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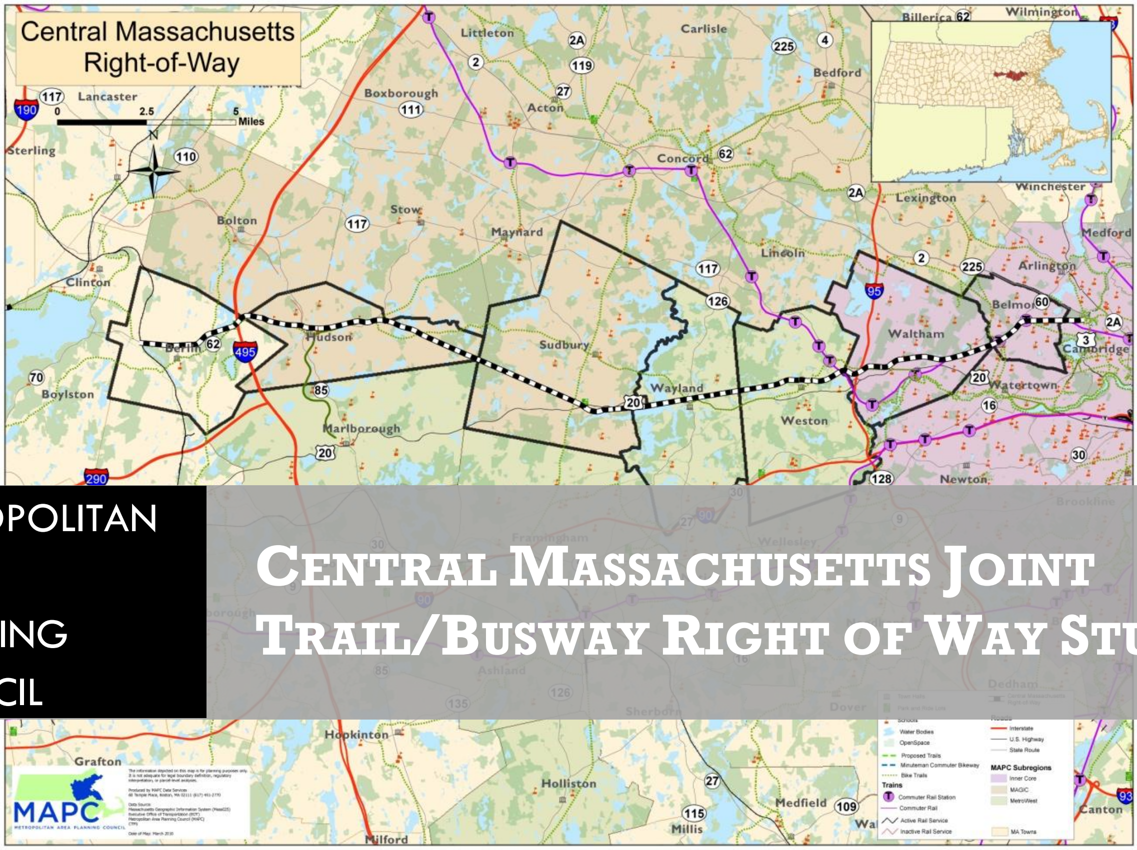

METROPOLITAN
AREA
PLANNING
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CENTRAL MASSACHUSETTS JOINT TRAIL/BUSWAY RIGHT OF WAY STUDY

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Table of Contents

Executive Summary

The Minuteman Advisory Group on Inter-local Coordination (MAGIC), a sub-region of the 101 cities and towns in the Metropolitan Area Planning Council (MAPC) region, requested and funded this initial feasibility study of the Central Massachusetts Railroad right-of-way (ROW) to accommodate both a shared use path (bicycle/pedestrian) and a dedicated busway. For the purpose of this study the concept will be referred to as the Mass Central Connector.

The MAPC prepared this study in close coordination with the communities along the ROW to gauge their support for the concept. MAPC also engaged the Central Transportation Planning Staff (CTPS) to examine the physical right-of-way, environmental issues, and potential trail usage and bus ridership.

The study builds on the work of two reports by CTPS, the Central Massachusetts Commuter Rail Feasibility Study (December 1996) and the Central Massachusetts Rail Trail Feasibility Study (April 1997). These two studies determined, respectively, the feasibility of reinstituting commuter rail service and establishing a trail along the corridor.

This study examines issues associated with accommodating a joint trail and busway facility in the existing corridor, including right-of-way constraints, environmental concerns, and potential usage. This study also identifies similar examples to this concept in North America and around the world, and initial community feedback to the concept.

The objective of this study is to take a broad, long-term look at the corridor, while considering the level of community support for the concept. Information from this study will help inform the corridor's future use.

The study focuses on the section of the Central Massachusetts Railroad ROW between Interstate 495 and Route 128, through the communities of Berlin, Bolton, Hudson, Stow, Sudbury, Wayland, and Weston. The study was written under the assumption that bus service would continue into Boston via Route 128 South to Interstate 90, terminating at South Station in Boston.

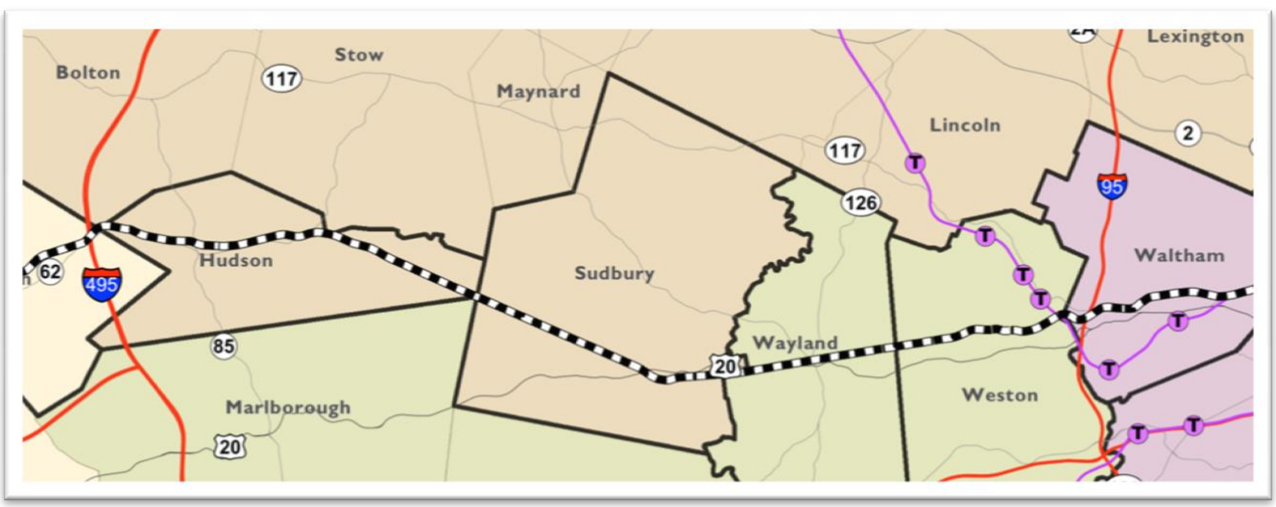
This initial feasibility analysis reveals significant challenges to establishing separate bike and busways along the corridor. However, MAPC believes that future planning of the corridor by the adjacent communities and Department of Conservation and Recreation (DCR) as a shared use path should not preclude a more robust transportation option, such as a dedicated busway or even a re-established commuter rail, in the future.

As gasoline prices rise and density along the corridor increases, it may make the viability of the Mass Central Connector concept more feasible.

Key Findings

At face value, the idea of a busway on the Mass Central line seems to make sense. It is a publicly-owned radial corridor that might appear ideal for bus service. On closer examination, however, there are serious obstacles:

- The ROW is very narrow in many points, especially near the corridor's numerous at-grade crossings, to accommodate both a shared use path and a dedicated busway.
- Travel times on the busway would be long because of the bus stops, numerous at-grade crossings, and lack of ROW continuing into downtown Boston. An in-bound trip from Berlin to Boston would take between 76 and 92 minutes depending on the bus ability to reach speeds of 55 miles per hour.
- Bicycle ridership would be at approximately 1,000 during the week. Bus ridership would be lower, with approximately 600 weekday riders.
- There are few similar examples of joint bike and busway corridors in North America existing in relatively low density areas like the Mass Central Corridor.
- Several of the communities along the corridor closer to Route 128 are unlikely to support the concept because of environmental impacts, abutter concerns, and perceived safety issues.



Background

The Massachusetts Bay Transportation Authority (MBTA) owns the section of the Central Massachusetts Railroad ROW from Beaver Street in Waltham to just east of Coburn Road in Berlin, a length of 23 miles. Originally extending from North Cambridge to Northampton, the rail line was used for both passenger and freight service, and is now abandoned. The western end in Northampton, owned by DCR, became the Norwottuck Rail Trail in 1993.

Until 1971, the line carried both passenger and freight service from Berlin and points west into Boston. The length of the full corridor is over 100 miles; however this study focuses on a roughly 17 mile section between I-495 and Route 128.

In the years since service was abandoned, various entities have expressed interest in restoring commuter rail service, and in 1996, CTPS produced a feasibility study. Their report predicted low ridership with high capital and operating costs. Over the years, there has been interest in using the ROW as a trail, and in 1997 CTPS conducted a study that concluded a trail was a feasible option moving forward. Since that time, plans for using the ROW for a trail have advanced. To that end, the MBTA and DCR have recently finalized an agreement whereby DCR will lease part of the ROW from the MBTA for 99 years with the intent of developing a shared use path.

In the meantime, the MAGIC subregion of MAPC is investigating public transportation options alongside a shared-use bicycle and pedestrian path.

Corridor Transportation Description

The major radial transportation corridor stemming northwest from Boston is comprised of Route 2, Route 117, and Route 20. This major transportation corridor also includes the Fitchburg Commuter Rail Line, although it diverts further north from the area in this study. Route 117 and Route 20 have experienced increasing traffic congestion during peak commuting hours, forcing many commuters in Hudson, Stow, and Bolton to travel on I-495 south and I-90 east to access the urban core of Boston. Route 20, in particular, carries high volumes of traffic, ranging from approximately 30,000 vehicles a day in Sudbury to 40,000 in Weston, according to 2007 traffic counts conducted by the Massachusetts Department of Transportation.

Demographics

The 2000 and 2010 U.S. Census and accompanying Journey to Work data indicates that the study area ranges from suburban to rural, with pockets of higher density along the ROW. The highest population density along the ROW lies at the western end in Hudson with almost 1,600 people per square mile. Moving east the density fluctuates, and then sharply increases in Waltham. Wayland demonstrates the second largest density with about 860 people per square mile, while Sudbury and Weston show populations between 650-725 people per square mile. Berlin has the lowest population density with a little over 200 people per square mile.

Tables 1 and 2 below demonstrate the changes in density among the communities along the corridor, with significant increases in Hudson and Sudbury. From 1990 to 2000, both towns saw a major increase in the number of people employed. Hudson recorded an increase of 4,904 people (from 9,364 to 14,268); and Sudbury almost doubled its employment population with an increase of 5,800 (6,111 in 1990 to 11,911 in 2000). From 1990 through 2010, a number of the communities along the corridor saw steady increases in population. Hudson grew by 5.24% from 2000 to 2010, continuing a growth trend. However, all of the communities combined do not have enough density needed to support a strong public transit route, given the relatively low cost and ease of automobile travel. In fact, the total population of just Waltham alone is over two-thirds of the entire corridor communities put together.

Table 1

Population, Land Area, Population Density, and Employment by community, 2000				
	2000 Population	Pop. Density (Persons/ sq. Mile)	Land Area (Sq. Mile)	2000 Employment
Berlin	2,380	184	13.01	1,265
Bolton	4,148	208	20.00	2,372
Stow	5,902	334	17.62	4,326
Hudson	18,113	1,575	11.50	14,268
Sudbury	16,841	691	24.37	11,911
Wayland	13,100	860	15.23	9,829
Weston	11,469	673	17.02	8,575
Total	*71,953*	606	118.75	*52,546*
Waltham	*59,226*	*4,935.5*	*12*	*51,037*
Total	*131,179*	*1,003.2*	*130.75*	*103,583*

Table 2

Population, Land Area, and Population Density by community, 2010			
	2010 Population	Pop. Density (Persons/ sq. Mile)	Land Area (Sq. Mile)
Berlin	2,866	220	13.01
Bolton	4,897	245	20.00
Stow	6,590	374	17.62
Hudson	19,063	1,657	11.50
Sudbury	17,659	724	24.37
Wayland	12,994	853	15.23
Weston	11,261	661	17.02
Total	*75,333*	633	118.75
Waltham	*60,632*	*5,052*	*12*
Total	*135,965*	*1,040*	*130.75*

Source: 2010 U.S. Census figures released in March 2011. At the time of this feasibility study, employment statics had not been released.

Table 3 below indicates the modes of transportation that residents of the study area use for commuting. Overwhelmingly, each town experienced over 70 percent of their commuting populations driving alone. This is largely attributed to the spread-out nature of development and lack of existing public transit. Of those towns along the ROW, Weston was the only town to show almost a five percent transit commuting share, which can be attributed to the Fitchburg Commuter Rail Line that runs through the Northeast section of town and has three rail stations. Hudson has both the lowest (0.7%) transit share and the highest number of commuting residents (9,889) along the ROW. Subsequently, Hudson showed the greatest number (9.2%) of residents choosing to carpool to work.

Table 3

Transportation Modes for Commuting by Community, 2000								
	all workers: 16+	drive alone	carpool	transit*	walk	other means	work from home	Average travel time (mines)
Berlin	1,240	85.0%	4.2%	2.7%	4.5%	0.0%	3.2%	21.9
Bolton	2,212	85.4%	3.4%	0.9%	0.9%	0.2%	8.9%	31.1
Stow	3,312	84.2%	4.6%	3.5%	1.2%	0.7%	5.8%	31.1
Hudson	9,889	84.8%	9.2%	0.7%	1.6%	1%	2.6%	25
Sudbury	7,939	84.8%	3.8%	3.1%	1.7%	0.7%	5.9%	33.2
Wayland	6,398	80.7%	7.1%	3.8%	0.6%	0.5%	7.3%	31.3
Weston	5,077	73.7%	5.6%	4.8%	4.5%	0.6%	10.9%	27.3
Waltham	*32,671*	*73.0%*	*8.4%*	*8.5%*	*6.7%*	*1.0%*	*2.4%*	*23.3*

Source: 2000 U.S. Census * The category "Public transportation (including taxicab)" includes workers who usually used a bus or trolley bus, streetcar or trolley car, subway or elevated, railroad, ferryboat, or taxicab during the reference week. **The category "Other" means includes workers who used a mode of travel that is not identified separately. Waltham is included to show the drastic increase as you move east along the route towards metro Boston. It should be noted that these census numbers are estimates based on a sample questionnaire. Only workers over 16 years of age are included. All students, including those over 16, are excluded.

Public Transit Options

Currently, the only direct bus service into Boston is a Cavalier Coach, which runs from Northborough to Boston along Route 20, making stops in Marlborough, Sudbury, Wayland and Weston. It runs twice a day during peak times, with a seating capacity of 55 riders. The route has a total of 11 stops, ending at Government Center outside the JFK Building.

The Cavalier route started as a demonstration project in January 2009, with a one-way fare of $6 and an approximate one-way trip time of 60 minutes. There is a possibility that it may be consolidated with the Marlborough to Boston route, which has been in service for over 30 years and runs to/from Boston via Marlborough, Southborough Center and Framingham, stopping at 6 different locations in downtown Boston. However, Cavalier Coach does not know of its immediate future plans. There is a general average of 80 to 100 total riders per day for both routes.

Transportation by commuter rail for the residents of these communities and the Central Mass area proves to be difficult. Situated between the MBTA Worcester Commuter Line to the south, and the Fitchburg Commuter Line to the north, residents often experience limited to no spaces left in parking lots at rail stations, and encounter peak traffic during their rides to such lots. Consequently, residents will often need to drive to one or more of the commuter stations, looking for availability.

There is no public transit in Bolton, Hudson and Stow. Sudbury residents commute to Framingham station to access commuter rail and Greyhound Bus Lines for transit access into the Boston area (two trips daily). Wayland does not have a commuter rail stop, but is within a short driving distance of Weston and Lincoln, where there is rail access into North Station. Wayland and Weston residents can also drive to Newton to take the MBTA Green Line, or use commuter rail service in neighboring Wellesley and Natick for access to South Station.

Concept

The concept for this feasibility study includes five proposed bus stops/stations from I-495 to Route 128, linked by a dedicated, paved 12 -foot bicycle/pedestrian path and a separate paved 20- foot wide suburban busway with two ten-foot wide lanes. The trail would have a three foot shoulder on both sides, and a busway with two- foot shoulders on each side. Separating the two dedicated paths would be a one foot buffer with a fence for safety. See image below.

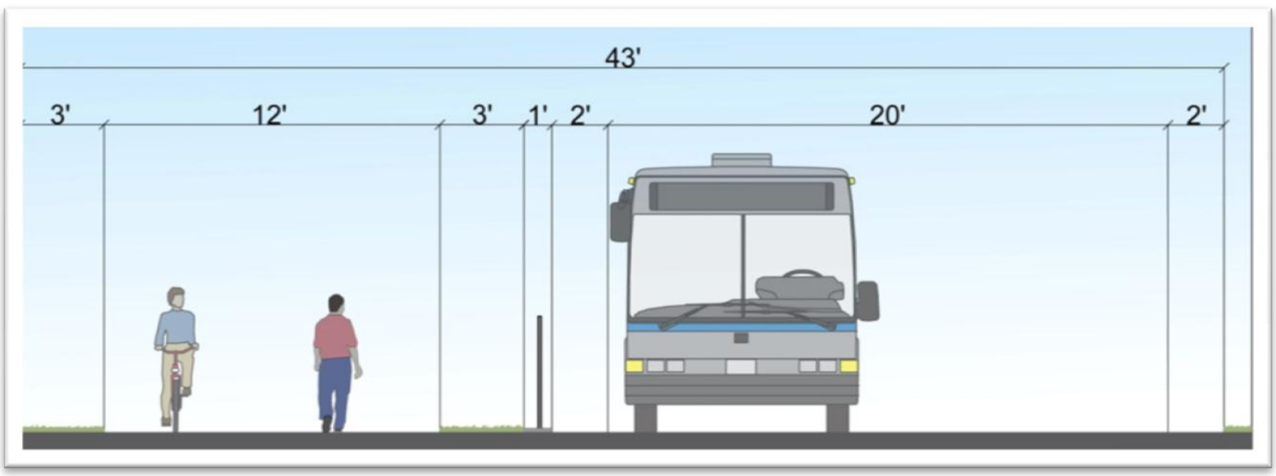


Figure 1. Proposed dimensions for bicycle/pedestrian path and busway

Stations

Currently, there is only one park-and-ride facility at any of the proposed station sites: a town-owned park-and-ride carpool facility located at the proposed Berlin station site. The bus ridership analysis on pages 18-27 does not assume that park-and-ride lots would be constructed at any of the four other stations. Thus, those stations would only be accessible by walking, bicycling, and kiss-and-ride trips.

The station at I-495, the western most section of the corridor, could be located on an open parking area adjacent to I-495 and Coolidge Road. This station could have structured parking and act as a hub for commuters along the I-495 corridor, as well as motorists along Route 62 running east through Berlin, and overflow commuters from Route 117. Additionally, this station would be located close to the new Highland Commons, an 820,000 square-foot retail mall with 20 stores, a bank, a gas station and a 29,400 square-foot office facility. A station hub could possibly connect users with mall shuttles, parking, bike access, and busway service, with the goal of alleviating congestion on Route 62 and I-495.

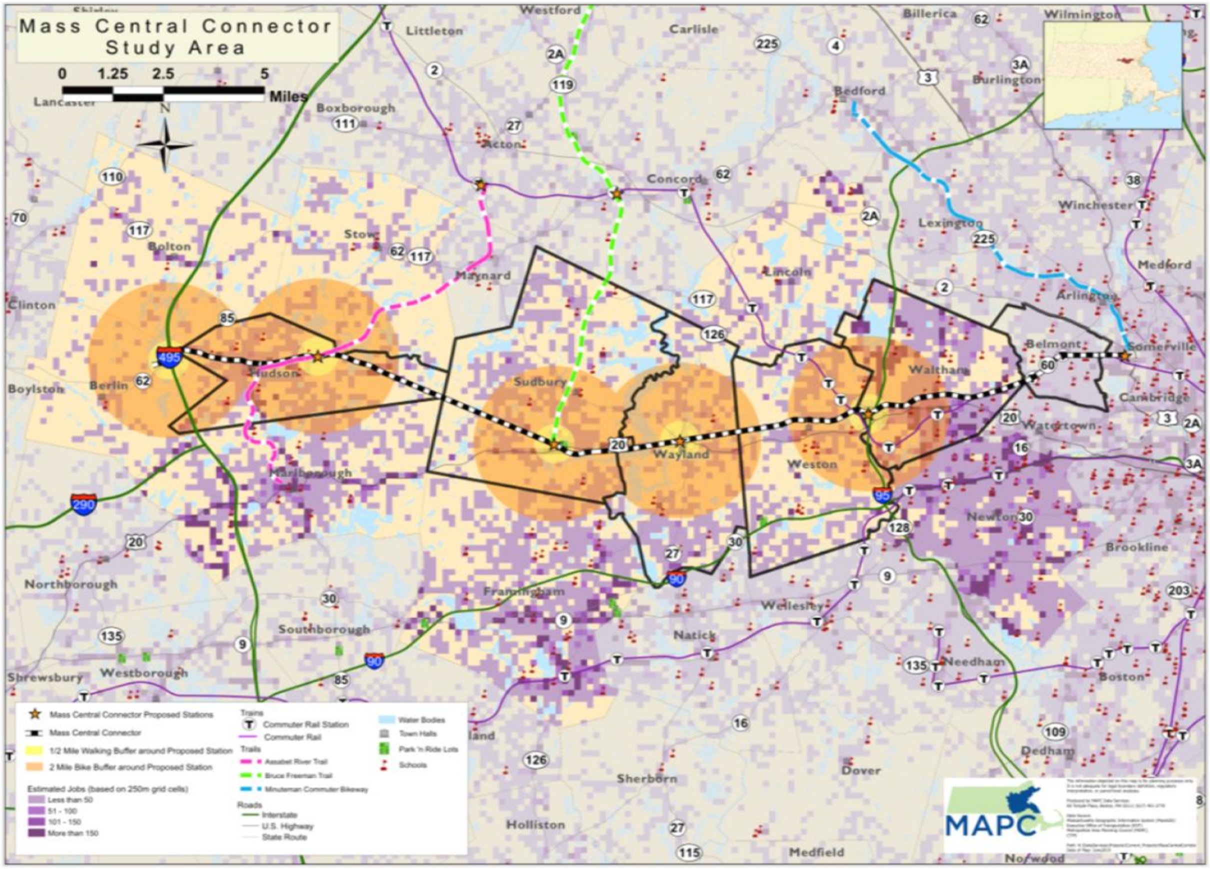
The next station could be located in Hudson on the east side of Cox Street, adjacent to the Assabet River Rail Trail and close to the Joseph L. Mulready School. This station would serve a higher density (both population and employment) community, and intersect with the existing and developing Assabet River Rail Trail shared use path.

Further east there could be a station in Sudbury, situated at the intersection of Station Road and Route 20. The proposed station would intersect with both Route 20 and the proposed Bruce Freeman Rail Trail shared use path. The site is also roughly 250 feet from a shopping center with stores and restaurants. Sudbury has the most environmentally sensitive areas along the corridor and therefore this station location would need extensive environmental review.

In Wayland, a station could be located at the intersection of Route 126 and Route 27 in a parking area east of both roadways and adjacent to the Wayland Public Library. This stop also provides access to the Wayland Shopping Center, and is a short walk to Wayland Town Hall.

The final station, at the eastern section of the corridor, could be located at the Weston and Waltham border close to Route 128 and the Fitchburg Commuter Rail Line, south of Jones Road. Preliminary analysis has been conducted by MAPC, in coordination with several communities along the Route 128 Central Corridor, to develop a multimodal station on the Fitchburg Line that would have close access on to Route 128. This could provide feeder bus service to major employment centers along Route 128. The hub station would serve commuters travelling along Route 20 to the south of the station, riders on the Fitchburg commuter line among others, and commuters whose destination is the dense Route 128 business corridor. A multimodal station would provide access and connections to the Fitchburg Line, bus or shuttle service to businesses along Route 128, continued bike path connections to points east through Waltham, and proposed continued bus service into Boston proper.

However, for the purpose of estimating bus ridership, we can only analyze potential bus stops in Berlin, Hudson, Sudbury, and Wayland because there is not an existing multi-modal center at Route 128.



The map above shows the five proposed station stops, overlaid on a map showing area employment. Connections with other bike paths are noted in pink (Assabet) and green (Bruce Freeman). The yellow circles surrounding stops shows the average half mile (roughly 10 minutes) distance a person will walk to a transit stop. When coupled with strong bicycle infrastructure, a transit stop can expand (represented in orange circles) the area it attracts riders from by three to four times the distance.

Bus vs. Restored Commuter Rail

This study examined bus service, because the MAGIC sub-region was interested in the potential of a less expensive and more flexible form of public transit than rail. Also, the 1996 study conducted by CTPS, *Central Mass. Commuter Rail Feasibility Study,* already identified many of the challenges of restored commuter rail service.

Unfortunately, the low density of the study area would likely limit the frequency of bus service and therefore it would not be considered true Bus Rapid Transit (BRT). Traditional BRT integrates facilities, services, and amenities to collectively improve the speed and reliability of traditional bus transit. BRT is most commonly used in high density urban areas. There are no examples of BRT in North America with a similar suburban/quasi-rural geography as the study area in this report.

The overall advantages of bus service include:

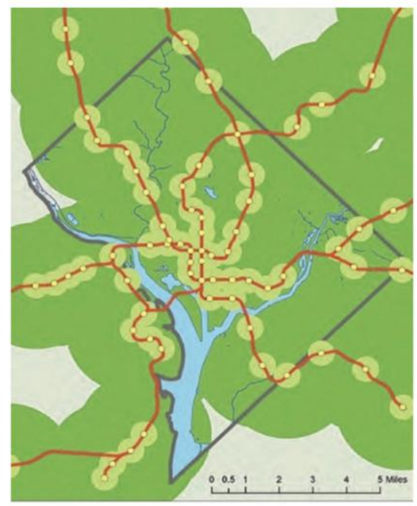
- Lower capital investment than light rail
- Higher federal funding opportunity than rail
- Route flexibility
- Shorter time frames for implementation

Benefits of Strong Bicycle Connection

A major goal of modern multimodal passenger transportation is to reduce dependence on the automobile as the major mode of ground transportation and increase the use of public transportation, biking, and walking. Recent research suggests that providing strong bicycle infrastructure (dedicated bike lanes, bike parking, secured covered bike lockers, on-board bike storage) that connects with public transit can increase transit ridership, drawing people from a wider area around the transit stop.

For example, a typical transit rider will walk about a half-mile (ten minute walk) to a transit stop, while a cyclist will bike upwards of two miles (ten minute bike ride) to reach a transit stop; quadrupling the ridership potential of that stop.

Therefore, examining and integrating bicycle facilities and dedicated bike paths with new transit lines is becoming a new part of planning for public transit infrastructure.



In the DC Metro suburbs, convenient access by bicycle would tremendously increase service area (dark green area within 10 minutes bicycling distance of a metro station). RTC

Right-of-Way Constraints

According to state guidelines, the standard width for a shared-use path is 12 feet. An additional three feet on each side is recommended for clearance, yielding a total cleared area that is 18 feet wide. A one-lane busway would require a minimum lane width of ten feet and minimum shoulder widths of two feet on each side, for a total of 14 feet. A two-lane busway would require minimum lane widths of ten feet and minimum shoulder widths of two feet, for a total of 24 feet. A minimum of 11 feet of space between an active rail line and a trail is recommended. Given the lighter weight and slower speed of a bus compared to a train, we will assume a separation of about half that distance to be adequate for a busway. Given the three-foot trail shoulder and two-foot bus shoulder, an additional one-foot buffer would need to be added to provide a total of six feet of separation between the trail and the busway. A fence would be built in the middle of this buffer.

Based on these guidelines, the following alternatives would require the corresponding right-of-way widths:

Width of Components of a Trail with Busway (in feet)

Description	Trail	Busway	Additional Separation	Total
Trail with one-lane busway	3 + 12 + 3	2 + 10 + 2	1.0	33.0
Trail with two-lane busway	3 + 12 + 3	2 + 20 + 2	1.0	43.0

While a one-lane busway would require 10 ten feet less of pavement width, it might have a negative impact on transit service. Buses could go in only one direction—for example, inbound in the morning and outbound in the afternoon—or there would have to be widened areas for a bus to pull over while it waited for a vehicle in the opposing direction to pass. The effect on service of these constraints would vary, depending on scheduling and on the number of buses assigned to the line. For the purposes of this study, a two-way busway is assumed.

One of the major issues to be addressed in accommodating a busway with a trail is the width of the usable ROW. The 1997 trail study documented the width of the entire ROW, which varies from 40 feet to over 200 feet, with much of the ROW over 80 feet wide. The total width refers to the land that belonged to the railroad and is now owned by the MBTA. The usable width is a different matter. For much of the ROW, the trains traveled on an embankment or in a cut. The railroad tracks were constructed to minimize the vertical grade so that locomotives would not have to continually go up and down, following the natural grades of the land.

Staff examined the ROW at 23 of the 33 crossings between Waltham and Berlin and provided a description of the existing usable right-of-way width at those intersection crossings. Intersection crossings that are deemed to have sufficient width are those where the usable ROW is at least 43 feet wide, the width required to accommodate a trail and a two-lane busway.

TABLE 4

Usable ROW at Central Mass. Intersection Crossings

Intersection	**Configuration of ROW**	**Usable Width**	**Type of Crossing**	**Comments**
Hudson				
Central St. at Coolidge St.	Embankment	16 ft.	At-grade	Drop-off on the south side. Abutted by Coolidge St. on the south side.
Manning St.	Embankment	17 ft.	At-grade	Narrow trestle bridge over Bruce's Pond on the west side.
Tower St.	Embankment	Sufficient	Above roadway	Eastbound bridge that crosses over Tower St. has been removed.

Wilkins St.	Embankment	19 ft.	Above roadway	Steep drop-off on both sides. Eastbound bridge over Wilkins St. has been removed. Lies south of Assabet River Rail Trail terminus/parking lot.
Chestnut St.	Embankment	19 ft.	Below roadway	Steep drop-off on both sides The crossing under Chestnut St. has been filled in.
Main St.	Cut	24 ft.	At-grade	3-ft. cut on the west side of Main St. 4-ft. cut on the east side of Main St.
Parmenter St.	At-grade	Sufficient	At-grade	Abutted by golf course on the southwest side.
White Pond Rd.	At-grade	Sufficient	At-grade	Guard rails have been placed on both sides of the crossing.
Sudbury				
Dutton Rd.	Embankment	35 ft.	At-grade	Steep drop-off on the south side.
Peakham Rd.	Embankment	24 ft.	At-grade	Present usable width is 24 ft. due to heavy tree growth on both sides.
Horse Pond Rd.	At-grade	20 ft.	At-grade	Present usable width is 20 ft. due to heavy tree growth on both sides.
Union Ave.	At-grade	Sufficient	At-grade	Crosses proposed Bruce Freeman Rail Trail. Old station located on the south side.
Boston Post Rd.	At-grade	24 ft.	At-grade	Present usable width is 24 ft. due to heavy tree growth on both sides and stream on north side
Landham Rd.	At-grade	25 ft.	Below roadway	ROW passes under Landham Rd. through 25 ft.-wide tunnel.
Wayland				
Boston Post Rd.	Embankment	18 ft.	At-grade	Drop-off on the south side. Present width is constrained to 14.4 ft. on the trestle bridge over the Sudbury River.
Old Sudbury Rd.	At-grade	25 ft.	At-grade	Width of owned ROW is 25 ft. Old station (now used as a shop) and parking lot are located on the south side.
Cochituate Rd.	At-grade	Sufficient	At-grade	Wayland Public Library is located on the north side.
Milbrook Rd.	At-grade	Sufficient	At-grade	
Glen Rd.	Embankment	Sufficient	At-grade	Drop-off on the south side.
Plain Rd.	At-grade	Sufficient	At-grade	
Weston				
Concord Rd.	At-grade	29 ft.	Below roadway	ROW passes under Concord Rd. through 29-ft.-wide tunnel.

Conant Rd.	At-grade	Sufficient	Below roadway	The crossing under Conant Rd. has been filled in. Pond located 100 ft. to the west of Conant Rd.
Church St.	At-grade	Sufficient	Below roadway	ROW passes under Church St. through adjacent tunnels that are 17 and 31 feet wide.

Fewer than half (48%) of the intersection crossings have a sufficient usable ROW needed to accommodate a joint trail/busway facility. Of the 23 street crossings examined, the railroad ran at grade at 13 of them, ran on an embankment at nine, and ran in a cut at one.

Note that the above description addresses only the nature of ROW, not the type of crossing at the roadway. The roadway can cross at grade, go over the ROW on a bridge, or go underneath, either in a tunnel or under a railroad bridge. The train may have traveled on an embankment and crossed a roadway at grade, such as occurs at Peakham Road in Sudbury and Boston Post Road in Wayland. In those two cases, the road crosses the ROW at grade, meaning the height of the road meets the height of the embankment.

In some locations the railroad runs on an embankment and is higher than the road, crossing the road on a bridge. Such was the case at Landham Road in Sudbury and Wilkins Street in Hudson, although in the latter case the bridge no longer exists. In addition, the roadway bridges can introduce further constraints. At Landham Road in Sudbury and Concord Road in Weston, the railroad underpasses cause the usable ROW to narrow to 25 feet and 29 feet, respectively. NSTAR utility poles constrain the usable right-of-way along the south side of the corridor for over seven miles between Sudbury and Waltham.

In order to accommodate a joint facility, several or all of the following actions would need to be considered:

- Widen some areas that are on embankments or in cuts
- Narrow some portions of the busway
- Use alternate on-road segments for buses
- Reconstruct bridges and widen underpasses

For some sections of the ROW, the embankments or cuts would have to be widened to accommodate a trail and a busway. However, many of the embankments contain steep drop-offs on one or both sides that would require more fill to expand the width of the embankment. For example, widening the 4-foot-deep cut in the ROW at Main Street in Hudson from 24 feet to 43 feet would be costly, but much less so than widening the much higher embankment at Chestnut Street from 19 feet to 43 feet. In some areas, the environmental impacts would likely prohibit these types of alterations in the width of the embankments or cuts.

The ROW has several crossings that would require complete bridge reconstruction, such as Tower Street and Wilkins Street in Hudson. There are other bridge structures that are not wide enough to accommodate a trail and even a one-lane busway, such as at Landham Road in Sudbury and Concord Road in Weston. One option would be to widen the bridge structures; another alternative would be to run the buses on the parallel roadway, Route 20. With regard to Landham Road, running the bus on Route 20 between the Central Mass/Bruce Freeman Rail Trail crossing and just east of the Sudbury River would provide a parallel route and a cost-effective alternative to bridge reconstruction. These are only a few examples of the conflicts that exist and that would need to be addressed if the project progresses.

Environmental Issues

The Mass Central Connector would pass through numerous bodies of water, including the Assabet and Sudbury rivers, Bruce Pond, several brooks, and special flood hazard areas. It would also bisect the Great Meadows National Wildlife Refuge in Wayland, making it vulnerable to inundation. During the major floods of 2010, the intersection of Routes 20 and 27 was closed for periods in mid-March and in early April due to flooding of the Sudbury River. This intersection is about 600 feet south of the ROW.

According to Federal Highway Administration (FHWA) regulations, bicycle facilities are categorical exemptions, meaning they are exempt from requiring an environmental impact statement (EIS). However, the joint facility would be subject to an EIS and to Massachusetts Environmental Policy Act (MEPA) requirements because its use would include motorized vehicles. The EIS would include a description of the affected environment, a range of alternatives to the proposed action, and an analysis of the environmental impacts of each of the possible alternatives.

It is beyond the scope of this study to say whether these environmental issues would prohibit the construction of a joint trail and busway. It is probable, however, that the construction of such a facility in environmentally sensitive areas would require extensive changes in the nature of the ROW and might not be permitted by the local conservation commissions.

Potential Trail Usage

According to trail counts conducted by the CTPS Staff, the average daily volumes for the Minuteman Bikeway are about 1,600 users on weekdays and 3,400 users on weekends and holidays. The population along the Mass Central Connector corridor is 65% of the Minuteman Corridor through Arlington, Lexington and Bedford. If the volumes on a trail are directly related to population, then the Mass Central Connector would have an average weekday volume of 1,050 users and an average daily weekend and holiday volume of 2,200 users. Yet, the employment population of the corridor is half that of the Minuteman Corridor, and the Mass Central Connector’s eastern terminus would not connect to a rapid transit line, as the Minuteman Bikeway does. Thus, 1,050 weekday users and 2,200 weekend users are upper-bound estimates of trail volumes, under present circumstances. If gasoline was to become scarce or its price was to increase substantially, then many more would likely use the trail.

Bus Ridership

An important task of this study is to develop demand and ridership estimates for the proposed Mass Central Connector bus service. Previous reports about the study corridor, such as CTPS's 1996 Central Mass. Commuter Rail Feasibility Study, were examined for insight. After careful consideration, a forecasting approach was chosen based upon the methodology employed and vetted in the 1996 study. Although that previous work concerned the feasibility of establishing commuter rail service in the corridor, it was able to serve as a modifiable template for the estimation of ridership of a unique commuter bus service.

Travel Markets

One of the first things that need to be assessed in a ridership forecast of potential transit service is the potential market groups that will use the service. Since the bulk of transit serves commuter markets, the Census 2000 Journey-to-Work reports were mined for data. This data is the most up-to-date available, since complete Census 2010 data will not be available until the summer of 2011. We collected information on work trips from the same corridor towns used in the 1996 study: Wayland, Sudbury, Hudson, Bolton, Berlin, Marlborough, Clinton, Boylston, and Stow. We also used the same destination towns for proposed stations—Berlin, Hudson, Sudbury, Wayland—as well as for other major destinations (Cambridge and Boston). These corridor towns are identical to the ones used in the 1996 study. Table 5 displays the percentages of the total work trips from each origin to each destination. For example, 5.6% of workers who live in Bolton work in Hudson.

Table 5
Percentage of Total Work Trips from Corridor Towns to Destinations with Proposed Stations

Origin/ Destination	Berlin	Hudson	Sudbury	Wayland	Cambridge	Boston	Corridor Totals	Non-Boarding Town Corridor Totals
Berlin	17.3	8.6	0.7	0.8	2.0	2.7	32.1	14.8
Bolton	0.2	5.6	1.5	0.2	2.5	3.5	13.5	13.3
Boylston	0.9	3.3	0.7	0.0	0.4	2.1	7.4	6.5
Clinton	0.7	3.0	1.0	0.2	0.8	1.7	7.4	6.7
Hudson	1.0	25.9	0.8	1.0	1.7	1.9	32.3	6.4
Marlborough	0.2	3.9	3.9	0.9	2.0	4.7	15.6	11.7
Stow	0.0	4.7	2.6	1.0	2.3	8.7	19.3	14.6
Sudbury	0.1	0.8	18.2	2.3	5.6	15.6	42.6	24.4
Wayland	0.0	0.2	2.6	15.9	4.8	19.1	42.6	26.7

Source: Census 2000 Journey-to-Work data.

Note: Non-boarding town corridor trips are trips headed for communities along the corridor other than the station at which boarding is presumed to occur.

None of the corridor communities have the majority of their projected work trips headed to the communities where proposed stations will be located or to Boston or Cambridge. Furthermore, the number of work trips headed for communities along the corridor other than the assumed boarding community is even smaller. This number can be seen in the rightmost column in Table 6. Other absolute numbers for the entire commute market are also displayed in Table 6.

TABLE 6
Daily Commute Trips from Corridor Towns:

Census 2000 Journey-to-Work Data

Origin Community	Total Commuters	Corridor Commuters	Corridor Totals Not Including Boarding Community
Berlin	1,240	398	184
Bolton	2,210	298	294
Boylston	2,060	152	134
Clinton	6,717	497	450
Hudson	9,875	3,190	632
Marlborough	19,850	3,097	2,322
Stow	3,112	601	454
Sudbury	7,941	3,383	1,938
Wayland	6,404	2,728	1,710
Total	59,409	14,344	8,118

Note: Non-boarding community corridor trips are trips headed for communities along the corridor other than the station at which boarding is presumed to occur.

Use of 1996 Study's Commuter Rail Methodology

Boston- and Cambridge-Bound Trips

The 1996 Central Mass. Commuter Rail Study examined the feasibility of commuter rail service along the study corridor. Several assumptions regarding mode share for the rail service were made in that report. The area having the Boston region's highest commuter rail market share is known as

Boston Proper, defined as the area bounded by Massachusetts Avenue, the Charles River, Boston Harbor, Fort Point Channel, and the Southeast Expressway. The report concluded that a commuter rail service might be able to capture 40% of these work trips. The study also projected that 15% of work trips to Boston locations outside of Boston Proper, as well as 15% of work trips to Cambridge locations, would be taken on this rail service. If these percentages are still assumed and applied to the data mined from the 2000 Journey-to-Work reports, roughly 1,330 daily work trips are projected for a possible corridor commuter rail service. These computations are shown in Table 7.

TABLE 7
Daily Corridor Work Commute Trips to Boston and Cambridge

From Corridor Town	Boston Proper Commute Trips	Boston Proper Transit Trips (40%)	Other Boston Commute Trips	Other Boston Transit Trips (15%)	Cambridge Commute Trips	Cambridge Transit Trips (15%)	Total Trips	Total Transit Trips
Berlin	0	0	34	5	25	4	59	9
Bolton	45	18	33	5	56	8	134	31
Boylston	0	0	44	7	8	1	52	8
Clinton	24	10	90	14	51	8	165	31
Hudson	0	0	186	28	163	24	349	52
Marlborough	288	115	640	96	406	61	1,334	272
Stow	155	62	115	17	71	11	341	90
Sudbury	759	304	479	72	441	66	1,679	442
Wayland	662	265	559	84	309	46	1,530	395
Total	1,933	773	2,180	327	1,530	230	5,643	1,330

Source: Census 2000 Journey-to-Work data.

It is worth noting that the 1,330 daily transit trips are 30% greater than the daily 1,023 transit trips calculated using the same method in the 1996 study. The reason for this increase is that the number of work trips headed towards Boston and Cambridge has increased since then. The 1990 Census Journey-to-Work data indicated 4,078 such trips, while the 2000 Census Journey-to-Work data indicated 5,643 trips, a 38% increase. Although the corridor population grew by about 7% between 1990 and 2000, one may speculate that the increase in work trips for the corridor had more to do with the booming economy of the late 1990s and early 2000s. Another reason is that the 1996 study considered potential riders from only the southern portion of Stow, while this study included the entire community as a source of potential riders.

The most recent regional household survey, performed in 1993, indicates that 86% of the daily rail trips with final destinations in Boston or Cambridge were commute trips. Given this assumption, 217 additional non-work trips to Boston and Cambridge were added to the estimate, bringing the daily total of Boston- and Cambridge-bound trips to 1,547. These non-work trips were distributed proportionally among the Corridor's origin towns, as shown in Table 8.

TABLE 8
Estimated Corridor Transit Trips

From Corridor Town	Boston/ Cambridge Work Transit Trips	Boston/ Cambridge Non-Work Transit Trips	Other Destination Transit Trips	Total Transit Trips
Berlin	9	1	1	11
Bolton	31	5	2	39
Boylston	8	1	1	10
Clinton	31	5	2	38
Hudson	52	9	4	65
Marlborough	272	44	19	336
Stow	90	15	6	111
Sudbury	442	72	31	545
Wayland	395	65	28	487
Total	1,330	217	94	1,641

Trips to Destinations Other than Boston or Cambridge

According to the MBTA's 2008–09 onboard survey, approximately 92% of the inbound trips along the Fitchburg commuter rail line, which is the MBTA commuter rail line closest to the study corridor, were destined for Boston and Cambridge. Interestingly enough, the Fitchburg Line operates at roughly the same inbound service frequencies as are being proposed for the AM-peak inbound service for the Mass Central Connector service (every 30 minutes). The next closest commuter rail line to the corridor, the Framingham/Worcester Line, had nearly 97% of its inbound trips headed to Boston and Cambridge. When these two figures are averaged, the result is that about 94% of inbound trips are headed to Boston and Cambridge. This would mean that approximately 6% of the rail trips would be headed to destinations other than Boston or Cambridge. As seen in Table 8, this would result in 94 rail trips that are not bound for Boston or Cambridge. When this figure is added to the total number of Boston- and Cambridge-bound trips (1,547), the resultant daily total for all inbound trips is 1,641.

Estimation of Bus Service Travel Times

The study corridor is not capable of attaining the commuter rail service characteristics assumed in the previous study. Not only is there a lack of reserved right-of-way between Route 128 and downtown Boston, but there are also 23 at-grade crossings along the 18-mile section of the study corridor between I-495 and Route 128. These would force the bus service to operate at a slower maximum cruising speed than commuter rail service, which the 1996 study assumed to run at 60 mph. The limited-stop Cavalier Coach bus service, connecting Northborough to Boston and roughly paralleling the study corridor, operates at an average inbound speed of nearly 29 mph prior to reaching Route 128. However, the absence of signalization at the grade crossings along this 18-mile section, due to the prohibitive costs (roughly $100,000 to $200,000 per intersection), would counteract the benefits of a reserved right-of-way, as deceleration, stopping, and acceleration would occur at every grade crossing. It is estimated that this process would result in a one minute delay at each grade crossing and each proposed station. Table 9 indicates the range of travel times from each of the proposed corridor stations if a range of maximum travel speeds, from roughly the speed of the Cavalier bus service to free-flow highway bus speed, is assumed between the stations and the grade crossings.

TABLE 9
Travel Times along the Central Mass. Corridor to Route 128

			Travel Time (min.)	
Study Corridor Stations	Number of Following Stations	Number of Grade Crossings	Maximum Speed of 55 mph	Maximum Speed of 30 mph
Berlin	3	23	46	62
Hudson	2	18	36	49
Sudbury	1	11	21	28
Wayland	0	6	11	16

It is estimated that the remaining portion of the transit trip, which is nearly 15 miles, from Route 128 to downtown Boston, traveling via Route 128 and the Massachusetts Turnpike, which is perceived to be the fastest travel route, would take roughly 30 minutes to traverse. The sums of these travel times and the times from Table 9 are shown in the columns for 55 mph and 30 mph in Table 10.

The rightmost column in Table 10 contains the estimated roadway travel times in the AM peak period, when traffic is congested, from each of the proposed stations to downtown Boston. These travel times are faster than nearly all of the proposed service times, which would occur at speeds ranging between 30 mph and 55 mph.

TABLE 10
Travel Times from Proposed Stations to Boston

Study Corridor Stations	Transit Travel Time (min.): Maximum Speed of 55 mph	Transit Travel Time (min.): Maximum Speed of 30 mph	Roadway Congested Travel Time (min.)
Berlin	76	92	61
Hudson	66	79	64
Sudbury	51	58	48
Wayland	41	46	45

Note: Transit travel times to downtown Boston via the Central Mass. Corridor.

Sources for roadway travel times: CTPS CMP 2002–05 speed data and 2010 travel-speed runs.

Use of Elasticities to Estimate Demand

Table 11 displays the ridership results for each corridor station town if the methodology from the 1996 study was followed exactly. It would be assumed that riders from Berlin, Bolton, Boylston, and Clinton would board at the proposed Berlin station, while Hudson, Marlborough, and Stow riders would board at the proposed Hudson station. However, as mentioned above, the service and travel times along the right-of-way would not be identical to that assumed in the previous study. Table 11 displays the 1996 commuter rail travel-time assumptions for the proposed stations, as well as the projected ridership using those same assumptions, also used for this study.

TABLE 11
1996 Study Commuter Rail Travel Times:

Census 2000 Ridership Data

Corridor Stations	1996 Commuter Rail Travel Time to Boston (min)	Ridership generated from Census 2000
Berlin	53	97
Hudson	43	511
Sudbury	36	545
Wayland	32	487
Total		1,641

Elasticities can be employed to discern how riders typically react to changes in service, assuming that other factors remain constant. All pertinent characteristics of the Mass Central Connector service, other than in-vehicle travel time, are assumed to be the same as the commuter rail service discussed in the 1996 study. Various components of out-of-vehicle time, as well as the price of the Mass Central Connector service relative to driving and other modes are assumed to be the same as they were in the earlier analysis. Based on published industry studies of American cities, the elasticity of transit ridership to changes in in-vehicle travel time is 0.35 (which means that 100% decrease in travel time results in roughly a 35% ridership increase). This nonlinear elasticity was individually applied to each station's travel market for the previously defined range of travel speeds and times (Table 11) to produce Table 12.

TABLE 12
Estimated Daily Demand in Calendar Year 2000

	Ridership	
Study Corridor Stations	**Maximum Speed of 55 mph**	**Maximum Speed of 30 mph**
Berlin	86	80
Hudson	441	415
Sudbury	483	462
Wayland	447	426
Total	1,457	1,383

Several things are worth noting about the results shown in Table 12. The market area of the proposed Berlin station (Berlin, Bolton, Boylston, and Clinton) would provide only about 6% of the projected ridership. The market area of the proposed Hudson station (Hudson, Marlborough, and Stow) is more robust, accounting for slightly more than 30% of the projected ridership, but this share is roughly equivalent to those generated by Sudbury and Wayland individually. Also, 800 study-area residents, according to the 2000 U.S. Census, currently use transit to make their daily work trips to Boston and Cambridge. Assuming all of those residents were diverted to the new service, approximately 400 to 600 new daily riders in calendar year 2000 would be attracted to the service. Thus, approximately 33% to slightly more than 40% of the service's riders would actually be new transit users. However, there is no guarantee that all of the present transit users would switch to the new service, especially if the travel time of the new service was longer than their present choice.

Looking beyond the year 2000, the MetroFuture socioeconomic projections, adopted as the official regional forecasts by the Boston Region MPO, indicate that the total growth in population between 2000 and 2030 for the region encompassing all of the study-area towns is projected to be roughly 14.5%. However, the cities of Boston and Cambridge are only projected to experience a 14.2% increase in employment between 2000 and 2030. This employment projection is probably a better yardstick for measuring increases in a service that is based primarily on work trips. When this factor

(14.2%) is applied to the year 2000 ridership shown in Table 12, the projections for year 2030 ridership are computed and are shown in Table 13.

TABLE 13
Estimated Current and Future-Year Demands

	2010 Ridership		2030 Ridership	
Study Corridor Stations	**Maximum Speed of 55 mph**	**Maximum Speed of 30 mph**	**Maximum Speed of 55 mph**	**Maximum Speed of 30 mph**
Berlin	91	85	98	91
Hudson	467	440	504	474
Sudbury	512	490	552	528
Wayland	474	451	511	487
Total	1,544	1,466	1,664	1,580

Removal of Park-and-Ride Trips

However, the methodology described above assumes that there would be park-and-ride (PNR) facilities at each of the proposed stations. Currently, there is only one park-and-ride facility at any of the proposed station sites: a town-owned park-and-ride carpool facility located at the proposed Berlin station site. This current analysis does not permit us to assume that park-and-ride lots would be constructed at any of the three other stations. Thus, those stations would only be accessible by walking, bicycling, and kiss-and-ride (KNR) trips.

The 1996 study concluded that only 16.7% of the boardings at the station with the greatest usage, Wayland, would be accessed by non-motorized modes. This non-motorized access percentage, applied to the demand forecast for the proposed stations, is shown in Table 14 in the “Non-M” rows. Recent CTPS studies have revealed that approximately 11.5% of riders on the Fitchburg and Framingham/Worcester lines, the commuter rail lines that are closest to the study area, access their stations by kiss-and-ride. However, stations on these nearby commuter rail lines have park-and-ride facilities, unlike what is being proposed for the Mass Central Connector stations. The absence of park-and-ride facilities most likely would increase the percentage of overall kiss-and-riders among the riders at each station. The KNR rows of Table 14 display the demand that would result when kiss-and-ride trips would be anticipated to compose nearly double the ridership they currently compose on the nearby commuter rail lines (11.5% currently, increasing to 20%). The park-and-ride lot that is currently located at the site of the proposed Berlin station has 45 parking spaces, and the current analysis does not permit us to assume that this facility’s capacity would be expanded. These spots were assumed to be filled and can be seen in the PNR row for each station. Table 15 provides a final summary of these calculations.

TABLE 14
Projected Daily Demand by Access Modes

Study Corridor Stations	2000 Ridership		2010 Ridership		2030 Ridership	
	Maximum Speed of 55 mph	Maximum Speed of 30 mph	Maximum Speed of 55 mph	Maximum Speed of 30 mph	Maximum Speed of 55 mph	Maximum Speed of 30 mph
Berlin - ALL	86	80	91	85	98	91
Berlin - NonM	14	13	15	14	16	15
Berlin - PNR	45	45	45	45	45	45
Berlin - KNR	17	16	18	17	20	18
Hudson - ALL	441	415	467	440	504	474
Hudson - NonM	74	69	78	73	84	79
Hudson - KNR	88	83	93	88	101	95
Sudbury - ALL	483	462	512	490	552	528
Sudbury - NonM	81	77	85	82	92	88
Sudbury - KNR	97	92	102	98	110	106
Wayland - ALL	447	426	474	451	511	487
Wayland - NonM	75	71	79	75	85	81
Wayland - KNR	89	85	95	90	102	97

Note: ALL = all modes of access, NonM = Non-motorized access, PNR = park-and-ride access, and KNR = kiss-and-ride access

TABLE 15
Summary of Estimated and Projected Ridership

Study Corridor Stations	2000 Ridership		2010 Ridership		2030 Ridership	
	Maximum Speed of 55 mph	Maximum Speed of 30 mph	Maximum Speed of 55 mph	Maximum Speed of 30 mph	Maximum Speed of 55 mph	Maximum Speed of 30 mph
Berlin	76	74	78	76	81	78
Hudson	162	152	171	161	185	174
Sudbury	178	169	187	180	202	194

Wayland	164	156	174	165	187	178
Total	580	551	610	582	655	624

Comparison with Other Suburban Services

Commuter Rail

As seen in Table 16, the potential ridership of the Mass Central Connector service would be considerably lower than current MBTA daily ridership on every commuter rail line, with the exception of the Fairmount Line, which has unique characteristics that distinguish it from other commuter rail service. The service would only achieve one-quarter to one-third of the ridership of the system's newest commuter rail line, the Greenbush Line.

TABLE 16
2008 MBTA Commuter Rail Daily Inbound Boardings

Commuter Rail Line	Inbound Boardings
Newburyport/Rockport	7,017
Haverhill	3,625
Lowell	5,033
Fitchburg	3,644
Framingham/Worcester	6,728
Needham	3,101
Franklin	5,377
Fairmount	539
Providence/Stoughton	11,432
Middleborough/Lakeville	3,503
Kingston/Plymouth	3,537
Greenbush	2,142

MBTA Express Bus Routes from the Suburbs Using the Massachusetts Turnpike

The MBTA services with the most similar characteristics to the proposed Mass Central Connector route are the "suburban" express bus routes that make a few stops prior to using the Massachusetts Turnpike to travel to downtown Boston. It is helpful to display and examine these bus routes according to their common service market and service corridor areas (Newton, Waltham, Watertown, and Brighton). Ridership and frequency data are displayed for these routes and route groupings in Table 17. Nearly every one of the routes in Table 17 has travel times that are considerably shorter (faster) than the forecasted times from each of the proposed Mass Central Connector stations. Also, the proposed service's headways of 30 minutes are considerably less than the roughly 5-minute combined headways found for each of these MBTA bus route corridor groupings. In the presence of other commuter rail and rapid transit options, Brighton, Newton, Waltham, and Watertown commuters choose to take these express-bus options only when provided service roughly every five minutes. Such empirical data points might provide some needed insight into the actual propensity of residents west of Boston to use suburban bus service.

TABLE 17
2010 Data for Daily Inbound MBTA Massachusetts Turnpike Bus Routes

Line	Service	Inbound Boardings	Peak Inbound Headways (min.)	Travel Time (min.)
500	Riverside Station - Federal & Franklin Streets	49	60	35
505	Waltham Center - Federal & Franklin Streets	478	11	45
553	Roberts - Federal & Franklin Streets	374	36	51
554	Waverley Square - Federal & Franklin Streets	330	60	63
556	Waltham Highlands - Federal & Franklin Streets	265	36	44
558	Riverside - Federal & Franklin Streets via Auburndale	186	60	51
Newton/Waltham Mass Turnpike Route Totals		1,682	5.1	
502	Watertown Square - Copley Square	670	9	20
504	Watertown Square - Federal & Franklin Streets.	875	10	23
Watertown Mass Turnpike Route Totals		1,545	4.8	
501	Brighton Center - Federal & Franklin Streets via Mass Pike	846	7	30
503	Brighton Center - Copley Square	236	23	23
Watertown Mass Turnpike Route Totals		1,082	5.3	

National and International Comparisons

There are many examples of dedicated bicycle/pedestrian paths and dedicated busways across North America and in many cities around the world, however most examples are found in high density urban areas. There are very few examples of combining these modes in the same ROW in a suburban setting. The Mass Central Connector would be a first of its kind within the United States. Below are examples bike and busway systems, some built and some still being designed, that come the closest to the Mass Central Connector concept.

New Britain to Hartford Busway, Connecticut

The New Britain to Hartford Busway will be a dedicated BRT facility along a 9.4-mile corridor between downtown New Britain and downtown Hartford. The busway will be constructed in an abandoned railroad right-of-way from New Britain to just south of Newington Junction (a distance of approximately 4.4 miles). From this point north, the busway corridor will be built in an easement alongside the active Amtrak railroad right-of-way for approximately 5 miles, ending at Asylum Street and Spruce Street adjacent to Hartford's Union Station. Approximately eleven bus stations will serve the users of the busway. The facility will permit bus access at intermediate points, so circulator bus routes can readily serve surrounding neighborhoods and then use the busway, thus providing a one-seat ride. The service plan includes commuter express, shuttle, circulator, and connecting feeder bus services.

While the demographics of this part of Connecticut have a higher density than the Mass Central Connector, it is notable that the Connecticut Department of Transportation is planning a BRT system over light rail because of the flexibility of buses. This planned transit line, which is on schedule to be completed in 2014, is similar to the Mass Central Connector concept in that a multi-use trail is being considered on or near the same 4.4 miles of abandoned rail right-of-way as the busway, from downtown New Britain to the Newington Junction Station. More information on this project can be found at http://www.ctrapidtransit.com

Bristol, UK (Bristol to Bath Bikeway/Busway incorporation proposal)

The Bristol & Bath Railway Path is a 13-mile off-road "cycleway" that forms part of Britain's National Cycle Network Route 4. The path consists of a three meter wide paved surface, and was used for 2.4 million trips in 2007, increasing by 10 percent per year, according to the bikeway website http://www.bristolbathrailwaypath.org.uk/home.shtml.

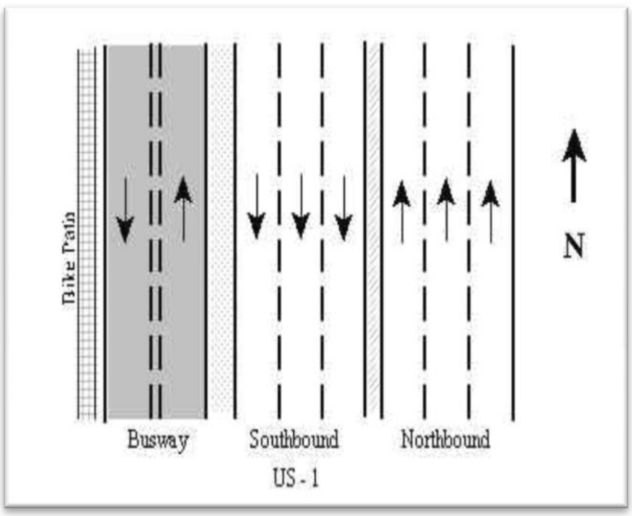
The cycleway was built by the cycling charity Sustrans between 1979 and 1986. Sustrans leased a five-mile stretch of this route, near Saltford, with the help of the then Avon County Council, and using volunteer effort turned it into their first cycleway. In January 2008, a plan was revealed by the West of England Partnership to turn sections of the path between Emersons Green and Bristol City Centre into a Guided Busway (pictured above). The railpath is one of the UK's oldest bike routes and is hugely popular with local cyclists. It was largely due to their opposition that the original plan, which would have seen buses run along half of the 13-mile traffic-free route, was shelved.

A petition against this proposal on Bristol City Council's website gained over 7,900 signatures within the first month, and a website has been set up by a group opposed to the plans. In a council meeting in 2008, plans for the busway were put on hold, but the council refused to completely rule out using the path for a busway. It has recently (as of 2010) been making traction with two potential 'rapid transit' bus routes – one from Emersons Green to Temple Meads Station along the M32 motorway and A4174 ring road, and another that links the same two places but passes further south. The second route would almost certainly use part of the rail path, given that roads and streets in that area are too narrow or busy for the 'bendy buses'. The joint pathway has major proponents due to the pre-development of the bikeway and its recreational success and use.

Los Angeles (Orange-Line)

The Orange Line, pictured left, is a two-lane, 14-mile, dedicated busway with a fleet of 60 foot long, 57 passenger articulated vehicles powered by compressed natural gas. The line crosses thirty-four streets and five mid-block pedestrian crosswalks, with loop detectors to allow bus signal prioritization at each of the signalized intersections. The BRT system uses rubberized asphalt and sound walls on portions of the busway to reduce noise impacts on adjacent neighborhoods. L.A. Metro also built eight miles of bicycle/pedestrian paths adjacent to the busway, with designated on-street bike lanes for the remaining six miles. The line has fourteen stations spaced roughly one mile apart and located near major residential areas, activity centers and major north/south arterials. Stations feature variable message signs and real-time bus arrival information. Each station also offers bicycle racks and lockers, covered seating, pay telephones, lighting, and security cameras. Six stations have park-and-ride lots, supplying a total of 3,800 free parking spaces. The corridor runs parallel to US 101, also known as the Ventura Freeway. Initially, Metro considered building rail in the corridor, but it was deemed too expensive and was not supported by abutting property owners. More information on this BRT system can be found at http://www.metro.net/around/

South Miami-Dade Busway



The South Miami-Dade Busway is an eight-mile two-lane roadway designed for exclusive use by transit buses and emergency security vehicles. Constructed in February 1997, the busway is located on a former rail right-of-way, approximately 100 feet from US 1. Bus lanes are in the center of the 100-foot right-of-way, each lane being 12 feet wide with a 3 foot striped median in between. An extension of the busway is currently being constructed further south to Florida City and Homestead. The busway was implemented in an effort to provide faster travel choices for customers of Miami-Dade Transit (MDT). A bike path also stretches the entire length of the busway, constructed on the far west side to separate the bus from cyclists. The path is approximately 8 feet wide, except along the approach to the Dadeland South station where the right-of-way narrows. Along this area the path is only separated from the busway by a curb. At station areas, the width of the busway increases from 28 feet to 52 feet to allow express buses to bypass other local buses that are boarding passengers at the stations.

The busway intersects with 20 major signalized intersections, of which 11 are within a 50 to 80 foot separation distance between the busway and the pavement edge of US 1. At these intersections, the busway and US 1 operate as a single signalized intersection. In order to operate the busway safely, exclusive right turn lanes with right turn signals along US 1 southbound were added at most of the intersections to provide an exclusive right turn movement. Another safety measure was the conversion of northbound left turns to restrictive protection phasing. Due to the close separation distance between the busway and the US 1 edge of pavements a portable message sign was installed during the early periods of operation with NO TURN ON RED indication, which warns motorists with the new signal configurations and the operation of the busway. Side street operations were also converted to directionally separate phasing. Programmable signal heads were installed at the side streets to prevent motorist confusion between busway and US 1 signal heads.

Advanced vehicle motion detectors are installed on the at-grade busway to allow express buses to travel from Dadeland South Station to Cutler Ridge Station without stopping. The advanced vehicle detectors are placed at 600 feet and 375 feet before the intersection to allow an approaching bus, if arriving during the allowable preemption window, to proceed through the intersection without stopping (Fowler 1995). Sufficient time is given for the preemption phase to terminate and clear before a bus reaches the dilemma zone. Thus, express buses can travel the entire length of the at-grade busway without making a local stop. The path is designated as the South Dade Trail and is considered the backbone of the Greenways network in Miami-Dade County. The bicycle path from Phase I will be extended the distance of the busway (11.5 miles) to NW 3rd Avenue in Florida City where it will link up with another bicycle path that continues to the Florida Keys.

More information can be found at http://www.miamidade.gov/transit/rider_busway.asp

(MTA) Maryland:

"The Corridor Cities Transitway" is a component of the I-270/US 15 Multi-Modal Corridor Study, which also includes highway improvements. The 13.5-mile "transitway" would run northwest from the Shady Grove Metrorail Station in Rockville through Gaithersburg and Germantown to its terminus at the COMSAT facility south of Clarksburg. Thirteen potential station locations have been identified along the alignment. No mode has been determined, but alternatives include light rail transit (LRT), BRT and premium bus service. A pedestrian/bicycle trail is also proposed along the transitway alignment. The transitway runs in close proximity to existing MARC commuter rail lines into WMATA Metrorail services.

More information on the Maryland "transitway" can be found at http://www.cctnow.org/

Oakland, CA

Oakland's portion of the 17-mile East Bay Bus Rapid Transit line (pictured below) is proposed to include dedicated bus and bike lanes across its entire length, accompanied by significant pedestrian improvements, creating what could be the longest complete street in California. It's not actually one street- it's two streets, and the middle portion (downtown) will not have dedicated bus lanes because buses already occupy most of the roadway during commute hours.

The BRT plan promises to be a radical improvement to an extraordinarily long transit corridor, potentially serving 40 percent of the city's population. This BRT is uniquely beneficial to bicyclists because without BRT, there would be no bike lane on Telegraph Road at all. Oakland's 1999 Bicycle Master Plan EIR was successfully challenged in court, and the 2007 Bicycle Master Plan had to abandon bike lanes on Telegraph (using instead the Webster-Shafter route). Oakland's transportation planners took advantage of the opportunity afforded by BRT to rethink Telegraph, and brought this much-desired bike lane back from the dead.

More information can be found at
http://www.ci.berkeley.ca.us/uploadedFiles/Planning_(new_site_map_walk-through)/Level_3_-_General/Brochure_Why%20EBBRT%20Project.pdf

Bogota, Columbia

Bogota has 350 kilometers of dedicated bikeways, the largest system in the developing world. The bikeways and pedestrian ways work as intermodal connections to the BRT TransMileno System. The BRT uses the operational scheme comprised of trunk-route services including express services and ordinary services, and feeder services. The infrastructure comprises exclusive lines for the systems' articulated buses; passenger access to stations through pedestrian bridges and tunnels; platforms, bays, small squares, and avenues. In addition, it has ways for feeder services, closed areas for bus parking and maintenance, and support infrastructures for system control.

The Main Network connects the main centers of the city in a direct manner, connecting the main work and education centers with the most populated residential areas, and receiving the flow from secondary networks. The Secondary Network leads riders to the main network, connecting housing centers/attraction centers & parks with the main network. The Complementary Network links and provides continuity to the network with additional bike paths to complete the mesh system and to distribute bicycle traffic on specific areas. It includes a recreational network, local networks and a system of long green areas. With parking for cars restricted to end stations, the TM carries 1 million people per day on 66km of lines. 21% of users used to go to work by car and 70% of riders reach stations by bike or foot. However, there is limited access from peripheral areas beyond central city's flatlands, as well as incongruity between world-class bikeways and undeveloped surroundings, expansion is underway for overcrowding bus issues because of underdeveloped city bike network.

San Fernando Valley, California

A 14-mile Bus Rapid Transit (BRT) system or the San Fernando Valley East-West Transit Corridor (pictured) is a proposed busway that would run from the Metro Red Line North Hollywood Station to Warner Center via the Burbank/Chandler right-of-way, which includes a 1.5-mile segment on Chandler Boulevard. The joint corridor is proposed to have 13 stations located at major cross streets

and trip destinations, spaced approximately one mile apart along the route. Service frequencies would be adjusted as demand for service grows. Initial time between bus arrivals during peak travel periods would be between seven to 10 minutes in each direction. A passenger information system at each station would inform travelers when the next bus is due to arrive. Compressed Natural Gas (CNG) buses and other clean fuel technologies are under consideration for deployment along the busway. Los Angeles Metropolitan Transportation Authority (MTA) currently operates the largest fleet of CNG-fueled buses in North America.

The 26-foot wide California busway would be built in the median of the Burbank/Chandler right-of-way. The right-of-way is generally 100 feet wide, leaving ample room for groundcover, new trees, bike and pedestrian paths, soundwalls, and other design enhancements. According to the MTA, The project will include room for a cross-valley bikeway. The MTA will initiate the bikeway design as part of the busway design and will seek funding so the two projects could be built concurrently. The project also will include the creation of two or more mid-block pedestrian crossings in the Orthodox community on Chandler Boulevard. They will include protected, signalized pedestrian crossings of both North and South Chandler Boulevards and the median busway.

The cost of the full BRT, including the busway, stations, landscaping, environmental mitigation, park-n-ride lots, new buses, and traffic signals is estimated at approximately $285 million. The state legislature awarded $145 million to the project. The balance will come from local transportation funds.

More information can be found at http://www.metro.net/projects/east-sfv/

Outreach and Community Response

A central component of this study was to engage the communities along the Mass Central Connector to determine their level of support and document community concerns. These findings are important to this initial feasibility study and will inform the future use of the corridor.

MAPC conducted in-person meetings in Stow, Bolton, Hudson, Sudbury, Wayland, and Weston with planning staff, town administrators, members of community planning boards/committees, and interested residents. MAPC also received feedback on the concept from attendees of a MAGIC subregional monthly open meeting. The following is a synopsis of the responses MAPC received to the concept and concerns expressed by each community.

Stow

Attendees: Planning Coordinator, Town Administrator, Planning Board Chairs, MAGIC Chairperson

There was general support for the concept among attendees, and agreement that residents' desire more transportation options. The main feedback focused on safe access from Stow to a proposed station. Stow board members and planners wanted more information on how the town could safely access and link up to the path due to the absence of pedestrian infrastructure.

Residents noted existing heavy traffic through their town during peak times and were concerned that developing this kind of transit infrastructure may increase traffic congestion as commuters from surrounding communities may come to access a station. Critical questions from attendees were: what would be the level of parking, and would the potential for increased traffic to access the service undercut its benefits?

Stow attendees also questioned if there was enough density to support the service, and if the transit subsidy and overall cost would be too high for the probable low level of use.

Bolton

Attendees: Town Administrator, Town Planner, Town Secretary, Planning Board Members, MAGIC/MAPC Chairperson

Bolton planners and administrators were more supportive of the shared use bicycle/pedestrian path, and generally supported the overall concept. However, they were skeptical about having enough people using the bus service in order to make it viable. They also noted major constraints of the ROW, such as at-grade crossings, the width of the ROW, and the height of the rail embankment.

As in Stow, Bolton residents brought up the possibility of increased congestion by automobiles accessing the station. The area is already experiencing considerable backup from the south along Route 62 due to the new Loews Shopping Plaza. It was stated that this congestion permeates in all directions through Berlin, Hudson and Marlborough. Traffic concerns also exist in the eastern part of Bolton along Route 117, which experiences volumes of roughly 25,000 cars daily. Residents asked if the endpoints would affect further back-ups and if the state would grant funding for improvements to Route 117 to accommodate bike ridership.

Bolton residents agreed that ITS bus technologies would be very important to the project for priority signaling, and could potentially dictate success of potential ridership. Community members liked the flexibility of a bus-transit vehicle, and supported alternative fuel vehicles to reduce green-house-gas emissions and air quality along the corridor.

Hudson

Attendees: Town Administrator, Planning Director, Town Planners, Planning Board, Economic Development Commission Chairman, State Representative, Community Development Director

Meeting attendees in Hudson had more technical questions and concerns on ridership, destinations, physical constraints, parking locations and signalization logistics. State representatives and community planners suggested that the concept provide a transit link to downtown Boston, as the majority of users in Hudson would want a transit connection to the urban core.

Attendees also recommended an analysis of journey to work data based on soon-to-be-available 2010 Census figures to help provide future evidence for regional commute trips moving east towards Boston. A discussion was had on the insufficient space along the corridor for both bus and bike heading into Alewife station, and members reiterated that plans will need to be formed now if the project were to move forward, or there would be major political issues in determining a continued ROW later on. For Hudson attendees, travel times to Boston would have to be significantly shorter than their existing commutes by automobile for the service to attract Hudson riders.

Attendees were also concerned about at-grade crossings and agreed that signal technologies along the corridor would be needed. They also wanted to know how the crossings would affect traffic management at points crossing the ROW. As mentioned in the Sudbury meeting, MBTA commuter stops would also need to become more reliable and efficient to link multi-modal connections throughout the system.

Questions on design of the rail-trail/bus concept were suggested as well. Hudson residents felt there should be more outreach and work in the community to connect this concept with riders, to discourage car usage.

Finally, resident and planners in Hudson wanted more information on how the project would be funded; noting that the environmental and engineering costs would be significant. They suggested the joint corridor be completed in separate stages, with the bike path first, making sure it does not preclude the busway.

Sudbury

Attendees: Town Planner, Conservation Commissioner and Members; Bike-Trail Activist/ Ret. Engineer, Town Manager, DPW Director, MAPC/MAGIC Chairperson

Sudbury attendees were generally opposed to the concept, largely because of potential environmental impacts. Meeting attendees voiced a number of concerns pertaining to wetlands impacts, endangered species, and parking. They also expressed concern that abutting property owners would never support the concept, noting that the community is only lukewarm towards a proposed rail trail. They wondered if utilizing the existing roadways to accommodate an additional lane along Route 9 or Route 20 would be another option that parallels the corridor in some sections.

Like other communities, attendees suggested using transportation resources instead for improving existing transit service, such as improving the Fitchburg Line by increasing parking and providing more express trains.

Department of Public Works personnel expressed concerns over major flooding along the corridor, citing consistent floods every five years as well as the flooding of Route 20. Attendees ruled out the use of Route 117 as an alternate route for pedestrian or bike access citing major safety issues.

Environmental representatives recalled state wetlands regulation as an anticipated barrier to development in Sudbury. Given the existing conditions (water wells, wildlife, and endangered species); there would be significant environmental impacts. Attendees believed that the Conservation Commission would never support the concept if designs did not have major mitigation plans through the area. Bike advocates also mentioned funds needed to mitigate existing issues of contamination from old rail beds, as EPA and local storm water standards have created similar issues along the Bruce Freeman Rail Trail.

Parks & Recreation members stated the need for more information on the physical constraints of the corridor, and would request an air quality assessment study to be done as part of any environmental assessment of the corridor.

Wayland (MetroWest region)

Attendees: Town Planner, Transportation/Traffic Committee, Conservation Committee)

The town of Wayland planners conceptually liked the idea; however they felt that town residents would not support it without extensive outreach. As with Sudbury they cited environmental and abutter concerns. Attendees felt commuters needing to travel through Wayland would be most supportive.

A rail trail alone would be supported, and is being planned by the Town. Wayland is conducting a feasibility and usage study on the trail for recreational purposes, utilizing $25,000 of Community Preservation Act (CPA) funds to study a 3 mile section.

The town planners do not anticipate enough demand in Wayland for bus service, citing that they would need an incentive since most commuters are car dependent and use the Weston commuter rail stops on the Fitchburg Line already. Planners mentioned the Cavalier Coach bus that runs twice a day to and from Boston as a point of reference for ridership, stating that people don't use it and many people don't even know about it. Wayland planners and Conservation Commission members felt that planning of the corridor shouldn't preclude the future use of a busway or other future options along the ROW. Attendees also doubted the ROW has the width to accommodate both dedicated paths safely.

Weston

Attendees: Town Manager; Chair, Planning Board; Town Planner; Planning Board Member; MA Central Rail Trail advocate; Conservation Commission; Weston resident along corridor; Weston Traffic & Sidewalk Committee

The town of Weston was largely opposed to the concept. Attendees discussed the history of the opposition to the rail trail, which was proposed over a decade ago. Attendees noted that although perspectives have shifted slightly on the idea and there is now relative support for the trail, the addition of a busway would not gain community support.

Major concerns included costs, abutter impacts, property values, safety, environmental concerns, and maintaining the current use of the trails for horseback riding.

Overall attendees agreed there are too many unanswered questions and would need more concrete information, such as how it will reduce traffic, financing plans, environmental impacts, and exactly where it would go.

Weston attendees would rather see transportation resources used on the existing commuter rail service the town has, such as creating more parking and better station facilities like showers for bike commuters. Attendees mentioned the problem of little to no commuter rail service on weekends or non-commuting times.

Waltham

(Phone conversation with town bike planner)

After examining demographics data along the abandoned ROW, and exploring connector options east of the Route-128 corridor, a phone interview was conducted with the town planner in Waltham. Currently, a combined shared-use path and busway east of Route 128 is not possible due to narrowing of the ROW and convergence with the Fitchburg commuter line.

There are existing master plans for bike networks in both Waltham and Watertown. Waltham has confirmed a design of a route from a bridge off of Route 128 through the old Polaroid site, and is working with DCR to acquire land along the Charles River on both sides to access Watertown Center. There are sections of path that exist currently, however there are a number of areas where procurement remains an issue at different points along the path. Watertown has their planned path available on the town website as of this year (summer 2010).

Recommendations for Future Study

While this initial feasibility analysis has identified a number of challenges for the creation of the Mass Central Connector concept, there are a number of recommendations for future transportation planning along this corridor.

Demographics

Continue to monitor the demographic changes (population and employment) along the corridor, particularly in the higher density communities closer to I-495. Analysis identified a 7% increase in population and a 38% increase in work trips headed to Boston from 1990 to 2000. And from 2000 to 2010, several communities (Hudson, Sudbury, Stow) continued to gain population by 5% or more. Transportation infrastructure must correlate with growth and development along the corridor and around the I-495 and Route 128 segments.

Research should be done to update demographic numbers in each community for comparison at the end of 2011, when all the census data becomes available. These numbers will help to illustrate changes in density for ridership along the corridor as well as journey to work trips.

At-Grade Crossings

Further analysis would be needed for all the at-grade crossings to determine how best to manage traffic, as well as evaluate the need for bridge re-construction or elevated corridors for wetland mitigation.

Environmental Impacts

Extensive research would need to be done to determine the level of environmental impact and what mitigation would be needed. Parts of the rail embankment would need to be cut down to achieve room for both dedicated paths, which would likely expose contamination and disrupt adjacent wetlands.

Bike Trail Development

As the communities and DCR plan this corridor as a shared use path, designs should not preclude the future use of a more robust transportation option such as a dedicated busway or even re-establishing commuter rail along the ROW.

Parking Needs

A closer examination of the potential for parking near the identified station areas is recommended for future study. Currently, there is only one park-and-ride facility at any of the proposed station sites: a town-owned park-and-ride carpool facility located at the proposed Berlin station site. The bus ridership analysis on pages 18-27 does not permit an assumption that park-and-ride lots would be constructed at any of the four other stations. Thus, those stations would only be accessible by walking, bicycling, and kiss-and-ride (KNR) trips.

Projects Costs

This study is not able to estimate costs related to operational, real estate or capital expenses due to study parameters. The report focused on right-of-way constraints, environmental concerns, and potential usage, as well as research on similar examples to this concept and gaining some initial community feedback. Costs, however, will be critical in determining the future use of the corridor, as well as community buy-in. Any future analysis should begin to estimate capital and operating costs.