA's railroad right-of-way, the 12 foot wide path would have a three foot wide shoulder on each side. A fence and/or separating wall occupying a maximum width of two feet would be situated at the edge of the shoulder adjacent to the railroad right-of-way. Therefore, the total right-of-way requirement for the path would be 20 feet.

In addition to coordinating the physical arrangements of the project, there is also an opportunity to integrate the Community Path's neighborhood connections into the transit stations, particularly where the path will cross local streets at grade. The alignments under consideration for the Beyond Lechmere Project will be coordinated with the community path for compatibility.

3.8.5 Union Square Master Plan / Phase II

The City of Somerville is undertaking a multi-phase plan for the revitalization of Union Square. The Square is a commercial business district and an historic crossroads where several major city arterials converge. The Fitchburg Division tracks also pass just south of the Square. Rail service represented an important feature in the development of the various industrial activities that once dominated the southern portions of the Square. This industrial activity has declined, and some of these remaining activities are viewed as being incompatible with plans for commercial and residential development of the area.

Presently, Union Square is considered to be viable but not as flourishing or vital as it once was. The Square is not served by rapid transit or commuter rail lines, and it is thus perceived to be at a competitive disadvantage as compared to other nearby neighborhood, community and office commercial centers – such as Davis Square, Porter Square, Central Square, Kendall Square and Harvard Square – all of which are served by the Red Line. The Master Plan's statement of goals and objectives identifies a need to "*maintain an efficient and thorough system of transportation that balances public transportation, private and commercial vehicles, bicycles, and pedestrians that is consistent with Union Square's image as a commercial center.*"

Specific activities include:

- Work with the MBTA to establish the commuter rail stops to utilize the Fitchburg Line that passes through Union Square
- Work with the MBTA to establish a transit stop via the Green Line and the proposed Urban Ring
- Work with the MBTA to coordinate bus service within Union Square

One of the key elements in the revitalization plan is the need to locate all new major development sites within an easy walking distance (1,200 to 1,500 feet) of a proposed new multi-modal transit station planned along the Fitchburg Division right-of-way at the intersection of Prospect Street and Webster Avenue. The development in the vicinity of this transit facility may shift the "center of gravity' of Union Square slightly east towards Prospect Street, serving to enhance Prospect Street as the southern gateway to the Square.

3.8.6 Transportation Improvement Projects

The Transportation Improvement Program (TIP) identifies several transportation improvement projects currently proposed in the study area. Development of transit alternatives will need to be coordinated with these roadway efforts. Some of these projects include, but are not limited to, the following:

- Beacon Street - Reconstruction from Oxford Street to the Cambridge city line.

- I-93/Mystic Avenue Interchange – Construct a new underpass grade separating Route 28 northbound and converting the existing underpass to exclusive Route 28 southbound use.
- Somerville Avenue – Reconstruct Somerville Avenue from Union Square to the Cambridge city line and install visual enhancements along the south side of Somerville Avenue to School Street.
- Temple Street – Reconstruct Temple Street from Broadway to Mystic Avenue.
- Washington Street – Reconstruct Washington Street from the Boston city line to Route 28.

3.8.7 Planning Studies and Regulatory Initiatives

There are a number of planning studies that are underway or have been completed. The studies have identified areas for redevelopment and the types of redevelopment that should occur. In some cases transportation issues have also been addressed. Alternatives under consideration for transit improvements will need to be sensitive to the land use and potential improvements identified in these studies. Additionally, a brief listing of the studies and regulatory initiatives follows:

- **Urban Ring Project** – The Urban Ring Project, currently in the planning stages, consists of a three-phase, staged implementation of transit services in a circumferential corridor located approximately two miles outside of the center of downtown Boston. The project includes segments within the municipalities of Boston, Cambridge, Somerville, Brookline, Everett, Medford and Chelsea. The initial phase has consisted of implementation of three "Crosstown" bus routes by the MBTA, designated CT-1, CT-2 and CT-3. In late 2004 the MBTA completed the Draft Environmental Impact Report (DEIR) for Phase 2 of the project, which envisions the implementation of various Bus Rapid Transit (BRT) routes, expanded Crosstown bus services and improved intermodal transit connections. These services would provide connections from the existing Silver Line / Dudley Street terminal in Boston extending north and then east through the Longwood Medical Area, Kenmore Square, MIT, Kendall Square Lechmere, Union Square, Assembly Square, Orange Line stations between Community College and Wellington and east to Chelsea and Logan Airport. In addition to the proposed BRT routes, Phase 2 of the Urban Ring Project provides for new commuter rail stations at Union Square, Gilman Square and Sullivan Square. Phase 3 of the Urban Ring Project envisions conversion of some Phase 2 BRT routes and services to light rail and heavy rail rapid transit operations. Phase 3 has been developed as part of a Major Investment Study by the MBTA. However, an implementation schedule and plans for Phase 3 have yet to be formulated.

- **Assembly Square Orange Line Study** – Several alternative configurations have been developed for the proposed Assembly Square Orange Line Station which is a project under study by the City of Somerville. All of the alternatives seek to minimize any encroachment on the development parcels at the western side of the proposed station, while also seeking to minimize the need for re-alignment of the Orange Line tracks and the Haverhill/Reading Line commuter rail tracks situated east oft the Orange Line. The station configuration is ultimately intended to consist of three tracks serving two center platforms, thereby taking full advantage of the three-track Orange Line configuration at this location. Operational issues are also being addressed, notably the impact on existing Orange Line operations due to the implementation of a new station. Issues include impacts on travel times, headways, passenger capacity and the possible need for additional cars.

- **Eastern Cambridge Planning Study** – This study includes an analysis of existing conditions in Eastern Cambridge – historical context, urban design and open space, land use and zoning, real estate market for housing, office/R&D, retail and transportation. The study provides recommendations on zoning, land use, transportation, and other issues that aim to fulfill the vision for the future of East Cambridge.

- **Somerville Land Use/Zoning Policy -** The City of Somerville has a Zoning Ordinance that identifies the requirements for developments in the city. Elements to consider include dimensional requirements, off-street parking and loading, and Planned Unit Development (PUD). A special consideration in zoning is the proximity of a development to rapid transit or public parking. Reduced parking requirements may be made on developments that are located within 650 feet of municipal parking facilities or within 1000 feet of a rapid transit station.

- **Inner Belt Planning Study –** The City of Somerville hopes to see the Inner Belt District develop with full potential. The Inner Belt Planning Study outlines the existing conditions of the district. Future documents will examine the potential of the district, explore possible zoning changes that might help the district reach its potential, and examine public improvements that might be needs in the future to help the district grow.

- **McGrath Highway Corridor Study –** This study provides an overview of the existing conditions and current zoning of the areas adjacent to Route 28/McGrath Highway from Washington Street to the Cambridge city line, extending east to Merriam and Harding Streets and west to the railroad tracks bordering Brickbottom.

- **Tufts University Master Plan** - Tufts University is in the early stages of initiating a master plan for the area. The goal of the study is to conduct a full assessment of the present and future needs of Tufts University.

- **The Vision of Medford Square** - Coordinated by the City's Office of Community Development, this study examined economic opportunities associated with redevelopment particularly in the Medford Square area. Recommendations of the study will be considered for future comprehensive planning efforts for the entire City and to create a specific master plan for the Medford Square area.

- **Medford Open Space Plan** – Major goals of the Open Space Plan are to serve the specific recreation needs of Medford residents and to use the open space system to strengthen the community. The Medford Recovery Action Plan (RAP) is a supplement to the Medford Open Space Plan, which provides a framework for applying the Federal Urban Parks and Recreation Recovery Action Program to Medford's open space and recreation system.

3.8.8 Additional Private Developments

There are a number of private development initiatives that occur within the project study area. One example of this type of development is K.S.S. Realty Partners, Inc. plan for a residential development at 56 and 61 Clyde Street. The parcels are adjacent to the Lowell Line and the Lowell Street Bridge. Coordination with private developments along potential alternative alignments, such as this one, will need to be done throughout the project.