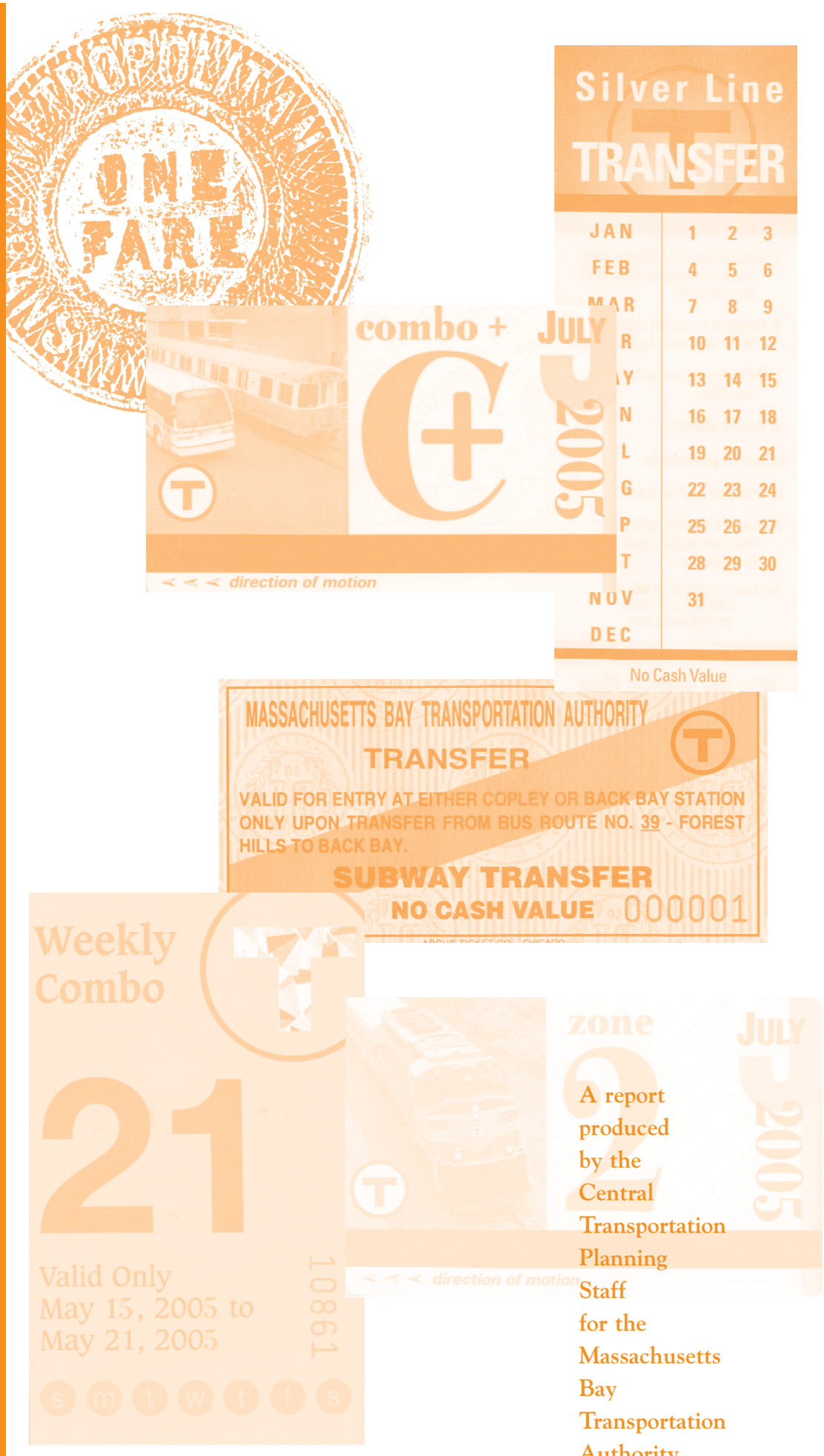
2005 Fare-Mix Study

MBTA Heavy Rail, Light Rail, Bus, and Commuter Rail Service: Average Fares and Ridership



A report produced by the Central Transportation Planning Staff for the Massachusetts Bay Transportation Authority

2005 Fare-Mix Study

MBTA Heavy Rail, Light Rail, Bus, and Commuter Rail Service: Average Fares and Ridership

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The preparation of this document was supported by the Massachusetts Bay Transportation Authority.

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Directed by the **Boston Region Metropolitan Planning Organization**. The MPO is composed of state and regional agencies and authorities, and local governments.

September 2006

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INTRODUCTION

Fare-mix studies are used to calculate the average revenue per passenger on each of the MBTA's transportation modes. The averages are then applied to reported revenue totals to estimate total ridership. These studies have been done only at intervals of several years. The most recent previous study was based on data collected in 2001-2002 for all modes. Because of a systemwide fare increase implemented in January 2004, the average revenues calculated in 2002 need to be revised. Data for updated fare-mix calculations for MBTA heavy rail (Red, Orange, and Blue lines), light rail (Green Line), bus, and trackless trolley were collected between January and November 2005. The fare-mix calculations for commuter rail were based on ticket and pass sales data from fiscal year 2005 (July 1, 2004 to June 30, 2005). The bus ridership and revenue figures include the Silver Line-Washington Street, which has the same fare structure as local bus routes, but free transfers from this line to rapid transit are allowed at certain locations. (Silver Line-Waterfront revenue was very small in the time span of the data examined, but was also included in the bus total.)

This report describes the methods that were used to collect data for each mode, the steps that were used to calculate average revenue per passenger from these data, and the results of the calculations with comparisons to 2002 and 1996. Unless otherwise stated, all of the fares described are those that became effective in January 2004.

It must be noted that the MBTA's present revenue accounting procedures do not provide information on fares collected by day and mode at the level of detail needed for precise ridership estimates. It is necessary to allocate much of the revenue on the basis of assumptions about when and where fares were collected. The finer the level of detail attempted in terms of ridership by time and route, the more influence these assumptions may have on the results.

Prior to 2002, the most recent MBTA fare-mix study had been conducted in 1996. In reviewing the 1996 results for purposes of comparison with the 2002 results, it was found that several of the breakdowns of fares in the 1996 report were inconsistent with information from other sources such as surveys and passenger counts. The most significant problems were in pass use. The total pass revenue figures were consistent with pass sales data from 1996, but the ratios of pass riders to cash-fare riders on all modes were unusually low. Consequently, figures for average pass ride value, true average fare, and average farebox deposit were all too high. This made the apparent changes in these measures between 1996 and 2002 inconsistent with the changes in fares implemented in 2000. To correct for this problem, 1996 pass rides by mode were re-estimated by applying pass-use rates obtained from the 1999 pass-user survey to 1996 pass sales figures. Other problems were found in the allocation of fare revenue between weekdays and weekends, and between the surface and subway segments of the Green

Line. Finally, the proportion of free outbound surface Green Line riders in the 1996 figures was found to be significantly overstated when compared with 1995 passenger counts on these lines. In the present report, any comparisons with 1996 results use the adjusted 1996 fare-mix figures.

SUMMARY OF RESULTS

Ridership figures based on a combination of data from fare-mix samples, revenue reports, and pass-user surveys indicate that between 2002 and 2005, weekly passenger boardings increased slightly on the Green Line and on the bus system, but decreased on the heavy rail and commuter rail networks. As shown in Table 1-4, on the MBTA system as a whole, weekly ridership increased by 0.4%. The Red, Orange, and Blue Lines combined showed a 7.4% ridership loss. The Central Subway portion of the Green Line had a 5.5.0% loss, offset by a 18.1% gain on the surface branches, for a net gain of 5.2%. (All of the heavy rail and Green Line totals exclude boardings made by free transfers to one line from another in the subway.) The bus and trackless trolley system as a whole showed a gain of 8.7%, and the commuter rail system as a whole had a decrease of 2.5% in riders. On all system components that showed losses between 2002 and 2005, the losses were smaller than gains registered between 1996 and 2002, so ridership remained higher than the 1996 level.

As shown in Table 1-2, between 2002 and 2005 the average farebox deposit increased on the heavy rail, bus, and commuter rail systems and the Green Line Central Subway, but decreased on the surface Green Line. The percentage changes in average farebox deposits differed from the percentage increases in cash fares, mostly because of changes in the proportions of cash-fare and pass-fare riders. Despite the negligible ridership gain, weekly system revenue (shown in Table 1-3) increased by 19.2% between 2002 and 2005. Cash-fare revenue (including tickets) grew by 16.0%, and pass-sales revenue by 22.3%. The only mode that did not show increases in both cash-fare and pass-sales revenue was the Green Line. Cash-fare revenue fell by 1.1% on the surface branches and 2.1% in the Central subway, but these losses were more than offset by gains of 60.8% and 29.4% in pass-sales revenue.

Between 1996 and 2002, weekly passenger boardings had decreased slightly on the bus system, but increased to varying degrees on all of the other modes. For the MBTA system as a whole, ridership had increased by 11%. The commuter rail system had shown the largest increase (34%) as the result of the opening of several new extensions and stations as well as ridership growth on older lines. The average farebox deposit had also increased on every mode. Revenue had increased on every mode including the bus system, where the higher fares implemented in 2000 were sufficient to offset the drop in revenue from lower ridership and from use of free transfers in place of other forms of fares.

Average Fares

Table 1-1 shows average farebox deposit, true average fare, and average pass ride value (all as defined below) for each mode for weekdays and weekend days combined. Table 1-2 shows the average farebox deposit for weekdays and weekend days separately.

Table 1-1
Weekly Average Farebox Deposit, True Average Fare, and Average Pass Ride Value by Mode in Dollars

	2005	2002	1996	Chg.2002 to 2005
Heavy Rail & Cent. Sub.				
Average Farebox Deposit	$0.477	$0.371	$0.361	+28.6%
True Average Fare	$0.929	$0.739	$0.647	+25.7%
Avg. Pass Ride Value	$0.765	$0.624	$0.508	+22.6%
Heavy Rail				
Average Farebox Deposit	$0.488	$0.361	$0.350	+35.3%
True Average Fare	$0.931	$0.730	$0.640	+27.5%
Avg. Pass Ride Value	$0.758	$0.613	$0.501	+23.6%
Surface Green Line				
Average Farebox Deposit	$0.341	$0.407	$0.347	-16.1%
True Average Fare	$0.711	$0.679	$0.538	+4.7%
Avg. Pass Ride Value	$0.783	$0.704	$0.548	+11.3%
Central Subway				
Average Farebox Deposit	$0.431	$0.416	$0.405	+3.6%
True Average Fare	$0.922	$0.775	$0.675	+19.0%
Avg. Pass Ride Value	$0.783	$0.673	$0.545	+16.4%
Green Surface & Subway				
Average Farebox Deposit	$0.385	$0.412	$0.377	-6.5%
True Average Fare	$0.814	$0.731	$0.608	+11.4%
Avg. Pass Ride Value	$0.790	$0.685	$0.546	+15.3%
Bus & Trackless Trolley				
Average Farebox Deposit	$0.264	$0.253	$0.229	+4.2%
True Average Fare	$0.533	$0.492	$0.404	+8.3%
Avg. Pass Ride Value	$0.490	$0.507	$0.348	-3.3%
Total Core System				
Average Farebox Deposit	$0.383	$0.334	$0.309	+14.6%
True Average Fare	$0.758	$0.648	$0.543	+17.0%
Avg. Pass Ride Value	$0.667	$0.593	$0.451	+12.4%
Commuter Rail				
Average Farebox Deposit	$1.340	$1.110	$0.937	+20.7%
True Average Fare	$3.312	$2.634	$2.033	+25.7%
Avg. Pass Ride Value	$2.891	$2.299	$1.774	+25.7%
Total System				
Average Farebox Deposit	$0.470	$0.407	$0.358	+15.6%
True Average Fare	$0.992	$0.835	$0.660	+18.8%
Avg. Pass Ride Value	$0.909	$0.790	$0.572	+15.0%

Notes: Surface Green Line values include free outbound boardings.

Average Pass Ride Values for 1996 include Adult and Student passes only.

Avgs for 2002 and 2005 also include Weekly, Visitor, and Senior/Disability

Table 1-2
Average Farebox Deposit by Mode for Weekdays and Weekends in Dollars

		2005	2002	1996	Chg.2002 to 2005
Weekday:	**Heavy Rail & Central Subway**	$0.454	$0.342	$0.337	+32.7%
	Heavy Rail	$0.468	$0.334	$0.333	+40.2%
	Surface Green Line	$0.315	$0.386	$0.330	-18.3%
	Central Subway	$0.393	$0.381	$0.356	+3.2%
	Green Surface and Subway	$0.354	$0.383	$0.334	-7.7%
	Bus and Trackless Trolley	$0.262	$0.252	$0.226	+4.0%
	Commuter Rail	$1.243	$1.026	$0.836	+18.8%
Weekend:	**Heavy Rail & Central Subway**	$0.605	$0.535	$0.487	+13.1%
	Heavy Rail	$0.607	$0.527	$0.460	+15.2%
	Surface Green Line	$0.451	$0.481	$0.412	-6.2%
	Central Subway	$0.598	$0.556	$0.541	+7.6%
	Green Surface and Subway	$0.522	$0.519	$0.467	+0.5%
	Bus and Trackless Trolley	$0.275	$0.260	$0.253	+5.7%
	Commuter Rail	$2.532	$2.082	$1.895	+21.6%

Note: Fare increases implemented in January 2004 raised adult cash fares 20% on basic-fare buses, 25% on basic fare rapid transit and surface Green Line segments, and 4% to 33% on commuter rail.

Average farebox deposit is the ratio of cash and ticket fare revenue to all passengers, including those using monthly or weekly passes or paper transfers. From 2002 to 2005, the average farebox deposit increased on the heavy rail, bus, and commuter rail systems and the Green Line Central Subway, but decreased on the surface Green Line.

From 1996 to 2002, the average farebox deposit had increased on all modes on both weekdays and weekends. The weekday increase on the Red, Orange, and Blue Lines combined was, however, very slight, because reduced-fare and pass ridership increased at much greater rates than full-cash-fare ridership. For the core system (that is, the whole system except commuter rail), the weekly average farebox deposit increased by 8.2% over that six-year interval, compared with a gain of 14.6% between 2002 and 2005.

The true average fare is the ratio of all revenue, including pass revenue, to all passengers. This measure was not calculated separately for weekdays and weekends in 1996 because of a lack of detailed revenue data. The 2002 and 2005 results do include estimates for weekdays and for weekends, but they are less reliable than the weekly averages. In 2005, the systemwide weekly true average fare was $0.992, compared with $0.835 in 2002, or an increase of 18.8%. The 2002 average was, in turn 26.6% greater than the 1996 average of $0.660. The heavy rail system showed the largest gain in true

average fare between 2002 and 2005, at 27.5%, followed by commuter rail, at 25.7%. The smallest gains were on the surface Green Line (4.7%) and the bus and trackless trolley system (8.3%).

Between 1996 and 2002, commuter rail had shown the largest gain in true average fare, at 29.6%, followed by the surface Green Line at 26.2%. For the core system overall, the increase in that span was 19.3%. The heavy rail lines and the Central Subway showed the smallest gains, at 14.1% and 14.8%. Bus and trackless trolley true average fare increased by 21.8%.

Average pass ride value is the ratio of pass revenue to total trips for which a pass is used. For 1996, this measure was calculated only as weekly averages by mode, but for 2005 and 2002 separate weekday and weekend figures were also calculated. For the system as a whole, weekly average pass ride value increased 15.0% from 2002 to 2005. The gain for the core system, at 12.4%, was smaller than that of commuter rail, at 25.7%. However, within the core system, the increase on heavy rail, at 23.6%, was only slightly lower than the commuter rail gain. In the same span, average pass ride value increased by 16.4% in the Central Subway, and 11.3% on the Surface Green Line, but fell 3.3% on the bus and trackless trolley system. (In part, these changes reflect more complete accounting for student pass use in the 2005 figures than in the 2002 results.)

For the system as a whole, weekly average pass ride value had increased 38.1% from 1996 to 1992. The gain for the core system, at 31.5%, was slightly greater than that of commuter rail, at 29.6%. Among core modes, bus and trackless trolley showed the greatest increase in average pass ride value, at 45.9%. (As discussed in Chapter 5, because of the implementation of free bus-to-bus transfers, pass use for trips involving two or more bus routes decreased significantly, resulting in some uncertainty as to the new number of average trips per pass for those still using them.) Average pass ride value increased from 1996 to 1992 by 22.5% on heavy rail, 23.6% on the Central Subway, and 25.5% on the surface Green Line.

Revenue

Weekly revenue figures are given in Table 1-3. Total revenue, including both farebox revenue and pass revenue, was 19.2% higher in 2005 than in 2002. For the core system (the whole system except commuter rail), farebox revenue increased by 15.4% and pass sales revenue rose by 20.3%. In 2005, pass revenue accounted for 49.5% of total core system revenue, compared with 48.5% in 2002 and 43.2% in 1996. The 2005 and 2002 pass figures include revenue from Weekly Combo and Senior/Transportation Access passes which were introduced after the 2000 fare increase. The 2005 and 2002 pass figures also include Visitor passes. In 1996 Visitor pass revenue was included in cash fare revenue, but the 2002 figures indicate that this would have had little impact on the overall results. Between 1996 and 2002, core system farebox revenue increased by 18.0%, but pass sales revenue rose by 46.3%.

Ridership

Table 1-4 shows the number of weekly and weekday passenger boardings by mode. In these results, passengers making free transfers among lines at downtown Boston

Table 1-3
Weekly Revenue from the Farebox and Pass Sales by Mode

	2005	2002	1996	Chg.2002 to 2005
Heavy Rail & Central Subway				
Farebox Revenue	$1,431,096	$1,199,322	$986,595	+19.3%
Pass Sales Revenue	$1,357,236	$1,185,728	$783,742	+14.5%
Heavy Rail				
Farebox Revenue	$1,174,223	$936,896	$769,100	+25.3%
Pass Sales Revenue	$1,064,724	$959,638	$639,016	+11.0%
Surface Green Line				
Farebox Revenue	$212,983	$215,313	$174,079	-1.1%
Pass Sales Revenue	$230,561	$143,405	$95,644	+60.8%
Central Subway				
Farebox Revenue	$256,873	$262,426	$217,495	-2.1%
Pass Sales Revenue	$292,513	$226,091	$144,726	+29.4%
Green Surface and Subway				
Farebox Revenue	$469,857	$477,739	$391,574	-1.6%
Pass Sales Revenue	$523,073	$369,496	$240,370	+41.6%
Bus & Trackless Trolley				
Farebox Revenue	$566,857	$500,521	$461,682	+13.3%
Pass Sales Revenue	$579,586	$472,911	$352,669	+22.6%
Core System				
Farebox Revenue	$2,210,937	$1,915,156	$1,622,356	+15.4%
Pass Sales Revenue	$2,167,383	$1,802,044	$1,232,054	+20.3%
Commuter Rail				
Farebox (Ticket) Revenue	$779,563	$661,840	$416,931	+17.8%
Pass Sales Revenue	$1,147,184	$909,232	$487,806	+26.2%
Total System				
Farebox Revenue	$2,990,500	$2,576,996	$2,039,287	+16.0%
Pass Sales Revenue	$3,314,567	$2,711,276	$1,719,861	+22.3%
Farebox and Pass	$6,305,067	$5,288,272	$3,759,147	+19.2%

Note: Pass Revenue figures for 1996 include Adult and Student passes only.
2002 and 2005 figures also include Weekly, Visitor, and Senior/Disability passes.

subway stations are counted at their initial heavy rail or Green Line boarding points but not at the transfer points. Passengers transferring between the Mattapan High Speed Trolley Line and the Red Line at Ashmont Station are included only in Red Line totals, and those transferring between the High Speed Line and buses are included only in bus totals. For reasons discussed in Chapter 2, passengers riding only the High Speed line are not included at all.

The 1996 fare-mix study report showed ridership for each mode by week only. The 1996 weekday figures in Table 1-4 were derived from data collected in 1996, but are less reliable than the weekly breakdowns. The entire MBTA system had about 6.36 million weekly boardings in 2005, compared with 6.33 million in 2002 or an increase of 0.4%.

Table 1-4
Weekly and Weekday Passenger Boardings by Mode

		2005	2002	1996	Chg.2002 to 2005
Weekly:	Heavy Rail & Central Subway	3,000,517	3,228,522	2,736,098	-7.1%
	Heavy Rail	2,404,613	2,597,965	2,199,180	-7.4%
	Surface Green Line	623,876	528,396	501,651	+18.1%
	Central Subway	595,904	630,556	536,918	-5.5%
	Green Surface and Subway	1,219,780	1,158,952	1,038,569	+5.2%
	Bus & Trackless Trolley	2,150,717	1,978,335	2,016,791	+8.7%
	Core System	5,775,110	5,735,252	5,254,540	+0.7%
	Commuter Rail	581,754	596,402	444,956	-2.5%
	Total System	6,356,864	6,331,654	5,699,496	+0.4%
Weekday:	Heavy Rail & Central Subway	508,492	548,299	461,385	-7.3%
	Heavy Rail	411,311	447,549	382,657	-8.1%
	Surface Green Line	100,929	81,763	75,597	+23.4%
	Central Subway	97,180	100,750	78,727	-3.5%
	Green Surface and Subway	198,109	182,513	154,325	+8.5%
	Bus & Trackless Trolley	377,536	343,445	350,121	+9.9%
	Core System	986,957	973,507	887,103	+1.4%
	Commuter Rail	107,616	109,855	80,412	-2.0%
	Total System	1,094,573	1,083,362	967,515	+1.0%

Average weekday boardings increased by a slightly greater 1.0%. However, weekly boardings in 2002 were 11.1% greater than the average of 5.7 million in 1996, so the 2005 average was 11.5% above the 1996 level. Weekday boardings in 2005 were 13.1% greater than in 1996.

Total boardings for the core system increased between 2002 and 2005 by about 40,000 per week (0.7%), and about 13,000 per weekday (1.4%). The heavy rail system (Red, Orange, and Blue Lines) showed a combined net loss of about 193,000 weekly, boardings, or 7.4% (36,000, or 8.1% per weekday) and the Green Line Central Subway lost about 35,000 boardings, or 5.5% per week (3,600, or 3.5% per weekday). In the same span, ridership on the bus and trackless trolley system increased by 172,000, or 8.7% per week (34,000, or 9.9% per weekday) and boardings on the surface Green Line increased by 95,000 or 18.1% per week (19,000 or 23.4% per weekday.)

It should be noted that all of the increase in surface Green Line ridership shown in these figures is based on pass revenue allocated to the Green Line, which in turn depends on the results of pass-user surveys. In the 2005 figures, pass revenue was allocated to system components using the results of the 2005 pass-user surveys, but in the 2002 figures, the results were based on the 1999 surveys. Some changes in pass use rates may already have occurred between 1999 and 2002. The 2005 figures for all core system services also have more complete accounting of Student and Visitor passes than earlier fare-mix studies had.

The 2002 fare-mix study found that boardings for the core system had increased between 1996 and 2002 by about 481,000 per week (9.1%), or about 86,400 per weekday (9.7%). The only component of the core system to register a decrease in ridership was bus and trackless trolley, which had a loss of 1.9%, or about 38,000 riders a week (6,700 per weekday). Earlier fare-mix studies had also found declining ridership on these modes, but the average annual loss between 1996 and 2002 was much smaller than that prior to 1996.

In 2005, the heavy rail lines had the greatest share of core boardings at 2,405,000 per week (411,000 per weekday) followed by the bus system at 2,150,0717 per week (378,000 per weekday) and the surface Green Line, at 624,000 per week (101,000 per weekday).

In 2002 the Green Line Central Subway had more boardings than the Surface Green Line. The heavy rail lines then had 2,598,000 boardings per week (448,000 per weekday) followed by the bus system at 1,978,000 per week (343,000 per weekday) and the Central Subway, at 631,000 per week (101,000 per weekday). Between 1996 and 2002, the commuter rail system had larger percentage gains than any of the core modes, at 34.0% per week and 36.6% per weekday, but the heavy rail lines had larger absolute gains.

Tables 1-5 to 1-8 show the distribution of fare payment methods by mode in 2005, 2002 and 1996. In each of these years the adult monthly pass was the most common payment method on every mode, although the share varied. In 2005 in the core system, such passes accounted for 44.6% of all fares, including 49.4% on heavy rail, 48.2% on the Green Line, and 38.5% on bus and trackless trolley lines. On the commuter rail system, 68.0% of passengers used monthly passes. The latter figure is partly a reflection of the higher proportion of repetitive work trips on the commuter rail lines, as passengers that travel most frequently receive the greatest benefits from pass use.

Some of the weekly pass trips shown in the 2005 and 2002 results represent shifts of trips that would have been made with monthly passes if weekly passes (introduced in 2000) had not been available. The weekly pass-user survey conducted in September and October 2005 showed that 57.4% of weekly pass users were former monthly pass users. Among those who had been using weekly passes for longer than two years, this proportion was 63.9%, but among those using weekly passes for less than one year it was only 42.5%. These figures suggest that many riders who only recently began using passes of any kind and chose weekly passes would have become monthly pass users if there had been no weekly passes.

In the breakdowns of ridership by fare-payment category for 2002, the distribution of weekly pass trips was based on weekly pass sales figures and the relative use rates of the corresponding monthly passes in the 1999 pass-user survey. This calculation method was necessary because no surveys of weekly pass-users had yet been conducted. In the 2005 results, weekly pass trips were allocated on the basis of the findings of the weekly pass-user survey conducted that year. In the 2002 calculations, no weekly pass trips were allocated to commuter rail, although such passes are valid for trips within Zone 1A or 1B. The 2005 calculations indicated that about 11% of the commuter rail pass trips within those two zones, equivalent to 0.2% of the weekly trips on the entire commuter rail system, were made with weekly passes.

Table 1-5
Weekly Passenger Boardings in 2005 by Fare Category by Mode

	Passenger Boardings	Adult Cash	Monthly Pass	Weekly Pass	Visitor Pass	Senior/ Disability Cash	Senior/ Disability Pass	Child/ Student Cash	Student Pass	Warrant/ Coupon	10-ride Ticket	Transfer	Free
Red, Orange, Blue & Cent. Sub.	3,000,517	1,067,910	1,483,423	127,120	23,704	79,776	46,959	29,222	92,533	2,668		4,095	43,108
		35.6%	49.4%	4.2%	0.8%	2.7%	1.6%	1.0%	3.1%	0.1%		0.1%	1.4%
Red, Orange and Blue	2,404,613	865,729	1,161,091	107,901	15,406	66,791	39,030	25,912	82,134	2,668		1,284	36,667
		36.0%	48.3%	4.5%	0.6%	2.8%	1.6%	1.1%	3.4%	0.1%		0.1%	1.5%
Surface Green Line	623,876	141,106	265,757	6,811	1,439	13,514	5,399	1,802	14,944	269	135	0	172,700
		22.6%	42.6%	1.1%	0.2%	2.2%	0.9%	0.3%	2.4%	0.0%	0.0%	0.0%	27.7%
Central Subway	595,904	202,180	322,332	19,219	8,297	12,985	7,929	3,310	10,399	0		2,811	6,441
		33.9%	54.1%	3.2%	1.4%	2.2%	1.3%	0.6%	1.7%	0.0%		0.5%	1.1%
Green Surface and Subway	1,219,780	343,287	588,089	26,030	9,736	26,499	13,327	5,112	25,343	269	135	2,811	179,141
		28.1%	48.2%	2.1%	0.8%	2.2%	1.1%	0.4%	2.1%	0.0%	0.0%	0.2%	14.7%
Bus & Trackless Trolley	2,150,717	535,805	828,620	103,302	517	123,786	45,932	28,861	203,939		2,342	215,583	62,031
		24.9%	38.5%	4.8%	0.0%	5.8%	2.1%	1.3%	9.5%		0.1%	10.0%	2.9%
Core System (excludes Commuter Rail)	5,775,110	1,744,821	2,577,800	237,233	25,659	217,076	98,289	59,885	311,416	2,937	2,477	219,677	277,839
		30.2%	44.6%	4.1%	0.4%	3.8%	1.7%	1.0%	5.4%	0.1%	0.0%	3.8%	4.8%
Commuter Rail	581,754	162,780	395,554	1,310		11,293		10,817					
		28.0%	68.0%	0.2%		1.9%		1.9%					
Total System	6,356,864	1,907,601	2,973,355	238,542	25,659	228,368	98,289	70,702	311,416	2,937	2,477	219,677	277,839
		30.0%	46.8%	3.8%	0.4%	3.6%	1.5%	1.1%	4.9%	0.0%	0.0%	3.5%	4.4%

Notes: Ridership for Mattapan-Ashmont High Speed Line is not included above. Silver Line Washington Street Results and Silver Line Waterfront on-board fares are included in Bus/Trackless Trolley figures.

Totals for commuter rail 12-ride tickets are included in Adult Cash. Half-fare 10-ride tickets are included in Senior/Disability and Child/Student cash

Table 1-6
Weekly Passenger Boardings in 2002 by Fare Category by Mode

	Passenger Boardings	Adult Cash	Monthly Pass	Weekly Pass	Visitor Pass	Senior/ Disability Cash	Senior/ Disability Pass	Child/ Student Cash	Student Pass	Warrant/ Coupon	10-ride Ticket	Transfer	Free
Red, Orange, Blue & Cent. Sub.	3,228,522	1,102,212	1,695,320	115,817	11,782	131,143	16,240	39,363	62,103	1,699			52,842
		34.1%	52.5%	3.6%	0.4%	4.1%	0.5%	1.2%	1.9%	0.1%			1.6%
Red, Orange and Blue	2,597,965	849,109	1,395,484	97,591	5,926	103,706	12,924	32,719	53,314	1,699			45,493
		32.7%	53.7%	3.8%	0.2%	4.0%	0.5%	1.3%	2.1%	0.1%			1.8%
Surface Green Line	528,396	165,146	189,770	6,721	2,075	20,658	2,446	5,514	2,601	422	361		132,682
		31.3%	35.9%	1.3%	0.4%	3.9%	0.5%	1.0%	0.5%	0.1%	0.1%		25.1%
Central Subway	630,556	253,104	299,836	18,226	5,856	27,437	3,316	6,644	8,789				7,349
		40.1%	47.6%	2.9%	0.9%	4.4%	0.5%	1.1%	1.4%				1.2%
Green Surface and Subway	1,158,952	418,250	489,606	24,947	7,931	48,095	5,763	12,158	11,390	422	361		140,031
		36.1%	42.2%	2.2%	0.7%	4.1%	0.5%	1.0%	1.0%	0.04%	0.03%		12.1%
Bus & Trackless Trolley	1,978,335	554,020	777,656	63,023	2,706	226,159	13,429	65,074	75,231		1,214	118,566	81,257
		28.0%	39.3%	3.2%	0.1%	11.4%	0.7%	3.3%	3.8%		0.1%	6.0%	4.1%
Core System (excludes Commuter Rail)	5,735,252	1,821,379	2,662,746	185,561	16,563	377,959	32,115	109,951	139,935	2,121	1,575	118,566	266,781
		31.8%	46.4%	3.2%	0.3%	6.6%	0.6%	1.9%	2.4%	0.04%	0.03%	2.1%	4.7%
Commuter Rail	596,402	177,703	395,454			11,993		11,251					
		29.8%	66.3%			2.0%		1.9%					
Total System	6,331,654	1,999,082	3,058,200	185,561	16,563	389,953	32,115	121,202	139,935	2,121	1,575	118,566	266,781
		31.6%	48.3%	2.9%	0.3%	6.2%	0.5%	1.9%	2.2%	0.03%	0.02%	1.9%	4.2%

Notes: Ridership for Mattapan-Ashmont High Speed Line is not included above

Totals for commuter rail 12-ride tickets are included in Adult Cash. Half-fare 10-ride tickets are included in Senior/Disability and Child/Student cash

Table 1-7
Absolute and Percent Change in Weekly Passenger Boardings from 2002 to 2005 by Fare Category by Mode

	Passenger Boardings	Adult Cash	Monthly Pass	Weekly Pass	Visitor Pass	Senior/ Disability Cash	Senior/ Disability Pass	Child/ Student Cash	Student Pass	Warrant/ Coupon	10-ride Ticket	Transfer	Free
Red, Orange, Blue & Cent. Sub.	-228,004	-34,303	-211,897	+11,303	+11,922	-51,367	+30,718	-10,141	30,430	+969			-9,734
	-7.1%	-3.1%	-12.5%	+9.8%	+101.2%	-39.2%	+189.2%	-25.8%	49.0%	57.0%			-18.4%
Red, Orange and Blue	-193,352	+16,621	-234,393	+10,310	+9,480	-36,915	+26,106	-6,807	28,820	+969			-8,827
	-7.4%	2.0%	-16.8%	+10.6%	+160.0%	-35.6%	+202.0%	-20.8%	54.1%	+57.0%			-19.4%
Surface Green Line	+95,480	-24,039	+75,987	+90	-637	-7,144	+2,953	-3,712	+12,343	-153	-225		+40,018
	+18.1%	-14.6%	+40.0%	+1.3%	-30.7%	-34.6%	+120.7%	-67.3%	+474.6%	-36.2%	-62.43%		+30.2%
Central Subway	-34,652	-50,924	+22,496	+993	2,442	-14,452	+4,612	-3,333	1,610				-907
	-5.5%	-20.1%	+7.5%	+5.4%	41.7%	-52.7%	+139.1%	-50.2%	18.3%				-12.3%
Green Surface and Subway	+60,828	-74,963	+98,483	+1,083	1,805	-21,596	+7,565	-7,045	13,953	-153	-225		+39,111
	+5.2%	-17.9%	+20.1%	+4.3%	22.8%	-44.9%	+131.3%	-58.0%	122.5%	-36.2%	-62.43%		+27.9%
Bus & Trackless Trolley	+172,382	-18,216	+50,964	+40,279	-2,189	-102,373	+32,503	-36,213	+128,709		+1,128	+97,016	-19,227
	+8.7%	-3.3%	+6.6%	+63.9%	-80.9%	-45.3%	+242.0%	-55.6%	+171.1%		+92.9%	+81.8%	-23.7%
Core System (excludes Commuter Rail)	39,858	-76,558	-84,946	+51,672	9,096	-160,884	+66,174	-50,066	171,481	+817	+902	+101,111	+11,057
	0.7%	-4.2%	-3.2%	+27.8%	54.9%	-42.6%	+206.0%	-45.5%	122.5%	+38.5%	+57.3%	+85.3%	+4.1%
Commuter Rail	-14,648	-14,923	+100			-701		-434					0
	-2.5%	-8.4%	+0.0%			-5.8%		-3.9%					
Total System	25,210	-91,481	-84,845	+52,981	9,096	-161,584	+66,174	-50,500	171,481	+817	+902	+101,111	+11,057
	0.4%	-4.6%	-2.8%	+28.6%	54.9%	-41.4%	+206.0%	-41.7%	122.5%	38.5%	+57.3%	+85.3%	+4.1%

Notes: Ridership for Mattapan-Ashmont High Speed Line is not included above

Revenue from Visitor passes and from Core System 10-ride tickets was included in cash fares in 1996

Totals for commuter rail 12-ride tickets are included in Adult Cash. Half-fare 10-ride tickets are included in Senior/Disability and Child/Student cash

Table 1-8
Absolute and Percent Change in Weekly Passenger Boardings from 1996 to 2002 by Fare Category by Mode

	Passenger Boardings	Adult Cash	Monthly Pass	Weekly Pass	Visitor Pass	Senior/ Disability Cash	Senior/ Disability Pass	Child/ Student Cash	Student Pass	Warrant/ Coupon	10-ride Ticket	Transfer	Free
Red, Orange, Blue & Cent. Sub.	+492,424	+28,453	+185,711	+115,817	+11,782	+58,611	+16,240	+13,698	+29,464	+1,699			+30,948
	+18.0%	+2.6%	+12.3%			+80.8%		+53.4%	+90.3%				+141.4%
Red, Orange and Blue	+398,785	+29,300	+150,535	+97,591	+5,926	+38,984	+12,924	+11,145	+21,783	+1,699			+28,898
	+18.1%	+3.6%	+12.1%			+60.2%		+51.7%	+69.1%				+174.1%
Surface Green Line	+26,745	+2,022	+21,646	+6,721	+2,075	-903	+2,446	+124	-3,867	-590	+361		-3,289
	+5.3%	+1.2%	+12.9%			-4.2%		+2.3%	-59.8%	-58.3%			-2.4%
Central Subway	+93,638	-847	+35,175	+18,226	+5,856	+19,627	3,316	+2,553	+7,681				+2,050
	+17.4%	-0.3%	+13.3%			+251.3%		+62.4%	+693.5%				+38.7%
Green Surface and Subway	+120,383	+1,175	+56,821	+24,947	+7,931	+18,724	+5,763	+2,677	+3,814	-590	+361		-1,239
	+11.6%	+0.3%	+13.1%			+63.8%		+28.2%	+50.3%	-58.3%			-0.9%
Bus & Trackless Trolley	-38,456	-164,994	-129,111	+63,023	+2,706	+98,293	+13,429	-10,904	-32,250		+1,214	+118,566	+1,572
	-1.9%	-22.9%	-14.2%			+76.9%		-14.4%	-30.0%				+2.0%
Core System	+480,712	-134,519	+78,245	+185,561	+16,563	+156,000	+32,115	+2,918	-6,653	+1,109	+1,575	+118,566	+29,231
(excludes Commuter Rail)	+9.1%	-6.9%	+3.0%			+70.3%		+2.7%	-4.5%	+109.5%			+12.3%
Commuter Rail	+151,446	+29,200	+120,418			550		+4,787					-3,510
	+34.0%	+19.7%	+43.8%			4.8%		+74.1%					
Total System	+632,158	-105,318	+198,663	+185,561	+16,563	+156,550	+32,115	+7,705	-6,653	+1,109	+1,575	+118,566	+25,721
	+11.1%	-5.0%	+6.9%			+67.1%		+6.8%	-4.5%	+109.5%			+10.7%

Notes: Ridership for Mattapan-Ashmont High Speed Line is not included above

Revenue from Visitor passes and from Core System 10-ride tickets was included in cash fares in 1996

Totals for commuter rail 12-ride tickets are included in Adult Cash. Half-fare 10-ride tickets are included in Senior/Disability and Child/Student cash

2. Description of MBTA Service and Ridership Classification

In 2005 the MBTA operated a system of five heavy and light rail lines, 13 commuter rail lines, about 175 bus routes, and four trackless trolley routes. (The reported bus route total varied among sources, depending on how route variations were counted.) The Silver Line bus rapid transit system included two sub-groups, the Washington Street line, operated with compressed natural gas buses, and the Waterfront lines, operated with dual-mode diesel/trackless trolley vehicles. The number of Waterfront routes varied during the year, but was three during the final quarter. The MBTA also provided for the operation of four commuter boat routes. Specialized accessible transportation was provided in 62 cities and towns. The MBTA also provided financial assistance to several private-carrier bus routes and small suburban bus systems serving communities in the MBTA district.

This study focuses on ridership on the MBTA's heavy and light rail, bus/trackless trolley (excluding contract bus routes), and commuter rail services. These services, and the classifications of riders on them, are described below.

DESCRIPTION OF SERVICE

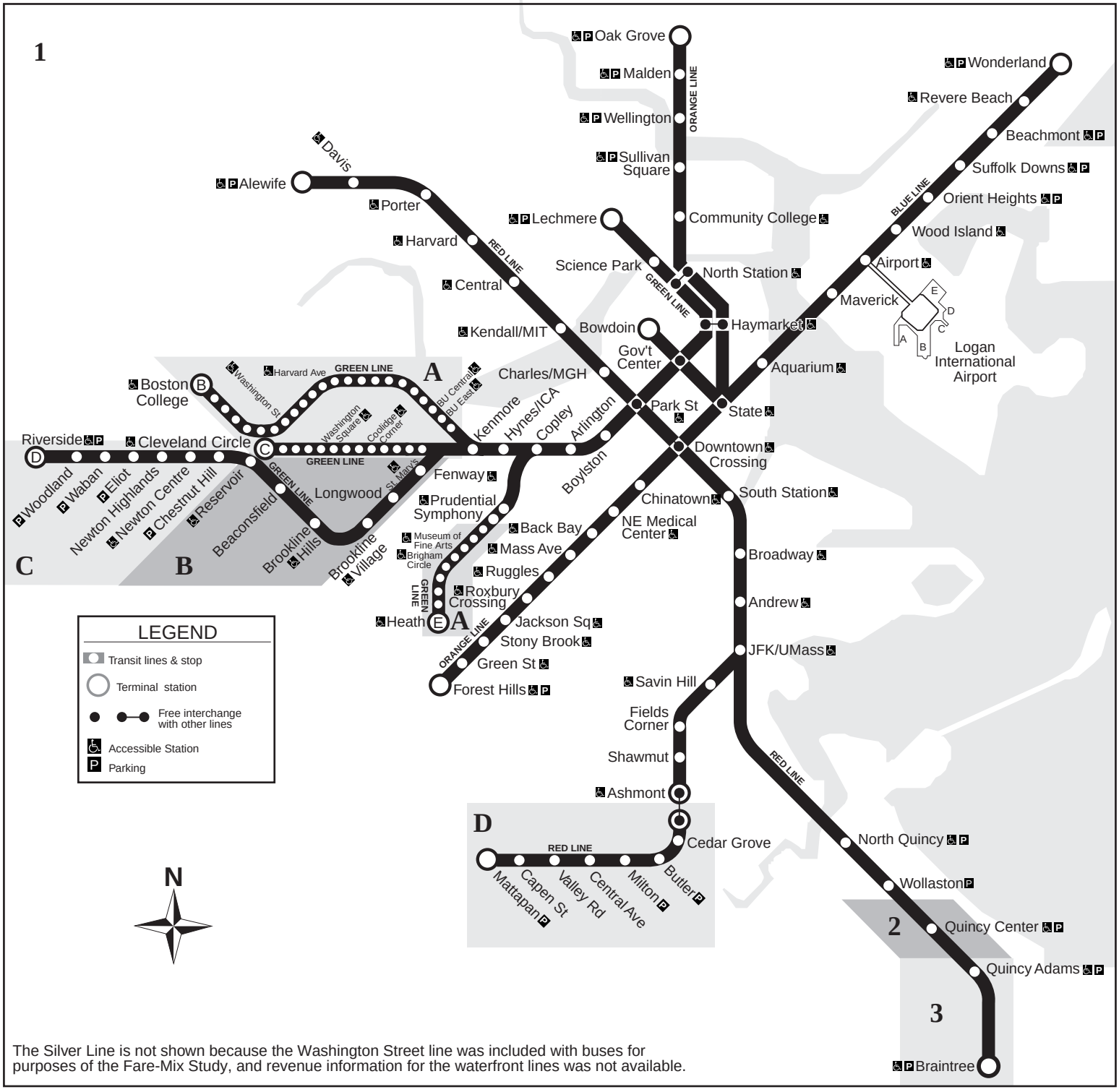
Heavy and Light Rail

The MBTA heavy and light rail system consists of five lines, including 60 stations and 65 surface stops: the Red Line, the Orange Line, the Blue Line, the Green Line, and the Mattapan High Speed Line (see Figure 2-1).

Red Line: The Red Line is 20.5 miles long. There are 22 stations on this line, 19 of which were accessible for persons with disabilities by the end of 2005. There are two branches, with service running between Alewife Station in North Cambridge and Ashmont Station in Dorchester or Braintree Station in Braintree. All service operates along a common alignment between Alewife and the JFK/UMass Station in Dorchester, at which point service branches off to either Ashmont or Braintree. Throughout most of the day, service is split equally between the two branches, but the Braintree Branch has more frequent peak service because of heavier ridership.

For fare purposes in 2005, most of the Red Line was in Zone 1. The exceptions were Quincy Center, which was in Zone 2, and Quincy Adams and Braintree, which were in Zone 3. Riders entering Zone 2 and 3 stations paid twice the base fare of $1.25, and riders exiting Zone 3 stations also paid an additional base fare. Passengers traveling between any Zone 2 or 3 station and any other station from Braintree to North Quincy, inclusive could do so by paying $2.50 at the boarding station and obtaining a warrant

Figure 2-1
Rapid Transit and Surface Green Line Map, Fare Zones and Adult Cash Fare



The Silver Line is not shown because the Washington Street line was included with buses for purposes of the Fare-Mix Study, and revenue information for the waterfront lines was not available.

FROM/TO	Zone 1	Zone 2	Zone 3	Zone A	Zone B	Zone C	Zone D
Zone 1	$1.25	$1.25	$2.50	$1.25	$1.25	$1.25	$1.25
Zone 2	$2.50*	---	$1.25	$2.50	$2.50	$2.50	$2.50
Zone 3	$2.50*	$1.25	$1.25	$2.50	$2.50	$2.50	$2.50
Zone A	$1.25	$1.25	$2.50	$1.25/free**	$1.25	$1.25	$1.25
Zone B	$1.50	$1.50	$2.75	$1.50	$1.50/free**	free	$1.50
Zone C	$3.00	$3.00	$4.25	$3.00	$3.00	$1.50/free**	$3.00
Zone D	$1.25	$1.25	$2.50	$1.25	$1.25	$1.25	90¢/free***

* Except $1.25 to/from Wollaston and N. Quincy
** Inbound/Outbound
***90¢ Inbound (Except free when alighting at Ashmont) free Outbound

valid for a $1.25 rebate and free exit at the alighting station. Commuter rail connections could be made at five Red Line Stations: Porter, South Station, JFK/UMass, Quincy Center, and Braintree.

Orange Line: The Orange Line is 11 miles long and operates between Oak Grove in Malden and Forest Hills in Jamaica Plain. There are 19 stations, all of which are accessible for persons with disabilities.

In 2005 all of the Orange Line was in Zone 1 and the base "subway" fare was charged for all trips. Much of the Orange line shares a right-of-way with commuter rail, in the Southwest corridor and along the Haverhill/Reading Line. Connections can be made with commuter rail at North Station and Malden Center on the north side, along with Back Bay/South End, Ruggles, and Forest Hills on the south side.

Blue Line: The Blue Line, the shortest of the three heavy rail lines at six miles, operates between Wonderland Station in Revere and Bowdoin Station in Boston. There are 12 stations. At the end of 2005, eight of these were accessible for persons with disabilities, and one more (State) was accessible only on the outbound platform side. Bowdoin Station, the southern terminus point (just past the Government Center stop), operates only until 6:30 PM Monday through Friday, and is closed on weekends. When Bowdoin is closed, service terminates at Government Center. In 2005 all the Blue Line was in Zone 1 and the base "subway" fare was charged for all trips. There are no direct connections with commuter rail on the Blue Line.

Green Line: The Green Line, at 25.5 miles, covers more route-miles than any of the three heavy rail lines. It includes subway, elevated, and surface segments. The latter are a mix of private right-of-way, center-of-street reservations, and in-street running. About one third of the 13 subway stations and the 53 surface stops provide access for persons with disabilities. The Green Line has four branches to the west and southwest of downtown Boston: the Boston College (B) branch, the Cleveland Circle (C) branch, the Riverside (D) branch, and the Heath Street (E) branch. All branches are identified by their outer terminals. The inner terminus of the Green Line is at Lechmere station in East Cambridge, but only E trains operated that far in 2005. Ridership north of downtown Boston is much lower than to the west and southwest. Because of that, B and D trains terminated at Government Center and C trains at North Station. (For more than half the year, no Green Line service was run between North Station and Lechmere because of a line relocation project.)

In 2005 the Central Subway portion of the Green Line (Lechmere to Kenmore and Symphony) was in Zone 1 and the base "subway" fare was charged for all trips. The surface Green Line had its own fare structure (described in detail in chapter 3). Fares ranged from free for outbound surface trips to $3.00 for inbound trips starting at stations on the outer half of the D Branch.

On the Green Line, North Station is the only station that connects directly with commuter rail. Copley station is about 1,000 feet from the Back Bay/South End commuter rail station via city streets, and is also an announced transfer point.

Mattapan High Speed Line: The Mattapan High Speed Line operates between Ashmont and Mattapan using PCC light rail vehicles. Although it is effectively an extension of the Red Line, its vehicles are maintained and operated as part of the Green Line fleet. The High Speed Line is 2.55 miles long, and has seven surface stops in addition to the Ashmont transfer station. Only the stations at each end of the line provide access for persons with disabilities. This line has no direct connections with commuter rail lines.

In 2005, no fares were charged for outbound travel on the High Speed Line, or for inbound travel to Ashmont. The official full cash fare for passengers alighting inbound before Ashmont was $0.90 (equivalent to the basic bus fare). Further details on the fare structure on this line appear in chapter 3.

Bus and Trackless Trolley

The MBTA operates about 175 bus routes, with the reported total depending on how route variations are counted. There are also four trackless trolley routes serving Cambridge, Watertown, and Belmont. Nearly all routes connect with the rapid transit system at least at one location. In areas closer to Boston, bus service generally fills gaps (including cross-town service) in the rapid transit system, provides feeder service to rapid transit stations, and provides line-haul service in heavily congested areas. Further out, buses provide local service, connections to the rapid transit system, and express service to downtown Boston.

In 2005, the majority of MBTA bus routes had an adult cash fare of $0.90, regardless of distance traveled. A few routes were divided into three fare zones, with the basic fare being charged for travel in one or two zones, but a full fare of $1.55 for travel in all three zones. There were also a number of provisions for free or reduced-fare transfers, as discussed in chapter 3. Several routes on the North Shore were zoned local/express combination routes, with full fares ranging from $0.90 to $3.45 depending on distance traveled. Several other express routes entering Boston from the north via Route I-93 or from the west via the Massachusetts Turnpike had fares of either $2.20 or $3.45 regardless of distance traveled.

Bus Rapid Transit

In 2005, the MBTA bus rapid transit system consisted of the Silver Line-Washington Street and the Silver Line-Waterfront routes. The Silver Line-Washington Street route ran from Dudley Square in Roxbury to Downtown Boston, over public streets but partly in reserved lanes. The Silver Line-Waterfront service had three routes, sharing a new transitway, partly in a tunnel, from South Station to Silver Line Way in South Boston, then splitting off over public roads to Logan Airport, Boston Marine Industrial Park, and City Point. All Silver Line routes served much more limited numbers of stops than typical MBTA local bus routes.

The Washington Street route was implemented in July 2002. The Waterfront routes were phased in beginning in December 2004. As of 2005 revenue data from the Washington Street route had not been reported separately from bus service data. Revenue from fares collected on-board Silver Line-Waterfront routes or at the two pre-

payment stations used exclusively by this service was reported as a separate category. However, during the time span from which revenue data used in this fare-mix study was obtained, not enough of the Waterfront service had been implemented to generate meaningful results. Furthermore, most of the outbound riders on these routes either transferred free from the Red Line within South Station, or entered through turnstiles there that were also used by Red Line passengers. As of 2005, no fare-mix observations had been done on the Silver Line-Waterfront routes, and the number of observations done on the Silver Line Washington Street route was too small to be statistically significant.

For all of the reasons cited above, the Silver Line services were combined with the bus and trackless trolley system in the analysis in this study.

Commuter Rail

The MBTA commuter rail system is made up of 13 lines and 125 stations, of which 81 stations were accessible at the end of 2005. In total, the network covers 353 route-miles. For administrative purposes, the commuter rail system is subdivided into North Side and South Side lines. The five North Side Lines all terminate at North Station, and serve a combined total of 56 other stations. Connections can be made to rapid transit at three stations: Porter Square (Red Line), Malden Center (Orange Line), and North Station (Green and Orange Lines). In 2005 all lines (but not all stations) had Saturday and Sunday service, but at lower levels than on weekdays.

The eight South Side lines all terminate at South Station, and serve a combined total of 67 other stations. All South Side lines except the Fairmount, Middleborough/Lakeville, and Plymouth/Kingston lines also serve Back Bay Station. Connections can be made to rapid transit at seven stations: South Station, JFK/UMass, Quincy Center, and Braintree (all Red Line), and Back Bay, Ruggles, and Forest Hills (Orange Line). In addition, Copley Station on the Green Line is about 1,000 feet from Back Bay via city streets. Weekend service levels varied among South Side Lines in 2005. The Framingham/Worcester, Franklin, Middleborough/Lakeville, and Plymouth/Kingston lines all had Saturday and Sunday service over their full routes, serving most stations, but at lower levels than on weekdays. The Attleboro Line had Saturday and Sunday service as far as South Attleboro, but no weekend service to Providence. The Needham Line had Saturday service but no Sunday service. The Fairmount Line and Stoughton Line had no weekend service, except at stations also served by other lines.

RIDERSHIP CLASSIFICATIONS

Heavy and Light Rail

The Red, Orange, and Blue Lines are classified as the heavy rail system, while the Green Line and the Mattapan High Speed Line are considered the light rail system. In this study, all figures for light rail ridership or revenue include only the Green Line, as information for the High Speed Line was not available. (As discussed in chapter 3, the majority of High Speed Line passengers transfer to or from the Red Line, so they are included in heavy rail ridership.) In some of the tables, the Green Line is further subdivided into Central Subway and Surface. For operating purposes, the Central

Subway includes the Green Line segments from Lechmere to Kenmore and Symphony, and the Surface includes everything else. In 2005, fares were collected on-board vehicles at the Symphony, Prudential, and Science Park Central Subway stations at all times and at Lechmere during off-peak hours. In revenue reports, these were indistinguishable from fares collected at surface stops. Therefore, the revenue and ridership figures referred to as surface Green Line in this study include results from the Central Subway stations where fares were collected on board. Conversely, the Central Subway results only include figures for off-train fare collection.

Some previous fare-mix studies used the term rapid transit to include the heavy rail lines and the Central Subway combined. To avoid confusion, this study refers specifically to heavy rail plus Central Subway or to Red, Orange, and Blue Lines plus Central Subway rather than using the term rapid transit.

Riders are classified as heavy rail or light rail riders based upon where they enter the system. Those first boarding on the heavy rail portion of the system are classified as heavy rail riders regardless of whether they exit at heavy rail or light rail stations. Likewise, passengers first boarding at light rail stops are classified as light rail riders, no matter where they exit. The total ridership figures for heavy and light rail are therefore lower than passenger count figures that include both initial entries and transfers.

In 2005, free transfers between the bus system and the heavy and light rail systems were available at only a very limited number of locations. Most passengers that used both bus and rail are included in the cash or pass totals for both systems. For those making free transfers, the trip on the second mode is counted either as a transfer or as an authorized free trip in the summary tables.

Bus and Trackless Trolley

All MBTA extra-fare bus routes operate out of garages where basic-fare routes are also based, and revenue reports do not provide a level of detail finer than total farebox collections by garage. Therefore, it is not possible to use fare-mix samples to estimate ridership separately for local and express routes. The average bus fares calculated in this report are a composite for the bus system as a whole. Samples from basic-fare and extra-fare routes were, however, weighted in proportion to the most recent available passenger counts for routes in each category, to avoid skewing the results toward the average fare for either local routes or express routes.

The four trackless trolley routes are based at a facility that does not serve any bus routes, and trackless trolley farebox revenue is reported separately from bus farebox revenue. The kind of service provided by the trackless trolley routes is, however, very similar to that provided by local bus routes, and trackless trolley fares are the same as one-zone local bus fares. For this reason, past fare-mix studies have included trackless trolley results in average fare and ridership calculations for the bus system. For consistency, the 2005 study also combines trackless trolley results with bus results. Because the number of trackless trolley routes is small relative to the number of bus routes, the average bus fare excluding trackless trolley was found to differ only slightly from the average for bus and trackless trolley combined.

Bus Rapid Transit

In 2005, the Silver Line-Washington and Silver Line-Waterfront routes were all operated out of the Southampton garage, but the heavily patronized bus Route 39 (Forest Hills Station – Back Bay Station) was also operated from there. In revenue reports, money deposited in fareboxes on Silver Line-Washington Street vehicles was not separated from that deposited on Route 39 vehicles. Therefore, it was necessary to include Silver Line-Washington Street passengers paying on-board fares in the bus ridership calculations. (The cash-fare structure on the Washington Street route was the same as that on local buses, but free transfers to and from the heavy and light rail systems were available at certain stations, and Subway passes were valid on Silver Line vehicles.)

The cash fare structure on the Silver Line-Waterfront was the same as the basic fare structure on the heavy rail system. The transitway shared by all the Waterfront routes served three pre-payment stations: South Station, Courthouse, and World Trade Center. At South Station, Silver Line passengers entered through the same fare-collection devices as Red Line passengers, and all tokens sold and cash fares deposited were credited to the Red Line. (All MBTA token revenue was accounted for by point of sale rather than where the tokens were used.)

At the time of this study, CTPS had no formulas for allocating any South Station revenue to the Silver Line. At the Courthouse and World Trade Center stations, off-vehicle fare collection was used only during weekday PM peak hours. At other times, fares were collected on-board vehicles. (During May 2005, reported token sales at Courthouse and World Trade Center combined averaged only 185 per day.) The daily revenue reports allowed for separate tracking of Silver Line-Waterfront on-board fares, but based on the amounts shown in the reports examined, some of the revenue may have been included in the other Southampton garage totals.

In the 2005 fare-mix, study revenue from the Silver Line-Waterfront was combined with bus system revenue, but was too small to affect the average fare calculations.

Commuter Rail

Commuter rail ridership figures in this report include all passengers on MBTA commuter rail lines, regardless of whether or not they transfer to or from other MBTA modes. The only exception is that free riders such as MBTA and railroad employees are not included, because there is no information available as to their numbers.

The commuter rail fare-mix calculations did not include data from observations of fare payments on selected trips or during selected time intervals, such as those that were taken on the other modes. Instead, "cash-fare" revenue was based on ticket sales figures, using methods described in Chapter 5. As was the case for other modes, pass revenue and pass use rates for commuter rail were based on factors calculated from the 2005 pass user survey applied to pass sales figures from fiscal year 2005.

3. MBTA Fare Structure

Fares on all MBTA modes in 2005 were based on zone systems, but the zone limits, basic fares, and fare increments differed among modes. The fare structures and payment options for each mode are described below.

CASH FARES

Adult Fares

Heavy Rail: In 2005 the heavy rail system was divided into three fare zones (see Figure 2-1). The majority of stations were in Zone 1, which extended eight miles from the core of downtown Boston. For trips within Zone 1, the one-way fare was $1.25. Only Quincy Center Station was in Zone 2. Stations further than nine miles from the core of Boston (including only Quincy Adams and Braintree) were in Zone 3. A double fare of $2.50 was collected upon entering stations in Zones 2 or 3, and an additional fare of $1.25 was charged upon exiting stations in Zone 3. A system of warrants and refunds allowed passengers to travel between any two stations in Quincy or Braintree, regardless of zone, for the basic $1.25 fare.

As detailed below under Bus and Trackless Trolley, in 2005 passengers could enter a limited number of heavy rail or Green Line Central Subway stations using paper transfers obtained on connecting bus routes. In the fare-mix samples prior to 2005, such passengers were recorded in the authorized free category rather than in a separate transfer category. In the 2005 samples, a separate category was included for paper transfers. However, only a small number of the randomly selected locations for fare-mix samples were at locations where such transfers are accepted. As shown in table 1-5, authorized free passengers of all kinds accounted for only about 1.6% of heavy rail and Central Subway entries.

Green Line: In 2005, the Green Line had four fare zones (see Figure 2-1). The Central Subway (Lechmere to Kenmore or Symphony) was included in heavy rail Zone 1, with an entry fare of $1.25 and no exit fare. The surface Green Line was divided into three fare zones, identified as A, B, and C on Figure 2-1. Zone A contained the B, C, and E Lines. The B Line extends 6.1 miles from Park Street Station, with surface stops in Zone A being those from Blandford Street to Boston College. The C Line extends 4.8 miles from Park Street, with surface stops in Zone A being those from St. Mary's Street to Cleveland Circle. The E Line extends 3.7 miles from Park Street, with surface stops in Zone A being those from Northeastern to Heath Street.

The D Line extends 11.6 miles from Park Street. Surface stops in Zone B were those from Fenway to Reservoir (5.3 miles from Park Street). Zone C included the rest of the surface D Line stops from Chestnut Hill to Riverside. For inbound travel (toward the subway) adult fares were $1.25 in Zone A, $1.50 in Zone B, and $3.00 in Zone C.

Table 3-1
One-Way Adult Cash Fares – 1996, 2002, and 2005

	1996	2002	2005
HEAVY and LIGHT RAIL			
All Stations on Blue, Green, Orange and Red Lines, excluding Quincy Center, Quincy Adams, Braintree, surface Green Line stops & Mattapan High Speed Trolley	$0.85	$1.00	$1.25
Quincy Center (Zone 2)	$1.70	$2.00	$2.50
Quincy Adams & Braintree (Zone 3)			
Entrance fare	$1.70	$2.00	$2.50
Exit fare	$0.85	$1.00	$1.25
Quincy Center, Quincy Adams & Braintree Local (Zone 2/3)	$0.85	$1.00	$1.25[1]
Mattapan High Speed Trolley (Zone D)			
Inbound	$0.60	$0.75	$0.90[2]
Outbound	free	free	free
Surface Green Line			
B, C, & E Lines (Zone A)			
Inbound	$0.85	$1.00	$1.25
Outbound	free	free	free
D Line			
Inbound Fenway - Reservoir (Zone B)	$1.00	$1.25	$1.50
Inbound Chestnut Hill - Riverside (Zone C)	$2.00	$2.50	$3.00
Inbound Newton Local (within Zone C)	$1.00	$1.25	$1.50[3]
Outbound (Zone B and C)	free	free	free
BUS			
Local/Zoned: One or two zones	$0.60	$0.75	$0.90[4]
Three zones	$1.00	$1.25	$1.55
Express: Zone 1	$1.50	$1.75	$2.20
Zone 2	$2.00	$2.75	$3.10
Zone 3	$2.25	$2.75	$3.45
BUS RAPID TRANSIT			
Silver Line-Washington Street (opened 2002)		$0.75	$0.90[5]
Silver Line-Waterfront (opened 2004-05)			$1.25[6]

[1]With warrant. Full fare charged at boarding station, and rebate is given at exit station.
[2]Pay fare upon exiting, except at Ashmont, which is free.
[3]With coupon. Coupon is given when exiting inbound trips in Zone C, and is good for half of fare on a subsequent trip.
[4]In 2003 and 2005, basic fare allows free transfers between basic-fare routes
[5]Basic fare allows free transfers to Heavy and Light Rail lines at selected stations
[6]Basic fare allows free transfer to Red Line at South Station

The fare for inbound trips entirely within Zone C was $1.50. Outbound travel from any stop in Zones A, B, or C was free.

Mattapan High Speed Line: In 2005, no fares were charged for outbound travel on the High Speed Line, or for inbound travel to Ashmont. Inbound passengers exiting before Ashmont were officially supposed to pay the same fares as they would have on a basic-fare bus route ($0.90 for adults). However, in MBTA daily and monthly revenue reports examined for this study the entries for revenue from Mattapan were all zero or blank. This implies either that no fares were collected on this route, or that Mattapan revenue was combined with that from some other source before it was counted. Because of the absence of any revenue data for this line, it was not explicitly included in the fare-mix calculations and results. Ridechecks on the High Speed Line conducted by CTPS in spring 2005 found a total of 403 riders alighting at inbound stops before Ashmont all day on a weekday. This number is small relative to total ridership on any of the other modes discussed in the study. Therefore, even if some Mattapan revenue were mixed in with that of another mode, it would have an insignificant impact on the fare-mix and ridership calculations for that mode. At full cash fare, 403 riders would have paid a total of $363 per day, but some inbound alighting passengers would have been eligible for reduced fares or would have had passes. For comparison, cash fares on the four surface Green Line branches combined averaged $70,050 per day at that time.

The free fares for High Speed Line passengers boarding and alighting at Ashmont are based on the assumption that most of them are transferring to or from the Red Line or bus routes, and will pay fares on those lines. The free Red Line transfer is consistent with the free transfers between rail lines at downtown Boston subway stations, and the free transfers with buses are consistent with free bus-to-bus transfers. The 2005 counts showed 2,930 inbound alightings from the High Speed Line at Ashmont, but did not differentiate between passengers transferring to other MBTA services and those using only the High Speed Line. CTPS counts from 1997 showed that 74.5% of passengers alighting from the High Speed Line at Ashmont transferred to the Red Line. The other 25.5% either transferred to buses or exited the station, but the split within this group was not observed. The 1994 rapid transit passenger survey results indicated that only 26% of those that alighted from the High Speed line at Ashmont and did not transfer to the Red Line transferred to MBTA buses there. Another 12% of these riders had transferred to the High Speed Line from connecting bus routes. Applying all these factors to the 2005 counts implies that about 460 passengers a day made inbound trips on the High Speed Line ending at Ashmont and did not pay fares either on that line or on any connecting MBTA service.

Bus and Trackless Trolley: Bus services are priced using a zone system. Fare zones are specific to each route and are based upon distance. In 2005, the majority of local routes had only a single zone with a $0.90 fare. Twelve longer routes were divided into three fare zones each. For travel in two zones, the basic $0.90 fare applied, but for three-zone travel there was an additional $0.65 charge. Fares for express bus service, which operated along I-93, on the Massachusetts Turnpike, or to the North Shore, ranged between $2.20 and $3.45 for through travel to Boston. (Some of these routes could also be used for local travel, with standard local fares being applied.)

After the implementation of the 2000 fare increase, a system of free transfers between local bus routes was established. Passengers paying the applicable fare when boarding can now obtain a transfer valid for a limited time for travel in the first one or two zones on any other local route.

Several other exceptions to the basic local fare have been in effect since before the 1996 fare-mix study. At New England Medical Center Station, free transfers were formerly provided between bus Route 49 and the Orange Line in either direction. This route was replaced by the Silver Line-Washington Street in July 2002. Fares on that service are discussed below.

On bus Route 39 in 2005, transfers to subway lines at Copley or Back Bay were available by paying $0.35 in addition to the bus fare (making a total of $1.25). Passengers transferring to Route 39 from the subway lines at these points could obtain transfers at no charge in addition to the $1.25 rail fare. Similarly, on the segment of bus Route 1 between Dudley Square and the Massachusetts Avenue Orange Line station, transfers to the Orange Line were available by paying $0.35 in addition to the bus fare. At Massachusetts Avenue, passengers alighting from the Orange Line could obtain free transfers for travel toward Dudley Square on Route 1. On bus Routes 15, 19, 23, 28, 42, 44, and 45, no fares were charged between Dudley Square and Ruggles on buses traveling toward Ruggles. On bus Routes 22, 29, and 44, no fares were charged between Egleston Square and Jackson Square on buses traveling toward Jackson Square.

On bus Routes CT1, CT2, and CT3 transfers to heavy rail or the Green Line at Hynes/ICA, Symphony, Ruggles, Massachusetts Avenue, Sullivan Square, Andrew, Central, and Kendall could be obtained by paying an additional $0.35, but there were no reduced fares for transferring to these bus routes from the rail lines.

In the fare-mix samples on bus routes, passengers using paper transfers from other bus routes or from rail lines are recorded in the transfer category. Passengers boarding in segments where no fares are charged are recorded in the authorized free category.

Bus Rapid Transit: When the Silver Line-Washington Street replaced bus Route 49 in 2002, the former cash-fare structure was retained. This included fares the same as those on one-zone local buses, with free transfers to the Orange Line at New England Medical Center, and transfer from the Orange Line there with no charge in addition to the rapid transit fare. The same transfer privileges were extended to Downtown Crossing (on the Orange and Red Lines) and to Boylston Station on the Green Line. At these transfer points, paper transfers were used going to or from the Silver Line.

When the Silver Line-Waterfront services were implemented in 2004 and 2005, cash fares were set the same as those at Zone 1 heavy rail stations. At South Station, the Silver Line-Waterfront platforms are within the same paid area as the Red Line, so use of paper transfers is not needed. However, this also means that Silver Line ridership there cannot be tracked through revenue data.

Commuter Rail: Commuter rail full fares for trips to or from downtown Boston in 2005 ranged from $1.25 in Zone 1A to $6.00 in Zone 8. Increments were not uniform, varying from $0.25 to $1.25 for each additional zone. Trips not to or through downtown Boston

or other Zone 1A or 1B stations were classified as Interzone. The minimum Interzone fare was $2.25 for travel in one zone, with an extra $0.25 to $0.50 charged for each additional zone traveled in.

Through tickets could be purchased at stations or ticket agencies or on trains. Interzone tickets could only be purchased on board. Through tickets purchased on board trains when off-train purchase was possible at the boarding location were subject to a $2.00 surcharge during peak hours and a $1.00 surcharge during weekday off-peak hours. Table 3-4 shows full-fare single-ride and pass fares for Through trips from each zone.

Special Fares

Reduced fares were available for senior citizens (age 65 and older), persons with disabilities, secondary school students, and children. The amount of the discount varied among modes and passenger categories. For senior citizens and persons with disabilities, fares in 2005 were $0.35 for rapid transit and surface Green Line service, and $0.25 for local bus service. Fares for students and children on these routes were 50% of full fares rounded to the nearest nickel. On zoned and express bus trips and on commuter rail, the discount for passengers in all four reduced-fare categories was 50 percent.

MULTIPLE-RIDE TICKETS

On several MBTA services, multiple-ride tickets can be used instead of paying cash fares. In most cases, these tickets offer discounts compared with full fares, but unlike passes they are valid for only a specified number of trips.

Ten-Ride Green Line and Express Bus Tickets**:** In 2005, ten-ride tickets were available in three different denominations for the Green Line and express bus routes: $20.00, $27.00, or $31.00. The $20.00 ticket was valid on express routes for which the adult cash fare was $2.20, so the ticket discount was 9.1% of the full fare. Applicable services included the I-93 routes from Medford, routes entering the Massachusetts Turnpike at Newton Corner, reverse-commuting Route 170 from Dudley Square to Waltham and Burlington, and inner segments of North Shore routes. (Trips on all of these services could also have been made with the Combo pass.)

The $27.00 ticket was valid on express routes for which the adult cash fare was $3.10, so the ticket discount was 12.9% of the full fare. Applicable services included North Shore express routes between Boston and Lynn. (Trips on these routes could also have been made with the Zone 1 pass.) These tickets were also valid for inbound trips starting at Green Line D Branch stations from Riverside to Chestnut Hill for which the adult cash fare was $3.00. (The Combo pass was also valid for such trips, because the outbound fare structure effectively reduces the one-way cash fare to $2.12 for round trips to Boston.)

The $31.00 ticket was valid on express routes for which the adult cash fare was $3.45, so the ticket discount was 10.1% of the full fare. This included the full lengths of North Shore express routes, the I-93 routes from Woburn and Burlington, and the

Massachusetts Turnpike routes from Riverside and Waltham. (Trips on these routes could also have been made with a Zone 2 pass.)

Twelve-Ride Commuter Rail Tickets: In 2005, 12-ride commuter rail tickets were available for through trips between each fare zone and downtown Boston, but there were no 12-ride Interzone tickets. Prior to the 2004 fare increase, the price of each 12-ride ticket had been the same as that of 11 full-fare tickets for the same trip, resulting in a discount of 8.3%. However, since January 2004 the price of a 12-ride ticket has been the same as that of 12 single-ride full fares. Twelve-ride tickets can only be purchased at off-trains ticket offices and agencies, or through the pass-by-mail program. In the summaries in this report, 12-ride ticket revenue and ridership is included in adult cash fares when not otherwise specified.

Family Fare Commuter Rail Tickets: In 2005, Family Fare tickets were available for all through and interzone trips on the commuter rail system. Each such ticket was valid for a round trip on the day of purchase for a group of up to five passengers, including at least one but no more than two over age 18. Each such ticket was priced the same as two full-fare round trips. This was the same as four one-way trips because no round-trip discounts for individuals were offered. Family Fare tickets could be purchased either on board trains or at ticket offices or agencies. In the summaries in this report, Family Fare ticket revenue and ridership is divided between adult cash fares and Child/Student half fares when not otherwise specified.

Ten-Ride Commuter Rail Tickets: On the commuter rail system in 2005, 10-ride tickets to downtown Boston from all zones were available to passengers eligible for half-fares. The price of each 10-ride ticket was the same as 10 individual half-fares from the same zone, so the advantage of the 10-ride was convenience rather than cost. Ten-ride tickets could only be purchased at off-trains ticket offices and agencies. In the summaries in this report, 10-ride ticket revenue and ridership is divided between Senior/Disability and Child/Student cash fares when not otherwise specified.

PASS FARES

Adult Monthly Passes

Adult monthly passes can be used for unlimited travel within one calendar month for those services on which they are valid. They are available through numerous sources, with the greatest number being distributed via employers, and the second-greatest number being sold at retail outlets. In 2005, the face value of most passes could be used as partial payment on higher priced transit services, with the rider paying the difference in cash. Exceptions were that Subway passes were not valid on most buses, and Local Bus passes were not valid on heavy rail. (Local Bus passes were valid on the surface Green Line.) Pass price break-even points (i.e. the number of monthly cash trips required to equal the cost of a monthly pass) were mostly between 16 and 20 round trips, although there were a number of exceptions (see Table 3-2).

Bus Pass: A Local Bus pass was valid for the entire fare for one or two zones on all local bus service, on the Mattapan High Speed Line, and on the surface Green Line except between Chestnut Hill and Riverside on the D Branch. It could be used as partial

payment for service on zoned bus routes, and the Chestnut Hill to Riverside section of the D Branch, with the difference being made up in cash or coupon. The local bus pass was also valid on the Silver Line-Washington Street, including the same free transfer privileges to subway lines accorded to cash-fare passengers. However, this pass was not valid on the Silver Line-Waterfront routes. The price of this pass was $31.00, and the break-even point for local bus riders was 17.2 round trips.

Subway Pass: The Subway pass was valid for all Zone 1 rapid transit and Green Line service, and commuter rail service between downtown Boston and Zone 1A or 1B stations. It was also valid on a limited number of specified bus routes (CT1, CT2, CT3, 39, and part of 1) and on all Silver Line bus rapid transit routes. The price of this pass was $44.00, giving a break-even point of 17.6 round trips in rapid transit Zone 1.

Combo Pass: The Combo pass was valid for all rapid transit service, except at Quincy Adams and Braintree, all surface Green Line service, and all local bus service. Bus riders could also use the pass to pay for the first $2.20 of express and zoned bus service. The price of this pass was $71.00. Depending on the number of modes used in a single trip, the break-even point ranged from 11 to 19 round trips for most users.

Combo Plus Pass: The Combo Plus pass was valid for all Combo pass service, and at Quincy Adams and Braintree stations. It was also valid for the first $2.50 of express and zoned bus route fares. The price of this pass was $79.00. For Quincy Adams and Braintree pass users not making bus transfers, the break-even point was 15.8 round trips. When used for multi-modal travel, the break-even point was most often 11.6 round trips.

Commuter Rail Passes: Commuter rail passes ranged in price from $106.00 in Zone 1 to $198.00 in Zone 8. In addition to being valid on commuter rail, Zone 2 and higher passes were also valid on all heavy and light rail services and buses. Zone 1 passes were valid for the same services, except that an additional payment of $0.20 was required for $3.45 bus trips. Table 3-3 shows pass prices for each zone, and break-even prices for passengers using only commuter rail. For those transferring to or from other modes, break-even points were lower.

Other Monthly Passes

Senior/Transportation Access (TAP) Pass: The Senior/Transportation Access (TAP) pass was available to passengers having MBTA Senior i.d. cards or to those with disabilities having Transportation Access passes issued by the MBTA or a Regional Transit Authority in the state. The TAP was valid for unlimited travel on all MBTA services except commuter rail, commuter boat, and express bus. It was priced at $16.00.

Student Pass: Student passes were purchased by various school departments. These passes permitted unlimited use of the local bus and rapid transit system by students on until 6:00 PM on days when their schools were in session. In 2005 a weekday-only pass was priced at $13.00, and a Monday-through Saturday pass was priced at $15.00.

Table 3-2
Rapid Transit and Bus Pass Fares - 2005

	Pass Type	Cost per Month	Break-Even Point[7]
RAPID TRANSIT			
All Stations on Blue, Green, Orange, and Red Lines, excluding Quincy Center, Quincy Adams, Braintree, and $3.00 stops on Green Line D Branch	Subway	$44	17.6
Quincy Center	Combo	$71	18.9
Quincy Adams & Braintree	Combo Plus	$79	15.8
Mattapan High Speed Trolley	Bus	$31	34.4
Surface Green Line			
B, C, & E Lines			
Surface trips (Zone A)	Bus	$31	24.8
Surface to subway trips	Subway	$44	17.6
D Line			
Fenway - Reservoir (Zone B)			
Surface trips	Bus	$31	20.7
Surface to subway trips	Subway	$44	16.0
Chestnut Hill-Riverside (Zone C)			
Surface trips in Zone C	Bus +coupon	$31	20.7
Surface trips to Zone B	Bus + $1.50	$31	20.7
Surface to subway trips	Combo	$71	16.7
BUS			
Local/Zoned: One or two zones	Bus	$31	17.2
Three zones	Bus + $0.65	$31	17.2
Express: $2.20 full-fare	Combo	$71	16.1
$3.10 full-fare	Zone 1	$106	17.1
$3.45 full-fare	Zone 2	$118	17.1
COMBINED RAPID TRANSIT & BUS TRIPS			
Local Bus to Zone 1 Rapid Transit or surface Green Line, except D Line beyond Reservoir	Combo	$71	15-17
Local Bus to Zone 2 Rapid Transit or D Line beyond Reservoir	Combo	$71	12-13
Local Bus to Zone 3 Rapid Transit	Combo Plus	$79	11.6

[7]Number of round-trips.

Table 3-3
Rapid Transit and Bus Pass Fares - 2002

	Pass Type	Cost per Month	Break-Even Point[8]
RAPID TRANSIT			
All Stations on Blue, Green, Orange, and Red Lines, excluding Quincy Center, Quincy Adams, Braintree, and $2.50 stops on Green Line D Branch	Subway	$35	17.5
Quincy Center	Combo	$57	19
Quincy Adams & Braintree	Combo Plus	$63	16
Mattapan High Speed Trolley	Bus	$25	33
Surface Green Line			
B, C, & E Lines			
Surface trips (Zone A)	Bus	$25	25
Surface to subway trips	Subway	$35	17.5
D Line			
Fenway - Reservoir (Zone B)			
Surface trips	Bus	$25	20
Surface to subway trips	Subway	$35	16
Chestnut Hill-Riverside (Zone C)			
Surface trips in Zone C	Bus +coupon	$25	20
Surface trips to Zone A	Bus + $1.25	$25	20
Surface to subway trips	Combo	$57	16
BUS			
Local/Zoned: One or two zones	Bus	$25	17
Three zones	Bus + $0.50		17
Express: $1.75 full-fare	Combo	$57	16
$2.50 full-fare	Zone 1	$85	17
$2.75 full-fare	Zone 2	$94	17
COMBINED RAPID TRANSIT & BUS TRIPS			
Local Bus to Zone 1 Rapid Transit or surface Green Line, except D Line beyond Reservoir	Combo	$57	15-16
Local Bus to Zone 2 Rapid Transit or all surface Green Line	Combo	$57	11-13
Local Bus to Zone 3 Rapid Transit	Combo Plus	$63	12

[8]Number of round-trips.

Weekly and Visitor Passes

Weekly Combo Pass: The Weekly Combo pass was valid for the same services for which the monthly Combo pass was valid, but only for one specified week, running from Sunday to Saturday. The price of this pass was $16.50. Over an entire year, a Weekly Combo pass would have cost 0.7% less than a monthly Combo pass, but the weekly pass could be purchased only at 15 locations in the core system.

Weekly Combo Plus Pass: The Weekly Combo plus pass was valid for the same services for which the monthly Combo Plus pass was valid, but only for one specified week, running from Sunday to Saturday. The price of this pass was $18.50. Over an entire year, a Weekly Combo Plus pass would have cost 1.5% less than a monthly Combo Plus pass, but the weekly pass could be purchased only at the Quincy Adams and Braintree Red Line stations.

Boston Visitor Pass: The Boston Visitor pass was available in three levels. Each pass allowed unlimited travel on all heavy and light rail lines and local bus routes for a specified number of days. In 2005 a one-day pass was priced at $7.50, a three-day pass at $18.00, and a seven-day pass at $35.00. These passes were sold at selected MBTA stations and tourist information centers.

Table 3-4
Commuter Rail Through Fares - 2005

To/from Boston	One-way Trip	12-ride Ticket	Cost of Pass per Month	Break-even Point[9]
Zone 1A	$1.25	$15.00	$44.00	17.6
Zone 1B	$2.00	$24.00	$44.00	11.0
Zone 1	$3.25	$39.00	$106.00	16.3
Zone 2	$3.50	$42.00	$118.00	16.9
Zone 3	$3.75	$45.00	$128.00	17.1
Zone 4	$4.50	$54.00	$149.00	16.6
Zone 5	$5.00	$60.00	$170.00	17.0
Zone 6	$5.25	$63.00	$181.00	17.2
Zone 7	$5.50	$66.00	$191.00	17.4
Zone 8	$6.00	$72.00	$198.00	16.5

[9]Number of round-trips.

4. Methods of Statistical Analysis

Because of the expense and time that would be required to count all of the MBTA's riders, most system-wide ridership estimates are based upon the total revenue collected by the MBTA and the fare payment characteristics of a sampled portion of MBTA ridership. For each mode, this requires reliable estimates of the average passenger fare, as well as an estimate of the proportion of passengers using each fare category (the "fare-mix"). The estimates of average fares are used in conjunction with revenue figures to determine total ridership by mode. The fare category proportions are then used in conjunction with the total ridership figures to determine the total number of passengers paying each type of fare on each mode.

Fare-mix figures for the core system are obtained through observations of the proportions of passengers by fare category; average fares are obtained by dividing the total revenue collected in all fare categories by total passenger boardings or entries during the observation interval. The observations are made for a random sample of heavy rail, light rail, and bus riders. Sampling programs of this type were first instituted by CTPS and the MBTA in 1981; since that time, variations of the sampling program have been used to develop fare-mix information.

Average fares and fare category proportions are obtained for each mode: heavy rail, light rail (with subway and surface Green Line analyzed separately), bus/trackless trolley, and commuter rail. Surface Green Line, bus, and trackless trolley data are obtained by recording the types of fares paid by boarding passengers on sampled trips, as well as farebox revenue data. Rapid transit data are obtained by recording the fares paid by passengers entering selected stations through turnstiles and collector's turnstiles. Commuter rail fare-mix data are obtained from ticket and pass sales figures rather then from direct observations. After calculation of average fares, modal ridership estimates are obtained by dividing modal revenue by the respective modal average fares. Systemwide information is obtained by combining the separate modal estimates.

In general, the methods used to calculate average fares and ridership in the 2005 and 2002 fare-mix studies were similar to those used in the 1996 study. An additional source of information available for the 2002 study that had not been available in 1996 was the report on a pass-user survey conducted in 1999. A new pass-user survey was conducted in 2005 in conjunction with the 2005 fare-mix study.

Assuming that the average use rate for most pass forms was similar in 1996 and 1999, the survey results indicated that pass use as calculated from the 1996 observations was significantly underestimated for all core system modes. This had the effect of reducing calculations of total ridership and increasing estimated average fares. In order to make valid comparisons of the 1996 and 2002 results, it was necessary to recalculate the 1996 values incorporating the pass-use rates from the 1999 survey. Pass ridership calculated from the 2002 observations was much closer to the levels indicated by the survey, but was slightly low for heavy rail and the Green Line. Therefore, some

adjustments were also made to the 2002 figures for these modes. In calculating pass ridership on the bus system, changes in pass-use rate resulting from the implementation of free transfers were taken into account.

The 2005 fare-mix study results showed large discrepancies between the numbers of pass trips by mode as calculated from the direct observations at selected locations or on selected trips and the numbers estimated from the pass-user surveys. The survey results were higher than the observation results for heavy and light rail, but lower for bus and trackless trolley. The results based on the direct observations required numerous assumptions as to the relative weights to be assigned to individual observations. These weights were based on previous passenger counts that were not broken down further than peak versus off-peak. Furthermore, the number of fare-mix observations at any one station or on any individual bus route were too small to be able to say with a high degree of confidence that they were representative of that station or route. Therefore, the estimates based on the pass-user survey were used in the final 2005 fare-mix calculations.

For each mode the measures calculated were average farebox deposit, true average fare, (which includes pass revenue), and average pass ride value. The calculation methods prior to adjustment for the discrepancy in the pass use totals is as follows:

Average farebox deposit for each system is calculated by dividing sampled farebox revenue by sampled passengers:

$$(1)\ \text{Average Farebox Deposit} = \frac{\text{Sampled Farebox Revenue}}{\text{Number of Passengers Observed}}$$

Total passenger trips can then be estimated by taking the ratio of total cash and token revenue to the average farebox deposit:

$$(2)\ \text{Total Passenger Trips} = \frac{\text{Total Cash \& Token Revenue}}{\text{Average Farebox Deposit}}$$

Before the true average fare can be computed, it is necessary to

- Determine the usage percent of each mode by each pass type, which is the ratio of received value on one system to the received value on all systems for which the pass is valid. (In the 2005 fare-mix study, the usage percent for each mode by pass type was based on the results of the 2005 pass-user survey.)

$$(3)\ \text{Usage Pct. of Mode } Y_k \text{ by Pass Type } X_i = \frac{\#\text{ of Trips per Month on } Y_k \times \text{One-way Fare}}{\sum_{k=1}^{n} \#\text{ of Trips on } Y_k \times \text{One-way Fare for } Y_k}$$

  In the case that the pass can be used only on one mode, the usage percent equals 100.

- Distribute the proportion of pass revenue for each pass type to each mode, according to the usage percent of the mode by pass type:

  (4) Pass Rev. of Pass Type X_i for Mode Y_k = Pass Rev. for X_i × Usage Pct. of Y_k by X_i

- Get the total pass revenue for each mode, which is the sum of the pass revenues for all different pass types used on each mode:

  (5) Total Pass Revenue for Mode $Y_k = \sum_{i=1}^{n}$ Pass Revenue of Pass Type X_i for Y_k

- Find the total revenue for each mode by adding up total pass revenue and total cash and token revenue:

  (6) Total Rev. for Mode Y_k = Total Pass Rev. for Y_k + Total Cash & Token Rev. for Y_k

Finally, the true average fare and the average pass ride value for each system are calculated by dividing total revenue by total passenger trips:

(7) $$\text{True Average Fare for Mode } Y_k = \frac{\text{Total Revenue for } Y_k}{\text{Total Passenger Trips on } Y_k}$$

(8) $$\text{Average Pass Ride Value for Mode } Y_k = \frac{\text{True Avg. Fare - Avg. Farebox Deposit}}{\text{Percent of Passengers Using Pass}}$$

An example of the above described method is given in Box 4-1, based on simplified fare-mix figures.

Box 4-1
Example of a Fare-Mix Calculation with Simplified Figures

Fare-Mix Data

BUS:	Cash Riders:	115	(35%)
	Pass Riders:	215	(65%)
	Passengers:	330	
	Farebox Revenues:	$107	
RAIL:	Cash Riders:	180	(40%)
	Pass Riders:	270	(60%)
	Passengers:	450	
	Farebox Revenues:	$223	

Additional Data

One-way Fare for Bus:	$0.90	
One-way Fare for Rail:	$1.25	
Total Farebox Revenues for Bus:	$1,668,000	
Total Farebox Revenues for Rail:	$3,750,000	
Pass Revenue for Bus Pass:	$1,023,000	($31 per pass)
Pass Revenue for Rail Pass:	$2,300,570	($44 per pass)
Pass Revenue for Combo Pass:	$2,242,100	($71 per pass)
Combo Pass Bus Trips per Month:	30	
Combo Pass Rail Trips per Month:	45	

First the average farebox deposit is calculated:

(1) Average Farebox Deposit = Farebox Revenue / Passenger

for BUS: = $107 / 330 riders = $0.323

for RAIL: = $223 / 450 riders = $0.496

This figure is then used to determine total passenger trips:

(2) Total Passenger Trips = Cash & Token Revenue / Average Farebox Deposit

for BUS: = $1,668,000 / $0.323 = 5,161,665 riders

for RAIL: = $3,750,000 / $0.496 = 7,560,485 riders

The usage percent of each mode by pass type is:

(3) Usage Pct. of Mode Y_k by Pass Type X_i = $$\frac{\#\text{ of Trips/Month on } Y_k \times \text{Fare for } Y_k}{\sum \#\text{ of Trips on } Y_k \times \text{Fare for } Y_k}$$

for Bus Pass on BUS: = 100%
for Rail Pass on RAIL: = 100%

$$\text{for Combo Pass on BUS} = \frac{30 \times \$0.90}{(30 \times \$0.90) + (45 \times \$1.25)} = \frac{\$27.0}{\$27.0 + \$56.25} = 33\%$$

$$\text{for Combo Pass on RAIL} = \frac{45 \times \$1.25}{(30 \times \$0.90) + (45 \times \$1.25)} = \frac{\$56.25}{\$27.0 + \$56.25} = 67\%$$

The pass revenue for each mode by pass type is:

(4) Rev. of Pass Type X_i for Mode Y_k = Pass Rev. for X_i × Usage Pct. of Y_k by X_i

for Bus Pass on BUS: = \$1,023,000 × 1 = \$1,023,000
for Combo Pass on BUS: = \$2,242,100 × 0.33 = \$726,440

for Rail Pass on RAIL: = \$2,300,570 × 1 = \$2,300,570
for Combo Pass on RAIL: = \$2,242,100 × 0.67 = \$1,515,660

Total pass revenue for each mode is:

(5) Total Pass Revenue for Mode $Y_k = \sum$ Pass Revenue of Pass Type X_i for Y_k

for BUS: = \$1,023,000 + \$726,440 = \$1,749,440
for RAIL: = \$2,300,570 + \$1,515,660 = \$3,816,230

Total revenue for each mode is:

(6) Total Rev. for Mode Y_k = Total Pass Rev. for Y_k + Total Cash & Token Rev.

for BUS: = \$1,749,440 + \$1,668,000 = \$3,417,440
for RAIL: = \$3,816,230 + \$3,750,000 = \$7,566,230

Then the true average fare for the mode can be estimated:

(7) True Avg. Fare for Mode Y_k = Total Rev. for Y_k / Total Passgr. Trips on Y_k

for BUS = \$3,417,440 / 5,161,665 = \$0.662
for RAIL = \$7,566,230 / 7,560,485 = \$1.001

$$\text{(8) Average Pass Ride Value} = \frac{\text{True Average Fare - Average Farebox Deposit}}{\text{Percentage of Passengers Using Passes}}$$

for BUS =(\$0.662 - \$0.323) / 0.65 = \$0.339 / 0.65 = \$0.522
for RAIL =(\$1.001 - \$0.496) / 0.60 = \$0.505 / 0.6 = \$0.842

Note that the calculations above are based on hypothetical values for purposes of illustration only, and are not the actual 2005 fare-mix results.

The example in box 4-1 implies that in addition to total numbers of cash and pass riders determined from fare-mix observations, there are also sources of information on total farebox and pass revenue over specified time intervals, and on pass use rates. For fare-mix studies, revenue figures are obtained from standard reports generated by the MBTA Revenue Department or the MBTA money center. (In the case of commuter rail,

revenue figures are taken partly from reports produced by the contract operator of the service.

Pass-use rates are obtained from pass-user surveys that have been conducted by CTPS for the MBTA from time to time. The 2002 fare-mix study used results of 1999 pass-user surveys, and the 2005 study used results of 2005 surveys. Average pass-ride values and pass trips can be calculated directly from the survey results independent of fare-mix observations. In the surveys, a sample of passengers using each form of MBTA pass is asked the number of times on a typical weekday and in a typical week that they expect to use their passes on each of several listed MBTA services. From these responses, mean weekday and weekly use rates are calculated for each pass on each of the listed services. Multiplying these use rates by total pass sales figures provides estimates of average total weekday and weekly pass trips during the time interval for which the sales figures apply. An example of such calculations follows.

In the 2005 survey results, Local Bus pass users reported using their passes for an average of 2.78 bus trips per day and 13.81 bus trips per week (including Silver Line Washington Street service). During fiscal year 2005, Local Bus pass sales averaged 23,071 per month. Therefore, on a typical weekday 23,071 x 2.78 = 64,137 bus trips would have been made using Local Bus passes, and in a typical week 23,071 x 13.01 = 318,612 bus trips would have been made using these passes. The only other service for which Local Bus pass use was reported was the Green Line, on which these passes are valid at surface stops. The average reported uses of Local Bus passes on the Green Line were 0.12 per day and 0.62 per week. Applying these to average pass sales gives estimates of 2,769 Green Line trips per weekday and 14,304 per week using Local Bus passes. The combined total number of bus and Green Line trips using these passes would have been 332,916 per week. (In 2005, Local Bus passes could also be used for free transfers from the Silver Line-Washington Street to subway lines at three stations, but no survey respondents indicated that they did this.)

To calculate the average pass ride value, pass sales revenue is allocated to each service on which a pass is used in proportion to the fare revenue that would have been collected if the pass riders had paid full cash fares instead of using passes. For bus trips on which Local Bus passes are used, the full cash fare in 2005 was $0.90. On the B, C, or E Lines, the full cash fare needed in place of a Local Bus pass would have been $1.25. On the D Line, the full cash fare needed would have been $1.50. Weighting these by older survey data, the average Green Line fare would have been $1.318. Using the weekly figures, the total cash fares that would have been needed in place of the pass would have been 318,612 x $0.90 + 14,304 x $1.318 = $297,604. Although Bus rides accounted for 95.7% of all rides made using these passes (318,612/332,916) they accounted for only 93.9% of equivalent cash fares ($286,751/$297,604). Therefore, under the conventions used in fare-mix studies for allocating pass revenue, 93.9% of revenue from Local Bus pass sales would be allocated to buses, and the remaining 6.1% to the Green Line.

During fiscal year 2005, revenue from sales of Local Bus passes averaged $712,308 per month. Using the factors above, $712,308 x .939 = $668,857 would be allocated to buses, and the remaining $43,451 to the Green Line in an average month. However, the pass-use figures in the survey are per weekday or per week rather than per month. To

convert monthly to weekly revenue, the monthly total is divided by 4.35, the average number of weeks per month. This would allocate $153,904 per week to bus and $9,998 per week to the Green Line from local bus pass sales revenue.

Finally, average pass ride values are calculated by dividing the amount of pass revenue allocated to each service by the number of trips reported in the pass use survey. For bus, the average pass ride value of Local bus passes, based on weekly totals was $153,904/318,612 = $0.4830. For the Green Line, the average pass ride value of Local bus passes was $9,998/14,304 = $0.6990. These numbers represent the effective average revenue received by the MBTA each time a pass was used. The value to the user for each trip equals the full cash fare of $0.90 on a bus or $1.31 on the Green Line.

The Pass-user surveys asked respondents to report their average pass use on a weekday and over an entire week, but did not specifically ask about Saturday or Sunday use. A reported weekly total could consist entirely of weekday trips or it could include some combination of weekday and weekend travel. Under the present MBTA fare structure, fares for any given service do not vary by time of day or by day of week. Therefore, the average pass-ride value calculations for a given pass form determine a single value that is applicable either on weekdays or on weekend days.

In the final calculations for the 2002 and 2005 fare-mix studies, estimates of total weekly trips made by pass users were allocated between weekdays and weekend days in proportion to the estimates obtained from the fare-mix observations. For example, if the weekly pass-use estimate from the survey exceeded that from the observations on a given service by 10%, the weekday, Saturday and Sunday totals from the observations were each factored up by 10%. (In the fare-mix observations, weekly totals were calculated as the sum of five times the weekday total plus the Saturday and Sunday total.) Once again, it must be emphasized that the finer the level at which results are broken down, the less reliable the findings will be.

In the tables in chapter 5, "2005" refers to results based on the fare-mix data collected in 2005 and "2002" refers to results based on the fare-mix data collected in 2001 and 2002. "1996 adj." refers to the revised calculations from the 1996 fare-mix data, using methods compatible with those of the 2002 calculations. These included tying pass use rates for all modes into the 1999 pass-user survey results.

"Red, Orange, and Blue Lines" or "Heavy Rail" refers to trips with cash or pass fares collected at stations on the Red, Orange, or Blue Lines, including passengers boarding one of these lines after entering at a station shared with the Green Line.

"Central Subway" refers to Green Line trips with off-train cash or pass fares collected at Green Line Central Subway stations, including passengers boarding after entering at a station shared with heavy rail. "Heavy Rail & Central Subway" refers to combined results from Red, Orange, and Blue Lines and Central Subway, as defined above.

In Green Line tables, Central Subway is the same as defined above. "Surface" refers to trips with cash or pass fares collected on-board trains at surface stops on the B, C, D, or E lines or at stations in the Central Subway without off-train fare-collection. (The

latter are Prudential, Symphony, and Science Park at all times and Lechmere in off-peak hours.) "Entire Green" refers to combined results from Central Subway and Surface. This is the same as "Light Rail" in the 1996 study.

At subway stations shared by the Green Line and heavy rail lines, it is not possible to determine which lines most passengers are going to as they pass through the entry turnstiles. In the 2005 and 2002 studies, passengers observed in fare-mix samples at such stations were allocated between lines using factors from more detailed passenger counts conducted by CTPS in 1997.

5. Sampling Program, Data Collection and Results of Analysis

To calculate ridership from revenue information, a reliable estimate of average farebox deposits is required. In the most recent fare-mix studies, estimates of these averages have been obtained by recording the proportion of passengers by fare type and fare revenue for a sample of heavy rail, light rail, and bus riders. Commuter rail fare-mix data have been obtained from ticket and pass sales figures. Separate sampling programs were designed for each mode to obtain modal estimates of average farebox deposit, riders by fare category, total ridership, and true average fare. The modal estimates were then combined to obtain system-wide estimates.

It must be noted that the MBTA's revenue accounting procedures in effect during the time span covered by this study did not provide information on fares collected by day and mode at the level of detail needed for precise ridership estimates. It was necessary to allocate much of the revenue on the basis of assumptions about when and where fares were collected. The finer the level of detail attempted in terms of ridership by time and route, the more influence these assumptions may have had on the results.

In reviewing the 1996 fare-mix study results for purposes of comparison with the 2002 results, it was found that several of the breakdowns of fares in the 1996 report were inconsistent with information from other sources such as surveys and passenger counts. The most significant problems were in pass use. The total pass revenue figures were consistent with pass sales data from 1996, but the ratios of pass riders to cash-fare riders on all modes were unusually low. Consequently, figures for average pass ride value, true average fare, and average farebox deposit were all too high. This made the apparent changes in these measures between 1996 and 2002 inconsistent with the changes in fares implemented in 2000. To correct for this problem, pass rides by mode were re-estimated by applying pass-use rates obtained from the 1999 pass-user survey to 1996 pass sales figures. Other problems were found in the allocation of fare revenue between weekdays and weekends, and between the surface and subway segments of the Green Line. Finally, the proportion of free outbound surface Green Line riders in the 1996 figures was found to be significantly overstated when compared with 1995 passenger counts on these lines. Any comparisons with 1996 data in this chapter reflect the adjustments made to correct for the problems discussed above.

The next sections of this chapter describe the methods used for data collection data processing and fare-mix calculations for each mode. Results for all modes are presented at the end of the chapter.

HEAVY RAIL AND GREEN LINE CENTRAL SUBWAY PRE-PAYMENT STATIONS

Method Used to Select Sampling Times and Locations

In the 2002 and 2005 studies, fare-mix samples at heavy rail stations and at Green Line Central Subway stations with off-train fare collection consisted of a series of half-hour observations at selected locations. Based on recommendations in prior fare-mix studies, a specified number of samples was to be taken from each of 13 groups of stations and time intervals. Pre-payment stations were first divided into three groups: Central Subway (including heavy rail transfer points), basic-fare heavy rail (excluding Central Subway transfer points), and extra-fare heavy rail.

The Central Subway group included all stations from Kenmore to North Station, inclusive. Of these, Park Street, Government Center, Haymarket, and North Station also serve heavy rail lines and are referred to as heavy rail transfer points. All of these are basic-fare stations, at which the adult full cash fare was one token, priced at $1.25 in 2005. Four stations that are classified as part of the Central Subway for operating purposes were not included in the fare-mix samples. At Prudential and Symphony, fares were collected on board trains at all times in 2005. Ordinarily fares would also have been collected on-board at Science Park at all times and at Lechmere during off-peak hours, but Green Line service to both stations was suspended due to a line relocation project during most of the time that 2005 fare-mix samples were being collected.

The basic-fare heavy rail station group included all stations on the Red, Blue, and Orange lines except for the four stations listed above that also serve the Green Line, and the three extra-fare stations. The latter consist of Quincy Center, Quincy Adams, and Braintree. At all three of those stations, the adult full cash fare in 2005 was two tokens when entering. Quincy Adams, and Braintree also had exit fares of one token for adult full-cash-fare passengers.

For fare-mix sampling purposes, each of the three pre-payment station groups was further subdivided into weekday, Saturday, and Sunday. The Central Subway and basic-fare heavy rail weekday subgroups were further divided into peak entries (from 6:00 to 9:00 AM or from 4:00 to 6:00 PM) and off-peak entries (all non-peak weekday entries). Peak and off-peak groups were then further divided into one-hour intervals. Based on results in the 1997 CTPS Rapid Transit and Central Subway Passenger Counts report, each off-peak station/hour interval was placed in one of two groups: high-volume (300 or more entries per hour expected) or low-volume (fewer than 300 entries per hour expected). Separate high-volume and low-volume groups were created for heavy rail and for Central Subway.

Each of the 13 groups initially contained many more station/hour combinations than the number planned to be observed. In order to obtain a cross-section from each group, a computer program was first used to make a series of random selections from within that group. The distribution of hours and locations selected was then compared with the overall distribution of hours and locations within the group. If some hours or locations were found to have been selected at significantly higher rates than they accounted for within the group as a whole, some picks for each such station or hour

were discarded, and new random selections made. This process continued until it appeared that a representative sample had been created for each group. Although the assignments were created by one-hour intervals, the sample lengths were required only to be 30 minutes somewhere within that hour.

Data Collected In Each Sample

For each assigned sample, a checker was supposed to record the number of passengers entering the station in a 30-minute interval, by each of the fare payment methods described below. At each basic-fare station (i.e. where the full entry fare is one token and there is no exit fare) passengers can enter either through full-fare turnstiles, at collectors booth turnstiles, or at collectors gates. Passengers entering via the full-fare turnstiles must either deposit one token or run a pass or ticket through a card-reader. Passengers entering at the collectors booth turnstiles or gates can use a much larger variety of fare payment options. In earlier past fare-mix studies, attempts were made to use farebox readings to determine the total value of cash-fare deposits at the collectors booth turnstiles. In 1996 it was found that a high proportion of farebox readers were malfunctioning. Preliminary results from 2001 showed that even fewer farebox readers were functioning correctly. Therefore, it was necessary to estimate cash-fare revenue by multiplying the number of observed cash-fare passengers in each category by the applicable fare and applying an adjustment factor for incorrect fares.

Since collectors are able to provide change, it is unnecessary for anyone to overpay a fare, but some people underpay. In the 1996 fare-mix study, in cases where cash-fare revenues had to be estimated, it was assumed that actual revenue was 92.6% of the amount that would be obtained if all passengers paid correct fares. In the 2002 and 2005 fare-mix samples, the proportions of cash fares relative to total station entries were so small that the specific factor used to adjust for short fares would have had little influence on average fare calculations. For consistency with the 1996 study, 92.6% short-fare factors were again used in 2002 and 2005.

Each passenger observed entering a basic-fare station via a collectors booth turnstile or gate was supposed to be recorded under one of 11 categories: Adult Full Fare, Adult Monthly Pass, Weekly Combo Pass, Senior/Disability Cash Fare, Senior/Disability Monthly Pass, Child/Student Reduced Cash Fare, Student Pass, Visitor's Pass, MBTA Employee Pass, Authorized Free, and Unauthorized Free. (In some cases it was difficult for the data collectors to distinguish MBTA employees from other authorized free riders, so the reported breakdowns between those two categories were imprecise.) At Red Line stations in Quincy and Braintree, an additional category was included for passengers purchasing warrants for trips between pairs of those stations.

Steps Used in Processing Sample Results

Calculation of Average Fare by Group

For each half-hour fare-mix sample, total passenger entries were calculated by adding the number of passengers in each fare category. Revenue was calculated by multiplying the number of cash fare and token passengers in each category by the applicable fare rate and applying a short-fare factor to cash fares at collectors booths. At

basic-fare stations, revenue from each passenger that used a token was valued at the 2005 token price of $1.25 or the 2002 token price of $1.00.

In 2005, a small number of the fare-mix observations were taken at Blue Line stations where use of tokens had been replaced by use of Charlie Cards. Each time such a card was used, the value of one full cash fare was deducted. Therefore, users of these cards were recorded as though they were token users.

At the extra-fare stations on the Red Line, calculations of revenue were more complicated. At Quincy Center, Quincy Adams, and Braintree, full-fare entry turnstiles require depositing two tokens per passenger, with a 2005 value of $2.50, or a 2002 value of $2.00. Quincy Center does not currently have an exit fare, but Quincy Adams and Braintree require each full-fare passenger to deposit one additional token to exit. Senior citizens and passengers with disabilities pay only to enter at these stations, but children and pupils who paid a $1.25 entry fare in 2005 also paid a 60-cent exit fare (up from $1.00 entry fare and 50-cent exit fare in 2002.)

Fare-mix samples at Quincy Adams and Braintree did not include counts of exiting passengers. If it were assumed that each passenger entering at these stations made a round trip, then each full-fare passenger in 2005 would effectively contribute revenue of $3.75 attributable to that station and each cash-fare child or pupil would effectively contribute $1.85. Spring 2002 CTPS counts at Quincy Adams and Braintree indicated that all-day outbound alightings at both stations were slightly lower than inbound boardings, so the estimated impacts of exit fares in the 2002 and 2005 fare-mix calculations were adjusted downward accordingly.

Revenue from local-fare warrants also had to be taken into account in the calculations. In 2005, an adult using a warrant to make a local trip between stations in Quincy or Braintree paid $2.50 to enter and purchase the warrant. At the exit station the warrant was turned in, and the passenger received a $1.25 refund and paid no exit fare. If such a passenger made a round trip, the warrant fee paid at the initial boarding station was effectively cancelled out by the $1.25 rebate when the passenger returned to that station. Therefore, the cash-fare total for the station at the end of the day would include $1.25 (the $2.50 entry fee minus the $1.25 exit rebate) for each adult passenger that made a warrant trip from there.

Cash-fare students or children making local trips were also supposed to purchase and redeem warrants, but for them the net revenue impact of each trip would have been only 60 cents. The fare-mix samples did not differentiate between sales of warrants to adults and sales to students or children. In other fare categories, students and children accounted for only a small percentage of total entries to these stations. Therefore, for purposes of revenue calculation it was assumed that each warrant sale generated the adult fare impact of $1.25 ($1.00 in 2002).

After passenger volumes and revenue for each sample record were calculated, the results for all records in each station group were added, and an average group fare was calculated. A further adjustment was then made to avoid over or under-representation of results from individual stations. This involved a multiple-step process, as follows. First, if more than one record in a group came from the same station, total observed

entries at that station were added together. Next, the percentage of observed entries in the group accounted for by each station was calculated. For peak-period samples, these percentages were compared with the distributions of total entries at the same stations during peak hours in the 1997 Rapid Transit and Central Subway Counts report. Similarly, for off-peak samples the distributions of observed entries were compared with off-peak entries at the same stations in the 1997 counts. Weight factors were then applied to each record to make the distribution of entries by station within the group the same as that observed in 1997. This changed the average fare by at most plus or minus 10%, and in most cases by much less, compared with the unweighted results. (Counts more recent than 1997 have been taken at many stations. However, in order to weight the results, it is necessary to use counts that were all taken at around the same time. The last time counts were taken at all heavy rail and rapid transit stations in the same year was 1997.)

The observation group for extra-fare stations on the Red Line did not originally differentiate between peak and off-peak hours. The sample results showed significantly higher average revenue per passenger in off-peak hours than in peak hours. To adjust for this, the results were separated into peak and off-peak sub-groups. Within each group the results from each station were weighted by passenger counts, in the same manner used at basic-fare stations.

Consolidation of Weekday Group Results

The station and hour groupings used in collecting the fare-mix samples were needed in order to obtain representative cross-sections, but they did not correspond directly with the breakdowns available in revenue reports. Therefore, some further calculations were needed. The finest level of detail at which revenue reports can be obtained is entire days, and even these do not credit all revenue to the dates on which fares were actually collected. Therefore, it is not possible to use separate average fares calculated for peak and off-peak hours to estimate peak and off-peak ridership separately. Revenue reports can be obtained for individual stations, but the sampling method did not include every station, and the samples that were taken were too short to ensure representative results below the station group level.

For some reporting purposes, it is necessary to calculate average revenue for Green Line Central Subway stations separately from that of heavy rail stations. Four stations (Park Street, Government Center, Haymarket, and North Station) are shared by the Green Line and heavy rail lines. Passengers entering any of these stations can go to either line, so revenue reports cannot show actual breakdowns of revenue by route. In the sampling procedure, the four transfer stations were included in the Central Subway groups, but in the final calculations it was necessary to separate them out.

The first step in consolidating average revenue deposit results was to combine the off-peak high- and low-volume entry observations for each set of stations into a single sub-group. Some stations were in the high-volume group in some hours and in the low-volume group in other hours, so it was not possible to derive overall weighting factors for high-volume and low-volume results. Instead, all the high-volume and low-volume records for each set of stations were combined into a single group. The records from each station were then weighted in proportion to the off-peak entries in that station set accounted for by that station in the 1997 counts. This left eight sets of records for

weekdays, consisting of peak and off-peak observations for Central Subway transfer stations, Central Subway non-transfer stations, other basic-fare heavy rail stations, and extra-fare heavy rail stations.

The next step was to combine the peak and off-peak results to calculate daily average revenue deposits. For Central Subway non-transfer stations, other basic-fare heavy rail stations, and extra-fare heavy rail stations, this was done by weighting the peak and off-peak averages in each set in proportion to peak and off-peak entries in the 1997 counts at all stations in the group represented by the observations. These weights were based on entries at all stations eligible for inclusion in a particular group whether or not any samples were actually taken there. For example, Jackson Square Station on the Orange Line is a basic-fare heavy rail station, but the random selection program did not assign any fare-mix observations at Jackson Square in 2002. Nevertheless, since Jackson Square is among the stations for which observed average deposits in the basic-fare group are supposed to be representative, 1997 entries at Jackson Square were included in the weighting of peak and off-peak results.

The 1997 counts at transfer stations included breakdowns of entries by line based on direct observations. This made it possible to estimate separate all-day average fare deposits for the Green Line and for the heavy rail lines at the four Central Subway transfer stations. Since the 1997 counts did not include fare-mix observations and the 2002 and 2005 fare-mix samples did not separate passenger entries by line, it was necessary to assume that within each time interval, the fare-mix at the transfer stations was the same for the Green Line and for the connecting heavy rail lines. An average Green Line fare deposit at transfer stations was calculated by weighting peak and off-peak average deposits by 1997 peak and off-peak Green Line entries at the four stations combined. Similarly, an average heavy rail deposit at Central Subway transfer stations was calculated by weighting the peak and off-peak average deposits by 1997 peak and off-peak heavy rail entries at the four stations.

The all-day averages for Central Subway transfer and non-transfer stations as calculated above were next combined into a single Central Subway average, by weighting the results in each group by all-day Green Line entries in the 1997 counts. A similar method was used to calculate a combined all-day average deposit for heavy rail passengers at basic-fare heavy rail stations and at Central Subway transfer stations. As in the case of the consolidations of peak and off-peak results, weights were based on entries at all stations eligible for inclusion in each group, whether or not any fare-mix samples were taken there.

For some reporting purposes, an overall average heavy rail fare for basic-fare and extra-fare stations together is required. This average was calculated by weighting the all-day averages for extra-fare stations and for basic-fare stations (including heavy rail entries at Central Subway stations) in proportion to 1997 all-day entries in each group.

Consolidation of Weekend Group Results

Calculations of average Saturday and Sunday fares required different procedures, because there were no recent Saturday or Sunday passenger counts to use in weighting results from the various stations or station groups. Unlike weekday travel, weekend travel does not include a large component of repetitive work trips, heavily concentrated

during a few hours. Therefore, the fare-mix samples on Saturdays and Sundays did not differentiate between peak and off-peak hours. Consequently, there was no need to consolidate results from two separate sub-groups when calculating all-day average revenue figure within each station group. It was, however, necessary to calculate the averages for each group without weighting the results for individual stations in proportion to boardings as was done for the weekday results.

In the absence of passenger counts to use in weighting fare-mix results, it should theoretically be possible to estimate weekend ridership for each station by dividing total revenue for a Saturday by the observed average Saturday fare there and total revenue for a Sunday by the observed average Sunday fare there. The fare-mix sampling interval at any individual station was, however, too short to allow a reliable calculation of the all-day average fare at that station to be made. Therefore, it was necessary to work with average fares for groups of stations.

If revenue for each station were reported separately for each day, total station entries within each group for any given day could be estimated by dividing total revenue from stations in that group on that day by the group's average fare for a corresponding day as determined from the fare-mix observations. The MBTA's daily revenue reports do not, however, provide complete breakdowns of when fares were actually paid. This made it necessary to calculate Saturday and Sunday ridership partly on the basis of estimated revenue figures. The components of reported revenue and the steps that were used in estimating weekend revenue are discussed in the remainder of this section.

The largest source of revenue at pre-payment stations is token sales. For tokens sold at collectors booths, the daily revenue reports apparently reflect actual sales on each day. An unknown percentage of tokens sold are used for return trips from stations other than those where they are purchased, or for trips on subsequent days. Money deposited in token vending machines (TVMs) is not removed every day, and is shown in the daily revenue reports on the dates when it is counted rather than the actual token sale dates.

If the fare registers for reduced-fare turnstiles at collectors booths are functioning, fares deposited there are reported for the dates that they are paid in. Otherwise, these fares are reported as "unregistered cash" which is often counted only at intervals of several days.

For the 2005 and 2002 fare-mix calculations detailed examinations were made of daily revenue reports for the months of May 2005 and May 2002. (Revenue varies from month to month, but May results are usually close to the average for all months in a given year). To estimate revenue by day, it was assumed that the distribution of reported token sales at collectors booths by weekday, Saturday, and Sunday was reasonably close to the actual distribution of full cash fares paid. Revenue from TVM token sales was reallocated to weekday, Saturday, and Sunday in the same proportion as collectors booth sales at the stations that had TVMs. For stations with working fare registers at collectors booths , it was assumed that the distribution of reported reduced-fare revenue by weekday, Saturday, and Sunday was reasonably close to the actual distribution of reduced fares paid. Unregistered cash from stations in each group was

reallocated to weekday, Saturday, and Sunday in the same proportion as registered reduced fares in the same group. In most station groups, average revenue was much lower during the final week of May than in the first three weeks, at least in part because of colleges starting summer breaks. Therefore, in estimating revenue for representative days, results for the final week were excluded.

For the Central Subway transfer station group it was assumed, for lack of better information, that Saturday and Sunday revenue was attributable to Green Line and heavy rail passengers in the same proportion as on weekdays. The 1997 counts showed that on weekdays 61% of the passengers entering Park Street, Government Center, Haymarket, and North Station combined were going to the Green Line and 39% to heavy rail lines. Green Line entries were however, more heavily concentrated than heavy rail entries during off-peak hours when average fare deposits were highest. Applying the 2002 peak and off-peak fare-mixes to the 1997 counts resulted in an estimate of 63.4% of weekday revenue at the transfer stations being attributable to the Green Line and 36.6% to heavy rail. These percentages were assumed to apply to Saturday and Sunday revenue also.

Total Saturday and Sunday ridership for each station group was estimated by dividing total revenue, estimated as above, by the average farebox deposit calculated from the 2005 or 2002 samples. Average fares for combined groups were then calculated by dividing the combined estimated revenue by the combined estimated ridership.

SURFACE GREEN LINE

Segments of the Green Line west of Kenmore Station on the B, C, and D lines or west of Symphony Station on the E Line are classified as Surface Green Line. Fares at Surface Green Line stops are collected on board vehicles, except that at certain times of day the Riverside terminal of the D Line has off-train fare collection. Fares at the Symphony and Prudential subway stations on the E Line are also collected on board. When the 2002 fare-mix study was conducted, fares at the Science Park and Lechmere stations (then served by the D and E Lines) were also collected on board, except that during weekday peak hours Lechmere had off-train fare collection. Green Line service to both Science Park and Lechmere was suspended during the time when most of the 2005 fare-mix observations were taken, but tokens were still sold at Lechmere during this time. The May 2005 revenue reports show revenue patterns with the two stations closed, including Lechmere token sales.

Method Used to Select Sampling Times and Locations

Fare-mix samples for the surface Green Line in 2002 as in 1996 were taken on board trains by two-person teams. One team member was responsible for observing passenger fare categories and the other for recording them. For the 2005 samples, it was concluded that use of two-person teams would not greatly improve accuracy compared with individual observers, so each assignment was done by one person.

In all three studies, each surface Green Line assignment began at a randomly assigned time at Copley Station in the Central Subway. From there, the team or

individual observer boarded the first outbound train to arrive on any line. They then rode all the way to the outer terminal, returned to Copley on the next inbound train and waited for another outbound train. At times of day when two-car trains were in operation, checkers alternated between observations of first cars and second cars on successive trips. A comparison of the number of weekday trips observed by Green Line branch with the number of scheduled trips shows that all lines were sampled at about equal rates.

Data Collected In Each Sample

The data collected differed significantly between inbound and outbound trips. No fares are collected on outbound trips on any surface portions of the Green Line. Therefore, on outbound trips all passengers boarding at surface stops were recorded as Authorized Free. Inbound, the B, C, and E lines all have the same single-zone fare structure, but the D Line has two fare zones. Therefore, the data collected on the D Line differed from that collected on the other three branches.

On all four lines, checkers recorded farebox register readings at the start of each inbound trip and after the last surface stop. (On the E Line the final farebox reading was taken after Prudential Station.) Farebox readings show the dollar value of coins deposited, but do not count tokens. Dollar bills go into a separate farebox compartment and are not registered. Checkers were supposed to record deposits of dollar bills as they occurred.

During each inbound trip on the B, C, and E Lines, checkers recorded boarding passengers in four categories, divided into 11 sub-categories according to method of fare payment. Adult fares were subdivided into Cash, Token, Monthly Pass, Weekly Pass and Visitors Pass. Senior Citizen and Disability fares were subdivided into Cash and Pass, as were Child and Student fares. Free riders were subdivided into Non-authorized and Authorized.

On the D Line, Adult fares included eight sub-categories. Of these, Cash and Monthly, Weekly, and Visitors passes were the same as those on the other lines. The category of Token was replaced with Token & Cash, because the price of a token is less than the full fare. Other sub-categories added were Pass Plus Cash, Cash & Newton Local Coupon, and 10-ride ticket. In all fare categories, checkers were supposed to keep separate counts of passengers boarding in the outer fare zone (from Riverside to Chestnut Hill) and in the inner zone (from Reservoir to Fenway).

Steps Used in Processing Sample Results

For each inbound trip record, total revenue received was calculated as the sum of the difference between the beginning and ending farebox readings, plus the number of dollar bills and the value of the number of tokens deposited. On the B, C, and E Lines and in the inner zone of the D Line each token-fare passenger was assumed to have deposited one token. In the outer zone of the D Line, each token passenger was assumed to have deposited two tokens. Expected total revenue was then calculated by multiplying the number of passengers in each cash or token fare category by the amount that should have been deposited if the correct fare was paid.

Actual and expected revenue for each record were compared. If there were discrepancies, the next step was to compare the information on the original data sheet with the database record and correct data entry errors. If the amount of the error remaining after this was equal to the difference between fares in two different categories or to a multiple of this difference it was assumed that the checker had mis-classified one or more passengers, and the results were adjusted accordingly. For example, in 2005, if the total actual revenue on a B Line trip exceeded the expected revenue by 90 cents, it was assumed that one passenger recorded as having paid a 35-cent reduced fare had actually paid a full $1.25 fare. (In the 1996 fare-mix study, if the ratio of recorded to expected revenue was below 80% or above 110%, the difference was attributed instead to incorrect farebox readings, and the revenue total was revised to match the expected figures more closely.)

After corrections were made for apparent errors in fare classification or recording of passengers paying with dollar bills, average fare deposits were calculated by dividing total revenue received on each trip by the total number of boarding passengers in all fare categories. The results of all inbound records for each individual branch were then added together, and an average inbound fare for the branch was calculated. No attempt was made to assign different weights to different trips. For each branch, a two-way average fare deposit was calculated by dividing the total revenue received on all inbound trips by the combined total of passenger boardings recorded on all inbound and outbound trips on the branch.

An overall average surface Green Line fare mix was calculated by weighting the results from each branch in the same proportion as the percentage of total weekday riders accounted for by that branch in the 1995 CTPS counts.

Calculation of Combined Surface and Subway Green Line Fares

For some reporting purposes, calculation of a combined average surface and subway Green Line fare deposit is required. The methods used in calculating the separate surface and subway fares are described above. Because of the manner in which fares are collected and the manner in which some of the fare-mix observations were done, some adjustments are required before these results are combined. On the E Line, fares were collected on board cars at the Symphony and Prudential stations in the subway as well as at inbound surface stops in 2002 and 2005. In the 2002 fare-mix samples, some checkers noted that they recorded boardings by fare category at these stations on inbound trips and took the final farebox reading after Prudential. Others did not indicate whether they had done so, so it is unclear if their reports included subway boardings. None of the outbound records included boardings at Prudential or Symphony, but outbound fares were supposed to be collected on board trains at both stations. Therefore, the fare-mix calculations for the surface E Line included at least some results from Prudential and Symphony inbound, but none from these stations outbound. In 2002, no fare-mix observations were done at Science Park Station, where all fares were collected on board, or at Lechmere, where off-peak fares were collected on board.

For the 2005 fare-mix observations, checkers were instructed to include boardings and fare-mixes at Symphony and Prudential in the totals for inbound trips and also to

record boardings by method of fare payment at these two stations on outbound trips. Green Line service to Lechmere and Science Park was temporarily suspended during the time that the 2005 surface Green Line fare-mix samples were collected.

When Green Line fareboxes are emptied, there is no way of determining where the revenue was deposited. If a car has been used on more than one route since the previous time the box was emptied, it is not even possible to determine which branch the revenue was from. Farebox revenue totals also include fares collected at Symphony and Prudential, and except in 2005 they also include fares collected at Lechmere and Science Park. In recent fare-mix studies, subway passengers paying on-board fares have in effect been counted as surface passengers. However, if the average fare paid at the subway stations differed from that at surface stops, dividing total farebox revenue by the average surface farebox deposit alone could result in over- or underestimation of total ridership. To correct for this in the 2002 calculations, an attempt was made to estimate the amount of on-board revenue attributable to the subway stations.

Lacking any other information, it was reasonable to assume that the fare-mix at the subway stations would be similar to that at other non-transfer Green Line stations. Using results of the 1995 surface Green Line counts and the 1997 subway counts, surface line average fares and assumed average fares at Lechmere, Science Park, Symphony and Prudential were weighted to calculate the combined average fares deposited in Green Line car fareboxes by surface and subway passengers. Finally using the same counts, average fares deposited at Green Line subway stations and average fares deposited in Green Line cars were weighted to find an overall average Green Line fare.

Because of service at Lechmere and Science Park having been suspended during the time period for which 2005 revenue figures were obtained, farebox revenue from Green Line vehicles did not include any fares deposited at those stations. Because the E Line fare-mix observations included boardings both inbound and outbound at Symphony and Prudential, average fares calculated for that line included the activity at those stations. Therefore, it was not necessary to make any additional adjustments to the average fares. However, Symphony and Prudential riders were counted as surface rather than subway passengers in the summary totals.

It should be noted that in the revenue calculations, passengers are allocated to the line that they first board after paying their fares. Thus, a passenger starting on the Green Line and transferring to a heavy rail line would be counted only as a Green Line passenger. A passenger making the same trip in the opposite direction would be counted only as a heavy rail passenger.

BUS AND TRACKLESS TROLLEY

Method Used to Select Sampling Times and Locations

All fare collection on MBTA bus and trackless trolley routes currently takes place on board vehicles. For the 2002 and 2005 fare-mix samples, lists were created of all

scheduled trips on all bus and trackless trolley routes. A computer program then selected a specified number of trips on which fare-mix samples were to be conducted.

MBTA bus routes have a much greater variety of fares than the heavy rail and Green Line system. Basic-fare routes account for the largest share of routes in the MBTA system. On these routes, the adult full cash fare in 2005 was 90 cents. Extra-fare routes include both zone-fare routes on which the fare depends on the distance traveled, and express routes on which the fare is higher than that of basic-fare routes but is the same regardless of distance on an individual route. Express routes do not all have the same full fare, however.

In part because of the difficulty of obtaining revenue information for specific routes, no attempt is made to calculate fare-mixes separately for routes with each of the different fare structures. Separate fare-mixes for basic-fare routes and for extra-fare routes were, however, calculated as an intermediate step in the calculation of the 2002 and 2005 bus system fare-mixes.

The four trackless trolley routes operated by the MBTA currently have the same fares as basic-fare bus routes. Trackless trolley fare-mixes were calculated separately from bus routes for both weekdays and Saturdays. (Trackless trolleys do not run on Sundays.) For final reporting purposes, a combined trackless trolley and bus fare-mix was calculated.

Data Collected In Each Sample

The fare-mix recording method and the information obtained on bus and trackless trolley routes were similar to those used on the surface Green Line, except that only one checker was assigned to each sample trip before 2005 as well as that year. Farebox readings were taken at the beginning and end of each trip, with dollar-bill deposits being recorded separately. Boarding passengers were recorded in the same four categories used on the B, C, and E lines. Adult fares were subdivided into Cash, Monthly Pass, Weekly Pass and Visitors Pass. Senior Citizen and Disability fares were subdivided into Cash and Pass, as were Child and Student fares. Free riders were subdivided into Non-authorized and Authorized. Two additional categories were provided for bus and trackless trolley passengers. These were transfers (from other bus or heavy rail) and short fares. The latter were indicated if the farebox showed that a passenger had deposited less than the correct applicable fare, however, as discussed below, overpaid fares outweighed short fares in 2005.

No provision was made for recording deposits of tokens. These are not registered by fareboxes. It is disadvantageous for passengers on basic-fare bus or trackless trolley routes to use tokens, because the full fare is only 90 cents and the token value is $1.25. Revenue reports, from both 2005 and 2002 indicated that tokens deposited in bus or trackless trolley fareboxes account for about 2% of all revenue received on those routes. Some checkers who saw tokens being deposited recorded them along with dollar bills but not all did so. If tokens were not recorded, the average cash fare would be understated.

Steps Used in Processing Sample Results

Reasonableness Checks on Revenue Results

For each trip record, total revenue received was calculated as the sum of the difference between the beginning and ending farebox readings, plus the number of dollar bills and the value of the number of tokens deposited, if shown. On basic-fare bus routes, expected total revenue was then calculated by multiplying the number of passengers in each cash or token fare category by the amount that should have been deposited if the correct fare was paid. On zoned-fare bus routes, insufficient information was collected to show how far each passenger traveled. Results were assumed to be plausible if actual revenue was between the value that would have been obtained if each passenger had paid the applicable one-zone fare and the amount that would have been obtained if each passenger had paid to travel the full length of the route.

On basic-fare routes each dollar bill received was assumed to represent one overpaid fare. Overpayment was much more common in 2005, when the full fare was 90 cents, than it had been in 2002, when the fare was 75 cents. In calculating the expected revenue for each trip in 2005, it was necessary to first subtract the number of dollar bills received from the reported number of adult cash fare passengers before determining whether the revenue reported for the rest of the passengers was reasonable.

On a basic-fare route record, if there was a discrepancy between actual and expected revenue, the next step was to compare the information on the original data sheet with the database record and correct data entry errors. As on the surface Green Line, if the amount of the error remaining after this was equal to the difference between fares in two different categories or to a multiple of this difference it was assumed that the checker had mis-classified one or more passengers, and the results were adjusted accordingly. For example, if the total actual revenue exceeded the expected revenue by 65 cents, it was assumed that one passenger recorded as having paid a 25-cent reduced fare had actually paid a full 90-cent fare. Smaller overpayments were attributed to passengers having paid $1.00 in coins instead of 90 cents. (In the 1996 fare-mix study, if the ratio of recorded to expected revenue was below 80% or above 110%, the difference was attributed instead to incorrect farebox readings, and the revenue total was revised to match the expected figures more closely.)

Despite efforts to clarify the instructions in 2005, some checkers were still confused as to how to record passengers paying their fares with dollar bills. Since bills did not register on the fareboxes, they were supposed to be tallied in a space provided on the form. The passengers that paid with bills were also supposed to be counted in the applicable cash-fare category. Some checkers counted the bills but did not also count the passengers that deposited them, resulting in an excess of actual versus expected revenue. Such cases were corrected by increasing the number of full cash fare riders. At the other extreme, some checkers recorded the passengers but not the number of dollar bills. This was apparent if the total amount of revenue reported was much smaller than expected for the number of passengers indicated and the box for reporting bills was blank. In such cases a number of bills sufficient to cover the discrepancy was added to the reported total.

The maximum fare on basic-fare routes was 90 cents in 2005 and 75 cents in 2002, so no passenger overpaying the fare on such routes would have needed to deposit more than one dollar bill. On zoned-fare routes, some passengers paying fares of more than $1.00 use a combination of bills and coins and some pay with bills only. In general, it appears that passengers that pay with bills plus coins have been recorded in the correct fare categories, but that passengers that pay entirely with bills may not have been included in any fare category by some checkers. Passengers were much less likely to have overpaid the 2005 express bus fares of $2.20, $3.10 or $3.45 than the 2002 fares of $1.75, $2.50 or $2.75, both because they were already having to pay more for the correct fares alone, and because the absolute amount of each overpayment would have been larger.

Again, however, it was possible to adjust the fare-mix boarding totals by comparing them with the ridecheck boarding totals. In 2005, the maximum Senior, Disability, Child, and Student fares on express routes was $1.70, compared with $1.35 in 2002. A reduced-fare passenger could have used two one-dollar bills for either a $1.70 fare or a $1.35 fare, but this was probably unusual as these are often the most cost-conscious passengers. Therefore, all adjustments for discrepancies between fare-mix and ridecheck totals caused by dollar bill deposits were made in the Adult cash fares.

Weighting of Records

The present revenue collection and accounting system used on MBTA bus routes does not reveal total cash-fare collections at a level of detail finer than individual garages. All zoned-fare bus routes are operated from garages that also house buses for basic-fare routes, so it is impossible to obtain separate revenue totals for basic-fare and zoned-fare routes. Therefore, when estimating ridership from revenue it is necessary to use a composite average fare for all routes. In 2005 and 2002 in order to avoid over or under-representation of zoned fares in the composite, separate average fares were first calculated for all basic-fare route records combined and for all zoned-fare route records combined. Within each group, records from observations on each route were weighted such that the proportion of riders accounted for by each sampled route was the same as the ratio of total riders on that route to total riders on all of the sampled routes in the most recent available all-day ridechecks. The fare-mix results for basic-fare and extra-fare bus routes were then weighted in the same proportion as ridership on all such routes in the ridechecks, to calculate an overall bus fare-mix. Separate averages were calculated for weekdays, Saturdays, and Sundays.

Trackless trolley routes are all based at the North Cambridge carhouse, which does not serve any bus routes. Revenue totals for the North Cambridge carhouse are reported separately from bus revenue, so it is theoretically possible to estimate trackless trolley ridership alone by applying the average trackless trolley fare to the North Cambridge revenue. This revenue, may, however be understated. The May 2002 revenue reports for North Cambridge show no dollar bills. In contrast, for all bus garages combined, revenue reported from dollar bills was equivalent to 19% of that from coins. This suggests that some of the bill revenue credited to buses was actually collected on trackless trolleys. In May 2005, the ratio of bill value to coin value on buses had increased to 64%, because of overpayment of fares, and for trackless trolleys the reported ratio was almost as large, at 59%.

For some reporting purposes, it is necessary to calculate a combined average fare for bus and trackless trolley. Fare-mix data for trackless trolleys was collected simultaneously with ridechecks on that mode, and resulted in a much larger sampling rate than that on bus routes. To correct for this difference in calculations of combined average bus and trackless trolley fares, averages for each mode were weighted in proportion to all-day ridership in the most recent available ridechecks.

ALLOCATION OF PASS REVENUE - CORE SYSTEM

About half of all MBTA core system fare revenue is collected through pre-paid pass sales rather than through farebox and turnstile deposits. Starting in 1996, MBTA fare-mix studies have included two measures to take pass use into account. These are true average fare and average pass ride value. The true average fare for each mode is calculated by allocating a portion of total pass sales revenue to that mode, adding this to the cash fare revenue for that mode within the same time interval, and dividing the result by the combined total cash-fare passengers and pass-users in this interval. Average pass ride value for each mode is equal to total pass revenue allocated to that mode divided by total pass-users on that mode in the same time interval.

Impact of Fare Increases on Pass Revenue Allocation Between Modes

In the 1996 study, revenue from each form of pass was allocated among modes in the same proportion that revenue from pass-users would have been distributed if they had paid full cash fares for the same trips. For example, the 1996 price of a Combo pass was $46.00. A hypothetical passenger who used such a pass to make 40 trips on basic-fare subway lines and 30 trips on basic-fare bus routes would have had to pay $52.00 (40 x $0.85 = $34.00 + 30 x $0.60 = $18.00) to make the same trips paying full cash fares. Of this, 65.4% (34.00/52.00) would go to heavy rail and 34.6% to bus. Therefore using the allocation in the 1996 study, 65.4% of the $46.00 pass price, or $30.08, would be allocated to heavy rail and 34.6%, or $15.92 to bus.

For consistency, the 2002 and 2005 fare-mix studies also allocated pass revenue to modes in proportion to the cash fares that would have had to be paid for the same trips. Because the 2000 fare increase did not raise all fares equally, modes for which each pass was valid received different percentage increases in pass revenue under this method. For example, under the 2000 fare structure, the Combo pass price was $57.00. A hypothetical passenger who used such a pass to make 40 trips on basic-fare subway lines and 30 trips on basic-fare bus routes would have had to pay $62.50 (40 x 1.00 + 30 x $0.75) to make the same trips paying full cash fares. Of this, 64.0% (40.00/62.50) would go to heavy rail and 36.0% to bus. Therefore using the same allocation method as in the 1996 study, 64.0% of the $57.00 pass price, or $36.48, would be allocated to heavy rail and 36.0%, or $20.52 to bus. In 2005 the price of a Combo pass was $71.00, the basic bus fare was $0.90 and the basic rapid transit fare was $1.25. Using the same calculation methods, 64.9% of the pass price, or $46.10 would be allocated to heavy rail and 35.1%, or $24.90 to bus.

A Combo pass user would have paid 23.9% more for a pass after 2000 than in 1996. In the same span, the full cash fare for local bus routes increased by 25%, but that for

basic-fare subway stations increased by only 17.6%. In the examples above, the revenue from the Combo pass allocated to the bus system would have increased by 28.9% (from $15.92 to $20.52) but that allocated to the heavy rail system would have increased by only 21.3% (from $30.08 to $36.48). Between 2002 and 2005, the price of a Combo pass increased by 24.6%, but the allocation formula increased the share of the revenue allocated to heavy rail by 26.4% and the share allocated to bus by only 21.3%.

Application of Pass-User Survey Results for Pass Revenue Allocation

All pre-paid passes are valid for unlimited numbers of rides within a specified time period. All are valid on more than one travel mode, and some are valid on every mode. Therefore, pass sales revenue cannot be assigned to individual modes without additional information or assumptions. In 2002, the most recent detailed breakdown of pass use was that contained in a pass-user survey that was conducted in 1999. In that survey, a sample set of passengers purchasing each form of MBTA pass then available was asked to indicate the number of trips per day and per week for which they expected to use the pass on each MBTA mode. (Free transfers between lines within the subway were not to be counted.) The systemwide fare increase implemented in the fall of 2000 may have had some impact on the manner in which passes were used, but there was insufficient information available to determine this. Each form of pass was still valid for the same services for which it was valid in 1999, so it was assumed that those purchasing a given pass form in 2002 would do so for purposes similar to those for which the same pass form was purchased in 1999. Therefore, for purposes of calculating true average fares for the 2002 fare-mix study, it was generally assumed that the patterns found in 1999 still applied. Adjustments required by the establishment of free bus-to-bus transfers and implementation of new pass options after 1999 are discussed below.

For consistency with the cash-fare calculations, pass sales data from the MBTA Prepaid Pass Report for May 2002 were used in the 2002 study. Total sales revenue for each pass form was allocated to modes using distributions based on use rates in the 1999 survey weighted by 2002 cash fares. The survey results did not subdivide the Red Line and the Green Line by fare zone. For passes that could be used in more than one zone, an average cash fare equivalent was calculated based on the relative use of the same pass form in each zone in the 1994 passenger survey.

In conjunction with the 2005 fare-mix study a new pass-user survey was conducted. Compared with the 1999 survey results, all pass forms except the Local Bus pass showed increases in the average number of trips made per weekday and per week. Total sales of almost every pass form decreased in the same time span. It would be expected that those most likely to stop using passes would be those that found them least cost-effective. The advantage of using a pass increases with the frequency of use, so it is likely that, on average, those that stopped getting passes had used them less frequently than those that continued to get them.

Impact of Free Bus Transfers on Bus Pass-Use Rate

For passengers regularly making trips involving one or more bus-to-bus transfers in each direction, a Local Bus pass offered significant cost savings under the old fare

structure. Prior to fall 2000, the full cash fare on a local bus route was $0.60, and a local bus pass was priced at $20.00. Therefore, a passenger boarding 34 or more local buses during a month could save money by using a pass. For a passenger using only one bus in each direction per trip, this was equivalent to 17 or more round trips, but for a passenger using two buses each way, the break-even point was only 8.5 round trips. Under the fall 2000 fare structure, the full cash fare on local bus routes was raised to $0.75 and the local bus pass price was raised to $25.00. This maintained the same break-even point between cash fares and passes as before, but a free bus-to-bus transfer system was subsequently implemented. For passengers making trips involving two buses each way, a pass was no longer cost-effective if used for fewer than 17 round trips per month. This would be expected to result in a shift from passes to cash in the fare-mix. However, the 1999 survey results did not provide separate breakdowns of the average pass-use rates by transfer and non-transfer riders. A more detailed analysis of the probable impacts of diversions for passes to cash for transfer trips is included in the presentation of fare-mix results for bus and trackless trolley later in this chapter.

In using the 1999 pass-user survey results to allocate 2002 pass revenue to modes, an adjustment was made for the expected reduced use of passes for local bus trips. Based on the drop-off in Local Bus pass sales between 1999 and 2002, it was estimated that as a result of free transfer implementation, use of Local Bus passes on local buses would have dropped from the 2.98 per day and 14.72 per week found in 1999 to 1.75 per day and 9.84 per week in 2002. However, the 2005 pass-user survey results show that the decrease was much smaller. On local buses alone, use rates were found to be 2.58 per day and 13.01 per week. Adding the Silver Line Washington Street, which replaced local bus Route 49 in 2002 but retained the fare structure of that route, the use rates were 2.78 per day and 13.81 per week.

Allocation of Revenue from Other Pass Forms

Pass options introduced since 1999 or not covered in the pass-user surveys required different revenue allocation methods. Revenue totals for Senior/Transportation Access passes are included in the Prepaid Pass Report, but revenue from Student, Visitors, Weekly Combo, and Weekly Combo Plus passes is not. Weekly passes are sold only at selected heavy rail stations. Sales totals are included in the daily revenue reports from these stations. Visitors passes are sold at some visitors centers as well as at certain heavy rail stations. Daily sales reports from the stations provide a partial accounting of the revenue from these passes. Revenue from Visitor pass sales from non-MBTA sources is reported as a monthly total. Adding the amount reported for May 2005 to the station sales totals from the daily reports provided a grand-total figure for these passes.

Student passes are sold through schools, and revenue totals are not included in standard reports. The available figures for these passes showed only the total number of units issued rather than revenue or separate totals for 5-day and 6-day passes. However, observations of Student pass use on weekdays and on Saturdays in the fare-mix samples provided a means of estimating such a breakdown. This in turn allowed revenue to be calculated.

In the absence of survey data from Visitor and Student pass users, revenue from each of these was allocated among modes using data from fare-mix observations. The

2002 and 2005 fare-mix samples on all modes included separate counts of the numbers of passengers using each of these pass forms. After average farebox deposits (cash fares/all riders) were calculated from the observations for each mode, total ridership for weekdays, Saturdays, and Sundays was estimated by dividing non-pass revenue allocated to each mode by the average farebox deposit. The percentages of passengers observed using Visitor or Student passes were applied to estimated total ridership to calculate the number of pass trips made on each mode. Using a method similar to that described above for Monthly passes, the equivalent cash-fare values of Visitor and Student pass trips on each mode were calculated and totaled. The proportion of the combined total value of each pass form calculated for each mode was multiplied by the total sales revenue to determine the amount of the revenue to be allocated to that mode.

In the average fare tables in this chapter, "average adult pass ride value" includes only revenue from pass forms (excluding student and visitor passes) that were available in both 1996 and 2002. The measure "average all pass ride value" includes revenue from all pass forms available in each year, except that 1996 figures exclude visitor passes.

The 2005 pass-user survey effort included a special survey of weekly pass users. It was intended that samples be obtained both from Weekly Combo pass users and from Weekly Combo Plus pass users, but because of problems in survey distribution, responses were obtained only from Weekly Combo pass users. Using methods similar to those used with monthly passes, average weekly sales revenue for Weekly Combo passes was allocated to services on which these passes were used in proportion to the amount of fares that would have been collected if the pass-users had paid full cash fares instead. Weekly Combo Plus pass use on each service was estimated to occur in the same ratio to Weekly Combo pass use as the ratio of Monthly Combo Plus to Monthly Combo pass use on the same service. For example, the 2005 survey showed that on local buses the average use rate per weekday was 0.84 trips for Monthly Combo Plus passes and 1.41 for Monthly Combo passes, or a ratio of 0.596. For Weekly Combo passes the average use rate was 1.88, so the use rate for Weekly Combo Plus passes was estimated to be 1.88 x 0.596 = 1.12 trips per weekday.

Adjustments to 1996 Pass Ridership Figures

Comparisons of the 1996 fare-mix study results with surveys conducted when the same fares were in effect indicates that passes were significantly under-counted in the fare-mix study. This was the case on all modes, with the largest shortfalls reported on the heavy rail system. The final report on the 1996 study refers to all revenue figures as being from Spring 1996, but does not specify the month. The pass revenue per week shown for all modes combined agrees closely with April 1996 pass sales revenue figures pro-rated to one week, but the formulas used to allocate revenue from each pass form to each mode are not shown. If correct pass sales figures were used but ridership figures were too low, average pass revenue, true average fare, and average farebox deposit would all be overstated. If subsequent study results reflected pass use more accurately, comparisons with the 1996 results as published would understate the revenue gains from the 2000 and 2004 fare increases.

To allow for more valid comparisons, 1996 pass-use was re-estimated by applying the use-rates for each pass form obtained from the 1999 survey to pass sales figures

from April 1996. This resulted in increases in pass trips per week of 22% on bus and trackless trolley, 39% on the Green Line, and 77% on the heavy rail lines, compared with the figures in the published final report on the 1996 fare-mix study.

COMMUTER RAIL

The fare structure and the fare-collection system on the MBTA commuter rail lines differ significantly from those on the core system modes discussed above. Consequently, calculation of the commuter rail fare-mix requires separate methods from those applicable to any of the other modes. The data used in the 2002 calculations, the steps used in processing these data, and the results, are presented below.

Summary of Fare Structure and Payment Options

The commuter rail system has a zone-fare structure, with zone limits based approximately on rail distance from the Boston terminal stations. In 2005 there were 10 fare zones, numbered 1A, 1B, and 1 through 8, starting outward from Boston. Half of the routes did not extend as far as Zone 8, and station locations on some routes resulted in omission of some intermediate zones. Trips with one end either at one of the Boston terminal stations or at another station in Zone 1A or 1B, or trips made by transferring between two lines at one of these stations were classified as Through trips. All trips not fitting this definition were classified as Interzone trips. Separate fare structures applied for Through and Interzone trips. Prior to the 2004 fare increase, the outermost stations in Zone 8 of the Fitchburg, Worcester, and Attleboro lines were in a Zone 9.

Fare payment options for Through trips in 2005 were One-Way, 12-ride, Monthly Pass, Half-Fare, Half-Fare 10-Ride, and Family Fare. Weekly passes could also be used in Zone 1A or Zone 1B. Half-Fare and Half-Fare 10-ride options were available to passengers over age 65, passengers with disabilities who held MBTA Transportation Access Passes, and children between ages five and eleven or up to high school with student i.d. badges when schools were in session. All passengers not qualifying for Half-Fares had to use one of the other payment options.

Family Fare tickets in all zones were priced the same as four One-Way tickets. They were valid for one roundtrip on the day of purchase for a group of up to five people, including at least one but no more than two over the age of 18. The Half-Fare in each zone was half the One-Way fare rounded down to the nearest nickel. The price of a 12-ride ticket in each zone in 2005 was the same as the price of 12 one-way tickets. Prior to the 2004 fare increase, the 12-ride ticket price was equivalent to 11 One-Way fares. Half-Fare 10-ride tickets have always been priced the same as 10 Half-Fare tickets, and have been used for convenience rather than cost saving. The price of a monthly pass relative to other fares varies by zone. In 2005, monthly pass price ranged between the equivalent of 32.6 and 35.2 One-Way full fares in all zones, except that in Zone 1B the factor was only 22. The cost of a Weekly Combo pass was equivalent to that of 13.2 One-Way fares from Zone 1A or 8.3 from Zone 1B. For a Weekly Combo Plus pass the corresponding factors were 14.4 and 9.0.

For Interzone trips there were only four fare payment options in 2005: One-Way, Half-Fare, Monthly Pass, or Family Fare. Eligibility for Interzone Half-Fares was the same as that described above for Through Half-Fares. As in the case of Through fares, Family Fares were priced the same as four One-Way fares, and the same rules applied. For an Interzone trip, the applicable fare level was based on the total number of zones traveled in rather than the particular zone. Thus, for example, the same two-zone fare applied for a trip from Zone 2 to Zone 1 or a trip from Zone 8 to Zone 7.

Twelve-ride and Half-Fare 10-ride tickets were sold only at stations or ticket outlets. Monthly Passes could be purchased at stations or ticket outlets or by various other means offered under the MBTA pass program, such as through employers. One-Way, single-ride Half-Fare, and Family Fare tickets could be purchased either at stations or ticket outlets or on board trains. To encourage off-train ticket purchases there was a $2.00 surcharge during peak hours and a $1.00 surcharge during off-peak hours for on-board ticket purchases if there was a ticket office or outlet open at the boarding location. In practice, the surcharge was often waived, especially for Half-Fare passengers. (In a one-day weekday sample of conductors' receipts from on-board ticket sales, only 7% of trips starting at North Station and 19% of trips starting at South Station or Back Bay showed that surcharges were collected, although ticket offices were open at these stations except late at night.)

Interzone Full-Fare and Half-Fare tickets were sold only on board trains. These were the only fare forms not sold at off-train locations. Interzone passes were available at the same off-train locations where tickets were sold.

Information Sources Available for Fare-Mix Calculations

In-station fare-mix sampling methods cannot be used on the commuter rail system, because there is no off-train fare collection. On-board fare collection is done by conductors who move through the cars after each stop. There is usually one conductor for every two cars. Each passenger may either surrender a single-ride ticket purchased previously, purchase a ticket from a conductor, present a multiple-ride ticket to be punched, or show a pass. Theoretically, fare-mix samples could be obtained by having checkers follow conductors and observe the fares being collected, but this would be very labor-intensive and costly because of train lengths and route lengths.

Ticket Audit Reports

Several times each year, conductors are required to record information on designated days for Ticket Audits. This includes the number of passengers, by fare payment method, boarding every inbound train at each station. Each Audit week covers one weekday, one Saturday, and one Sunday. The results should theoretically yield similar information to that provided by on-vehicle fare-mix observations performed by CTPS. In the past, however, there have been significant inconsistencies between the fare-mixes indicated by the Audit reports and the mixes indicated by ticket and pass sales reports for the same months. Therefore, the Audit reports alone are inadequate for Fare-mix reports.

Revenue Ridership Reports

Each month, the contract operator of MBTA commuter rail service, currently Massachusetts Bay Commuter Railroad Company (MBCR) prepares a Revenue Ridership Report. These reports give detailed breakdowns of the number of commuter rail tickets and passes sold by sales location and the revenue derived from these sales. MBCR records pass sales figures only for locations that are staffed by MBCR personnel. These are North Station, South Station, and Back Bay. Passes sold at all other locations are supplied to vendors directly by the MBTA. Comparisons of the pass totals shown in the Revenue Ridership reports and in the MBTA Prepaid Pass reports for the same months show that MBCR is provided with only partial sales figures for non-MBCR locations. There are also some minor differences between pass sales totals for MBCR locations shown in the two reports. Since the MBTA has the ultimate responsibility for accounting for all pass revenue, pass sales figures from the Prepaid Pass reports were used in the 2002 and 2005 fare-mix calculations. For consistency with the rest of this study, revenue from passes was re-allocated between commuter rail and other modes on the basis of the patterns indicated in the 1999 or 2005 pass-user surveys.

On-Train Ticket Receipts

The monthly Revenue Ridership Reports include breakdowns of ticket sales by zone and ticket form for all off-train ticket sales. For on-train ticket sales, the number of tickets sold and revenue collected are shown for all North Side lines combined and for all South Side lines combined, but no details on sales by zone and form of fare are provided. In calculating total ridership, the reports treat each on-board ticket sale as representing one passenger trip. This understates ridership, because on-board sales include round trips, Family fares, or other sales to two or more passengers traveling together. Factors for distributing on-board sales by ticket type and zone were calculated for the 2002 fare-mix study, as described below, and were used again, with some modifications, in the 2005 study.

In both fiscal 2002 and fiscal 2005, revenue from on-board ticket sales accounted for 39% of all MBTA commuter rail non-pass fare revenue, so the potential impact on fare-mix calculations of disregarding multiple-ride on-board tickets was not insignificant. The only way to determine the number of trips represented by on-board tickets is to manually examine the ticket receipts for a sample weekday, Saturday, and Sunday. This also provides the only source of information on Interzone travel other than by pass-users.

For the 2002 fare-mix study, ticket receipts were obtained for one weekday, Saturday, and Sunday in July 2002. Information on boarding and alighting zones, number of passengers, fare category, and revenue collected for each receipt was entered in spreadsheets, with results kept separate for North Side and South Side tickets and for day of the week. In total, results were entered for 15,236 receipts.

Because of summer recreational travel, there was some concern that the fare-mix on the sampled tickets might be less representative than a sample from non-summer months would be. The use of July receipts was, however, necessary, because they were the only ones available when the CTPS request for them was answered, and the project schedule would not allow waiting for a fall sample.

For consistency with the calculations used for other modes, the fare-mix calculations for commuter rail were to be based on May 2002 revenue data. To check the validity of using the July on-board fare mix with the May data, the weekday, Saturday, and Sunday receipt totals for ticket sales and revenue were multiplied by the number of weekdays, Saturdays and Sundays in May. (Memorial Day was counted as a Sunday, because a Sunday schedule was operated.) The ticket sales projected by this method were 4.3% lower than the reported May total and the revenue projection was 4.0% lower. The projected average revenue per ticket was 0.3% higher than the reported average for May. Based on these findings, it was concluded that the fare-mix in the receipt sample was representative, but that the total was slightly below average because of seasonal variation. Therefore, the proportions of tickets for each distance and fare category found in the sample were used in the calculations, but the results were scaled up to the May sales figures.

For all lines combined, the receipt sample showed an average of 1.45 passenger trips per ticket on the weekday. On the Saturday, the average was 1.79, reflecting the higher proportion of recreational trips by people traveling together. On the Sunday, the average was 1.56. These ratios varied only slightly between the North Side and South Side systems.

The only previous examination of on-board ticket receipts by CTPS was done for a sample from October 1994. Compared with the average trips per ticket found in that sample, the 2002 averages showed increases of about 7% on a weekday and 5% on a Saturday, but a decrease of 19% on a Sunday. In the 2002 sample, Sunday sales accounted for about 5% of total weekly on-board sales, so variation in the Sunday average trip rate would have little impact on the overall weekly average. Under the assumption that the average number of trips per on-board ticket would have changed even less between 2002 and 2005 than between 1994 and 2002, the 2005 fare-mix study used the 2002 factors rather than examining a 2005 ticket sample.

Calculation Methods and Results - Commuter Rail Ticket Fares

The fare-mix studies required separate calculations to be made of weekday, weekend, and weekly ridership and revenue, with further breakdowns of fares by payment methods. As discussed above, the 2002 on-board ticket-receipt sample included results for one weekday, one Saturday, and one Sunday. These were kept separate in the databases, so the weekday and weekend splits were provided directly. The only adjustment needed was to factor the totals up to adjust for seasonal variation between July and May. The 2005 analysis used average monthly commuter rail data for fiscal year 2005 rather than data for a single month, but the 2002 analysis indicated that May was a representative month for that year.

Off-train ticket and pass sales results are reported only for entire months, so it was necessary to allocate these to weekdays and weekends. Ticket and pass sales volumes and revenues were both reported on a zone-by-zone basis, and were kept separated that way throughout the calculations.

One Way Full-Fare Tickets

In each fare zone, the maximum fares are those paid by passengers that use one-way tickets. The MBTA does not offer reduced-fare round-trip tickets, so a passenger paying for a round trip at the starting end is sold two separate one-way tickets. There is no advantage to buying a large quantity of one-way tickets in advance, so most can be presumed to be used on the day of purchase.

The fiscal 2005 Revenue Ridership Reports showed average monthly sales of 161,259 full-fare one-way tickets at all off-train sales locations combined. The only available source of information showing ridership by payment form separately for weekdays and weekends is Ticket Audit Reports. For purposes of analysis the fare-mix study used information from the May 2005 Audit. The Audit Reports do not distinguish between off-train and on-train ticket sales in the one-way ticket results. Interzone and Through fares are supposed to be reported separately, but the number of Interzone fares shown in the Audit was less than half the number projected from the July on-board ticket receipt sample. Comparisons with 2002 Audit figures showed similar discrepancies. Such large differences would be unlikely to result from normal variation, so it was assumed that much of the Interzone ridership on the Audit days had been included in Through fares. This made it necessary to work with combined sales figures for off-train, on-train, Through, and Interzone trips.

Based on the fare-mix and average rides per ticket found in the July receipt sample, on-train ticket sales in an average month in fiscal year 2005 included 227,397 full-fare one-way Through trips and 38,689 full-fare one-way Interzone trips. (Each on-board round-trip fare was counted as two one-way fares.) Off-train and on-train one-way Through and Interzone fares combined added up to a total of 427,344.

Multiplying the weekday, Saturday, and Sunday one-way tickets reported in the May 2005 Audit Report by twice the number of weekdays, Saturdays, and Sundays in fiscal 2005 and dividing by 12 to calculate two-way ridership in an average month resulted in a projected total of 822,575 rides in these categories, or 1.9 times as many as the number accounted for by ticket sales. Because the Audit was conducted in May but the ticket sales figures are for the entire fiscal year, it was possible that some of this discrepancy resulted from month-to-month differences in ridership. However, such variation could not explain a difference this large.

Using similar calculation methods, the 2002 fare-mix study found that a one-month projection of one-way ticket rides from a June 2002 Audit was also 1.9 times as great as the number of full-fare single-ride trips that could be accounted for by June ticket sales. This implies either that the Audit took place on a day with unusually heavy ridership, that there was very heavy fare evasion on non-audited days, or that the Audit figures were highly overstated.

Given the large discrepancies between the Audit projections and the ticket sales figures, Audit results cannot not be used to separate weekday and weekend ridership on single-ride full-fare tickets. Instead, for the 2002 and 2005 studies, the ratios of off-train to on-train full-fare one-way ride sales in each fare zone for one month were calculated. These ratios were then applied to the estimates of on-train weekday, Saturday, and Sunday sales derived from the 2002 ticket receipt sample. This method

required an assumption that the ratio of off-train to on-train sales was the same on weekdays as on weekends. The actual ratio was probably somewhat lower on weekends, because of the higher proportion of occasional riders unfamiliar with off-train sales locations. Also, some off-train sales locations have more limited hours on weekend days. Nevertheless, because of the greater number of weekdays and the higher average ridership compared with weekend days, errors in allocation of off-train sales between weekdays and weekend days would have very little impact on weekday results. For example, if 50% of the off-train tickets allocated to weekends by the method above were reallocated to weekdays, total weekday rides with this ticket form would increase by only 3.4%.

One Way Half-Fare Tickets

The method used for calculating weekday and weekend day ridership on half-fare one-way tickets was similar to that used for full fares. The fiscal 2005 Revenue Ridership Reports showed total sales of 24,095 half-fare one-way tickets at all sales locations combined in an average month. Based on the fare-mix and average rides per ticket found in the 2002 receipt sample, on-train ticket sales in an average month in fiscal 2005 included 18,971 half-fare one-way Through trips and 5,883 half-fare one-way Interzone trips. Off-train and on-train one-way Through and Interzone half-fares combined added up to a total of 48,950. Multiplying the weekday, Saturday, and Sunday one-way half-fare tickets reported in the May 2005 Audit Report by twice the number of weekdays, Saturdays, and Sundays in fiscal 2005 and dividing by 12 to calculate two-way ridership in an average month resulted in a projected total of 191,346 rides in these categories, or 3.9 times as many as the number accounted for by ticket sales. A similar calculation in the 2002 fare-mix study using 2002 data had found a ratio of 3.5 projected Audit tickets to ride sales. Therefore, it was concluded that the Audit figures in both years were highly overstated.

As in the case of full-fare rides, for the fare-mix studies half-fare rides were allocated to weekdays and to weekend days by applying the ratios of off-train fares to on-train fares in each fare zone. Half-fare passengers were found to be much more likely than full-fare passengers to purchase single-ride tickets before boarding. Overall, in 2005 off-train sales accounted for 38% of single-ride full fares, but for 49% of single-ride half-fares. In 2002 the ratios were 35% and 52%. These differences occurred partly because full-fare riders had more other options for off-train purchases, such as buying 12-ride tickets or monthly passes. Half-fare riders also had a choice of buying 10-ride tickets, but these did not provide any discount compared with 10 single rides.

As in the case of full-fare tickets, possible differences in the ratio of off-train to on-train sales on weekdays and weekend days would have little impact on the estimates of weekday ridership. For example, if 50% of the off-train tickets allocated to weekends by the method above were reallocated to weekdays, total weekday rides with this ticket form would increase by only 4.9%.

Twelve-Ride Tickets

A 12-ride ticket is not necessarily used up during the same month when it is purchased. Nevertheless, it would be expected that rides taken in any given month using tickets bought in a prior month would be offset by rides not taken until a later month using tickets bought in the given month. Under this assumption, the number of

rides taken in any month using 12-ride tickets would equal 12 times the number of tickets sold. Twelve-ride tickets are not sold on board trains. Most are sold at stations or suburban sales outlets near stations. A small number are sold through the pass-by-mail program.

The fiscal 2005 Revenue Ridership Reports showed average monthly total sales of 21,009 twelve-ride tickets at all sales locations combined. These would have been valid for a total of 252,113 trips. Multiplying the weekday, Saturday, and Sunday 12-ride ticket trips reported in the May 2005 Audit Report by twice the number of weekdays, Saturdays, and Sundays in fiscal 2005 and dividing by 12 to calculate two-way ridership in an average month resulted in a projected total of 669,049 rides in these categories, or 2.7 times as many as the number accounted for by ticket sales. Calculations using a similar method with June 2002 ticket sales and Audit figures resulted in a ratio of 2.5. For such large ratios to have occurred through deferred rides, the number of passengers using 12-ride tickets purchased before the Audit months would have had to greatly exceed the number using tickets purchased in the same month. Comparisons of 12-ride ticket sales figures from throughout fiscal 2005 with those from May 2005 show only slight month-to-month variations, so it is unlikely that the number of tickets used in May but bought in previous months greatly exceeded the number bought in May but used in later months.

Unlike the single-ride ticket figures, the 12-ride ticket sales have no on-train results to use as a guide in separating weekday and weekend ridership. In the expanded Audit figures, weekday ridership accounted for 97% of all 12-ride ticket use, so the largest share of the discrepancy with sales results had to have occurred in the weekday reports. In the fare-mix calculations, Saturday and Sunday trips with 12-ride tickets were based directly on the expanded Audit figures, and the entire discrepancy was deducted from the weekday Audit results. If the discrepancy had been attributed to the weekday and weekend results in proportion to their Audit totals, weekday 12-ride ticket trips would have increased by about 5%.

Ten-Ride Tickets

Ten-ride tickets are much less common than 12-ride tickets, because a smaller proportion of riders is eligible to use 10-ride tickets. Ten-ride tickets offer no discount compared with single rides, but until the 2004 fare increase 12-ride tickets did offer a discount. The method used to split use of 10-ride tickets between weekdays and weekend days was similar to that discussed above for 12-ride tickets.

The fiscal 2005 Revenue Ridership Reports showed average monthly total sales of 2,589 ten-ride tickets at all sales locations combined. These would have been valid for a total of 25,890 trips. Multiplying the weekday, Saturday, and Sunday 10-ride ticket trips reported in the May 2005 Audit Report by twice the number of weekdays, Saturdays, and Sundays in fiscal 2005 and dividing by 12 to calculate two-way ridership in an average month resulted in a projected total of 127,165 rides in these categories, or 4.9 times as many as the number accounted for by ticket sales. Calculations using a similar method with June 2002 ticket sales and Audit figures resulted in a ratio of 2.5. Comparisons of 10-ride ticket sales figures from throughout fiscal 2005 with those from May 2005 show only slight month-to-month variations, so it is unlikely that the number

of tickets used in May but bought in previous months greatly exceeded the number bought in May but used in later months.

In the expanded Audit figures, weekday ridership accounted for 97% of all 10-ride ticket use, so the largest share of the discrepancy with sales results had to have occurred in the weekday reports. In the fare-mix calculations, Saturday and Sunday trips with 10-ride tickets were based directly on the expanded Audit figures, and the entire discrepancy was deducted from the weekday Audit results. If the discrepancy had been attributed to the weekday and weekend results in proportion to their Audit totals, weekday 10-ride ticket trips would have increased by 15%. Proportionally this is a much greater potential error than identified in the allocation methods for single-ride and 12-ride tickets. In absolute terms, however, it would make a difference of only 77 riders each way per weekday.

Family Fare Tickets

Family Fare tickets account for a very small share of all trips on the commuter rail system. They are valid only on the day of purchase, so any sales reported during a given month represent rides taken during the same month. Each Family Fare ticket can be used for a round trip by up to five people, including at least one but not more than two passengers over the age of 18. Each Family Fare ticket is priced the same as two full-fare round trips, so the Family Fare offers no cost advantage for two adults unless traveling with at least one passenger under age 18, or for one adult unless traveling with more than two passengers under age 18.

The fare-mix results from the July 2002 ticket receipt sample, applied to the fiscal year 2005 off-train ticket sales totals, indicate that about six times as many Family Fares were sold on board trains as at stations or ticket agencies in an average month. Specifically, 4,553 tickets were sold on-board, in an average month, compared with only 734 off-train. The on-train tickets include a box to indicate the number of passengers traveling on a Family Fare ticket. The majority in the receipt sample did include this information, but some did not. When the results were processed, if the number of passengers was missing it was filled in assigning 3 or 4 passengers on alternate records being edited. (This was because 3 and 4 were the numbers most commonly shown on receipts that had been completed properly.) In the final totals, the average number of riders per ticket was 3.9. The number of passenger trips sold with each Family Fare ticket is twice the number of passengers traveling, since these are round-trip tickets.

In the Revenue Ridership Reports, the numbers of passengers traveling on Family Fare tickets sold at agencies are not shown. Numbers are shown for tickets sold at stations, but they appear to be based on standard factors rather than actual records. For the fare-mix calculations, it was assumed that the average number of passenger trips for each Family Fare ticket sold off-train was the same as the average for on-train tickets sold in the same fare zone. Almost all of the on-train Family Fare ticket sales were for Through trips to Boston. Most Family Fare trips would not be repeated on a regular basis. Because the number of Interzone Family Fare trips found in the receipt sample was very small, it was concluded that it would be unreasonable to apply separate expansion factors to these trips. Therefore, these totals were combined with Through Family Fares in the results. Off-train and on-train sales combined resulted in an

estimated total of 41,714 rides sold on Family Fare tickets in an average month in fiscal 2005.

In the Audit Reports, the number of Family Fare passengers reported is the same as the number of tickets shown, rather than the average of about 3.9 inbound riders that would be expected. Multiplying the weekday, Saturday, and Sunday Family Fare tickets reported in the May 2005 Audit Report by twice the number of weekdays, Saturdays, and Sundays in fiscal 2005, weighting each ticket by 3.9 passengers, and dividing by 12 to calculate two-way ridership in an average month, resulted in a projected total of 46,229 rides in these categories, or 10.8% more than the number accounted for by ticket sales.

Because the majority of Family Fare tickets were sold on-board, and the receipt samples provided a breakdown by weekday, Saturday and Sunday, it was concluded that off-train sales could be allocated between weekdays and weekend days in the same proportion as on-train sales. Because of the greater number of weekdays and the higher average ridership compared with weekend days, errors in allocation of off-train sales between weekdays and weekend days would have very little impact on weekday results. For example, if 50% of the off-train tickets allocated to weekends by the method above were reallocated to weekdays, total weekday Family Fare rides would increase by only 3.3%.

Calculation Methods and Results - Commuter Rail Monthly Passes

Pass Options

Monthly Pass Ridership is more difficult to calculate than ticket ridership, because passes are valid for unlimited numbers of rides, and for travel on several modes. It is necessary to rely in part on survey data to estimate pass use on commuter rail as well as on other modes. At present, passengers purchasing passes for Zone 3 or above can be presumed to be doing so primarily for use on commuter rail, because no other MBTA mode would require this high a pass level. (The South Shore Commuter Boat pass is priced the same as the Zone 8 pass, but the latter is not valid on the boat.) In the past, one MBTA bus route required a Zone 3 pass for passengers traveling its entire length, but the number that did so was so low that Zone 3 passes could all be allocated to commuter rail.

Several MBTA express bus routes require Zone 2 or Zone 1 passes. Some of the passengers who ride such routes can alternate between them or parallel commuter rail lines, but many would use their passes only on the buses. There are no passes designated specifically for commuter rail Zone 1B or 1A. The minimum pass required for either of these is the Subway pass, but any higher-level pass is also valid for trips in these zones.

Commuter rail passengers with Zone 2 or higher passes can use them for free transfers to all other MBTA modes (except South Shore commuter boats). Zone 1 passes allow free transfers except to bus routes requiring Zone 2 fares, and can be used to ride the latter if an additional 20 cents is paid in cash.

Passengers using Subway passes for Zone 1A or 1B commuter rail trips can also transfer to segments of the rapid transit system or the Green Line within the basic fare zone, but higher level passes are required for transfers to other services.

Information Sources and Allocation Formulas

Commuter Rail passes can be obtained in a variety of ways. The most complete source of information on the number of active passes each month is the Prepaid Pass Report prepared by the MBTA. The MBCR Revenue Ridership Report has incomplete information on passes. The methods used to allocate passes to commuter rail in these reports and the sources through which passes are available are described below.

Employer Pass Program

The most common way of obtaining passes is through the employer pass program. This accounts for nearly two thirds of all commuter rail passes sold. These passes are distributed to employers directly by the MBTA. The number of active passes from this program each month for each Zone from 3 through 8 is reported to MBCR by the MBTA, and is included in the Revenue Ridership Report. Separate totals are shown for the North Side and South Side systems. This split is based on factors derived from off-train ticket revenue rather than on information on actual pass use by line.

The Prepaid Pass Report allocates 70% of the Zone 1 and Zone 2 employer passes to commuter rail, but the Revenue Ridership Reports omit any entries for these passes for these zones. The results of the 2005 pass-user survey indicate that that about 53% of the weekly uses of Zone 1 and Zone 2 passes are on commuter rail lines. However, because the equivalent cash fares are higher on the commuter rail trips than on the other trips that the passes are used for, the formulas in the pass-user survey allocate 73% of the revenue from these passes to the commuter rail system.

No Subway, Combo, or Combo Plus passes distributed through the employer pass program are allocated to commuter rail either in the Prepaid Pass Report or in the Revenue Ridership Report. This is reasonable, as the 2005 survey found that less than 1% of the weekly uses and less than 2% of the equivalent weekly cash-fare value of any of these three passes obtained through the employer pass program were on commuter rail.

Commuter Rail Stations

The second-most-common way of obtaining commuter rail passes is to buy them at stations. In Boston, passes are sold at North Station, South Station, and Back Bay. At present MBCR employs no ticket agents at outlying stations. Passes sold by concessionaires at stations are accounted for in a separate category. Pass sales by zone for each downtown Boston station are shown separately in the Revenue Ridership reports.

Subway, Combo, and Combo Plus passes are sold at North Station, South Station, and Back Bay, but sales greatly exceed the number likely to be used on commuter rail. None of these are allocated to commuter rail in either report.

Private Agents

The third-most-common way of obtaining commuter rail passes for Zones 3 and above is from private agents. This includes businesses such as newsstands, coffee shops, and convenience stores located in or near many of the stations outside downtown Boston. These agents also sell tickets. There are also some agents in Zones 1 and 2, but they account for a smaller share of sales in those zones. Passes sold by agents are distributed directly by the MBTA, with the totals being reported to MBCR. In the Revenue Ridership reports, sales by zone are shown separately for North Side and South Side Lines, but not for individual agents. Agent totals by zone are also shown in the Prepaid Pass reports.

Internet, Phone and Mail Sales

The fourth-most- common way of obtaining commuter rail passes for Zones 3 and above in 2005 was by internet, telephone, or mail. These passes were distributed directly by the MBTA, with the totals being reported to MBCR. They are shown in a separate line in the North Side Revenue Ridership summaries, although the passes are probably not all used on North Side Lines.

Retail Sales

The fifth-most-common way of obtaining commuter rail passes for Zones 3 and above in 2005 was from MBTA retail sales, or commission sales. These are pass sales outlets that are not in the vicinity of commuter rail stations and that do not also sell tickets. Revenue Ridership reports do not include retail or commission sales in any zone. The Prepaid Pass reports allocate all retail sales for Zones 3 and above, but none for lower pass levels, to commuter rail. In September 2005, there were 487 sales of passes for Zones 3 and above at MBTA-operated retail outlets, and another 126 at commission sales locations.

Other

Several additional methods are possible for obtaining passes directly from the MBTA, but each of them accounts for relatively small number of sales. These include the semester pass program for college students, and the annual pass program. These accounted for 425 and 132 sales of Zone 3 or higher passes in September 2005.

Starting in 2005, at stations with Automated Fare Collection (AFC) equipment it was possible to purchase monthly passes from vending machines. MBTA accounting procedures were initially unable to separate revenue from such pass sales from that of other transactions at these machines. However, the pass-sales data used in the 2005 fare-mix study pre-dated AFC machine installation.

Calculation of Pass Use Rates

The Revenue Ridership reports estimate monthly pass trips by applying a factor of 42 to each of the reported pass sales. As discussed above, a significant number of active passes used on commuter rail are omitted from these reports. The factor of 42 has been used for many years. It appears to be based on doubling the average number of days per month on which weekday service is operated, assuming that each pass holder makes one round trip per weekday. This does not take into account variation in the number of weekdays per month. Over the course of a year, it slightly understates the average number of days per month (21.3) on which weekday service is operated.

Application of a weekday factor does not allow for any pass use on Saturdays and Sundays, but this is partly offset by the fact that some pass users travel on fewer than five weekdays.

For consistency with the fare-mix calculations for other modes in the 2002 and 2005 fare-mix studies, pass-use rates for commuter rail were derived, respectively, from the 1999 and 2005 pass-user surveys. In those surveys, respondents purchasing each form of monthly pass were asked how many times they would use it on each of several listed services, including commuter rail, on one weekday. Assuming that the samples were representative of pass-use rates in 2002 and 2005, the average number of commuter rail trips per day or per week made with each pass form in a given month can be estimated by multiplying the use rate by the number of active passes in that month. For the 2002 study, the active pass totals used were those from the Prepaid Pass Report for May 2002. For the 2005 study, the active pass totals used were monthly averages from the Prepaid Pass reports for all of fiscal year 2005. All passes were included regardless of how they were allocated by mode in those reports, since they were to be re-allocated on the basis of the survey data.

As would be expected, the average reported weekday use rates for Zone 3 and above passes were all close to 2.0, although slightly lower in 2005 than in 1999. Most commuter rail routes are too long for passengers to make more than one round trip in a day, but most passengers who use the service often enough to justify pass purchases use it in both directions. Estimated weekday trips using each of these pass forms were added to the ticket-trip totals for the same zones. For Zone 1 and Zone 2 passes, the reported average weekday use rates on commuter rail were somewhat lower, at 1.9 and 1.7 in 2005. This reflected the fact that some of these passes were purchased primarily or exclusively for use on express buses. As with Zone 3 and above passes, estimated weekday trips using Zone 1 and 2 passes were added to the ticket-trip totals for the same zones.

Estimation of pass use in Zone 1A and 1B was slightly more complicated. Passengers reporting use of Subway, Combo, Combo Plus, or Boat passes on commuter rail could have been boarding in either Zone 1A or 1B. As would be expected, average use rates on commuter rail for all of these passes were very low, because most of them were purchased primarily or exclusively for use on other modes. After commuter rail trips for each of these pass forms were calculated, the results were added together. They were then divided between Zone 1A and Zone 1B in the same proportion as indicated for passes in these zones in the June 2002 ticket Audit. This initially resulted in much higher ridership totals for these zones than could be explained by available passenger counts. The commuter rail use rates for these passes were expanded from much smaller samples than those for higher fare zones, so there was more chance of errors. To compensate for this, the original estimates were reduced by half.

Interzone pass sales are not included in the Prepaid Pass Report, but are included in the Revenue Ridership Report separately from through passes. Use of Interzone passes is fairly uncommon, because overall interzone ridership is low and many interzone trips are not repeated often enough to justify buying a pass. In May 2002, a total of only 79 Interzone passes were sold. In the weekday ridership calculations it was assumed that each Interzone pass was used for an average of one round trip per day.

The 1999 and 2005 pass-user surveys also asked respondents how many times they would use their passes on each mode during an entire seven-day week. This provided a second means of estimating monthly pass trips, in addition to the weekday use factors. In the final memorandum on the 1999 survey, monthly rates were estimated from the weekly use rates using a factor of 4.35 for the number of weeks in an average month. Estimates of monthly use rates based on the weekday use responses required additional assumptions about weekend use. For Core System passes (Local Bus, Subway, Combo, and Combo Plus) weekend use rates were assumed to equal 30% of weekday rates. For Zone 1 passes, the assumed weekend use rates were 15% of the weekday rates, and for Zone 2 or higher passes it was assumed there would be 5% as many pass trips on a weekend days as on a weekday. These rates were said to have been based on the results of the Systemwide Passenger Survey, but further details were not provided. For reasons discussed below, the 2002 and 2005 fare-mix studies assumed somewhat higher rates. Because passes can be used for unlimited numbers of trips, assumptions about weekend use rates do not affect weekday figures.

Past surveys of commuter rail riders have indicated very low weekend ridership by weekday passengers. In the 1993 survey, only 3.3% of pass users reported usually riding six days a week, and only 0.6% reported usually riding seven days a week. These figures indicate an average use rate of about 2% on each weekend day. This would have understated weekend riding, as it would not have counted occasional weekend trips by pass users. The survey did not ask which days in the week passengers rode. For some, the usual pattern could have been one or two weekend days in combination with three or four weekdays, keeping their totals to five days or less.

The 1998 Old Colony commuter rail survey included specific questions about weekend riding. Among pass users, only 2.3% reported riding regularly on Saturday. Another 54.3% reported occasional Saturday riding, but there was no indication of how often this meant. The other 43% said they never used Saturday service. Sunday ridership was even lower, with 1.4% of pass users riding regularly, 48.4% occasionally, and 50.2% not at all. If it is assumed that occasional Saturday riders made one Saturday trip every four weeks and that occasional Sunday riders made one Sunday trip every eight weeks, this would result in average pass use rates of 15.8% on Saturdays and 7.5% on Sundays.

With these factors, estimated pass trips on commuter rail for the entire month of May 2002 would total 1,738,784. Pass use projected from the June Audit would have been only 1,389,406, or 20% less than this. The calculation method based on the 1999 survey factors has an underlying assumption that the one-day weekday pass use rate reported by each survey respondent would not vary from day to day. In contrast, the 1993 commuter rail survey found that 7% of pass users rode fewer than five days a week. The survey distribution method resulted in almost all respondents being surveyed on days when they made at least one pass trip. For a passenger that usually rode fewer than five days a week, the use rate could have been 2.0 on the survey day but zero on another weekday. Ridership counts typically show more passengers on mid-week days than on Mondays or Fridays. The 1999 method is therefore better at predicting mid-week ridership than weekly or monthly totals.

2005 FARE-MIX RESULTS AND COMPARISONS WITH 2002 AND 1996 – CORE SYSTEM

Heavy Rail and Central Subway

Table 5-1 shows the percentage distributions of passengers by fare-payment method on the heavy rail (Red, Orange, and Blue) lines and the Central Subway as calculated from the 2005 and 2002 fare-mix study results and from the corrected 1996 results. In all three years, monthly passes were the most common method of fare payment. The monthly pass shares on both heavy rail and Central Subway declined slightly between 1996 and 2002, but the decreases were almost the same as the proportion of weekly passes used in 2002. (Weekly passes were introduced after the 2000 fare increase.) Between 2002 and 2005, there was a further decline in heavy rail monthly pass use, only partly offset by weekly pass increases, but Central Subway pass use increased to an even higher share than that found in 1996. The 2005 pass-user surveys showed increased mean use rates of almost every pass form on the Green line, but the reason for this was not determined.

Adult cash fares, the second-most-common fare payment method on the heavy rail lines and the Central Subway in all three years, also accounted for smaller shares in 2002 than in 1996, with most of the smaller categories showing gains. Between 2002 and 2005, the share for adult cash fares on the heavy rail lines returned almost to the 1996 level, with the gain almost equal to the decrease in the monthly pass share. On the Central Subway, the share for adult cash fares dropped further between 2002 and 2005, with most of the loss represented by shifts to monthly pass use.

All Central Subway stations and all but three heavy rail line stations are in the basic fare zone (one-token for entry and no exit fare). Therefore, average fares would be expected to be influenced most strongly by basic fares. The 2000 fare increase raised the full cash fare at basic-fare stations by 17.6% from $0.85 to $1.00. The 2004 fare increase raised the basic fare by an additional 25.0%, to $1.25, or 47.1% above the 1996 fare. In 2000, the price of a Subway pass, the most commonly used pass form at the basic-fare stations, increased by 29.6%, from $27.00 to $35.00. In 2004, the price was raised by an additional 25.7%, to $44.00, or 62.9% above the 1996 price. In 2000, the price of a Combo pass, the second-most-common form, increased by only 23.9%, from $46.00 to $57.00. In 2004, the price was raised by an additional 24.5%, to $71.00, or 54.3% above the 1996 price. For reasons discussed earlier in this chapter, the formulas used to allocate pass revenue by mode assigned a greater proportional share of the 2002 increase in Combo pass revenue to bus than to Heavy Rail or Central Subway, but the opposite occurred with the 2004 increase.

Table 5-2 shows the average farebox deposit, true average fare, and average pass-ride value for the heavy rail lines and the Central Subway in 1996, 2002, and 2005. The average farebox deposit is calculated by dividing total cash fares by total station entries, regardless of method of fare payment. Decreases in the proportion of cash-fare riders relative to pass, transfer, and free riders reduce the average farebox deposit, while increases in the proportion of cash-fare riders have the opposite effect. Increases in the proportion of reduced cash fares versus full cash fares also reduce the average farebox deposit.

Table 5-1
Heavy Rail and Green Line Central Subway Fare Category Proportions in Percentages
2005 versus 2002 and 1996

	Adult Cash	Monthly Pass	Weekly Pass	Visitor Pass	Senior/ Disability Cash	Senior/ Disability Pass	Child/ Student Cash	Student Pass	Warrant/ Coupon	Author-ized Free	Unauthor-ized Free	Paper Trans.
Week												
Heavy Rail (Red, Orange and Blue Lines)												
2005	36.0	48.3	4.5	0.6	2.8	1.6	1.1	3.4	0.1	1.3	0.2	0.1
2002	32.7	53.7	3.8	0.2	4.0	0.5	1.3	2.1	0.1	1.4	0.4	
1996 adj.	37.3	56.6	0.0		2.9	0.0	1.0	1.4	0.0	0.8	0.0	
Central Subway												
2005	33.9	54.1	3.2	1.4	2.2	1.3	0.6	1.7	0.0	0.9	0.1	0.5
2002	40.1	47.6	2.9	0.9	4.4	0.5	1.1	1.4	0.0	0.9	0.3	
1996 adj.	47.3	49.3	na		1.5	na	0.8	0.2		1.0	0.0	
Heavy Rail & Central Subway												
2005	35.6	49.4	4.2	0.8	2.7	1.6	1.0	3.1	0.1	1.2	0.2	0.1
2002	34.1	52.5	3.6	0.4	4.1	0.5	1.2	1.9	0.1	1.3	0.3	
1996 adj.	39.2	55.2	na		2.7	na	0.9	1.2		0.8	0.0	
Weekday												
Heavy Rail (Red, Orange and Blue Lines)												
2005	34.5	50.2	4.3	0.5	2.7	1.5	1.1	3.9	0.1	1.0	0.2	0.1
2002	30.1	57.0	3.6	0.1	3.8	0.5	1.3	2.4	0.1	0.8	0.3	
1996 adj.	35.3	59.2	0.0	0.0	2.5	0.0	0.9	1.6	0.0	0.6	0.0	
Central Subway												
2005	30.9	56.9	3.4	1.4	2.2	1.2	0.5	2.1	0.0	0.7	0.1	0.5
2002	36.6	51.6	2.9	0.6	4.4	0.5	1.1	1.7	0.0	0.4	0.2	
1996 adj.	43.2	54.2	na		1.3	na	0.5	0.3		0.6	0.0	
Heavy Rail & Central Subway												
2005	33.8	51.4	4.1	0.7	2.6	1.5	1.0	3.5	0.1	1.0	0.2	0.1
2002	31.3	56.0	3.5	0.2	3.9	0.5	1.3	2.3	0.1	0.8	0.3	
1996 adj.	36.6	58.4	na		2.3	na	0.8	1.4		0.6	0.0	
Weekend												
Heavy Rail (Red, Orange and Blue Lines)												
2005	44.7	37.1	5.8	1.6	3.1	2.3	1.0	0.6	0.2	2.9	0.6	0.0
2002	48.7	33.2	4.7	0.8	5.2	0.5	0.9	0.1	0.0	4.8	0.9	
1996 adj.	51.9	37.8	0.0	0.0	6.3	0.0	2.2	0.1	0.0	1.8	0.0	
Central Subway												
2005	47.2	41.9	2.3	1.2	2.0	1.7	0.9	0.4	0.0	1.9	0.3	0.2
2002	54.2	31.6	2.9	2.1	4.3	0.6	1.0	0.0	0.0	2.8	0.5	
1996 adj.	57.0	35.9	na		2.3	na	1.8	0.0		3.0	0.0	
Heavy Rail & Central Subway												
2005	45.3	38.3	5.0	1.5	2.9	2.2	1.0	0.6	0.2	2.7	0.5	0.1
2002	50.1	32.8	4.2	1.1	5.0	0.5	0.9	0.1	0.0	4.3	0.8	
1996 adj.	53.6	37.2	na		4.9	na	2.1	0.1		2.2	0.0	

na=fare category was not offered in year indicated

Blank entry indicates fare category was not recorded separately in year indicated

Table 5-2
Heavy Rail and Green Line Central Subway
Average Fare in Dollars 2005 versus 2002 and 1996

	Average Farebox Deposit	True Average Fare	Avg. Adult Pass Ride Value	Avg. All Pass Ride Value	Avg. Cash Fare excl. Trans & Free	Avg. Cash Fare incl. Trans & Free
Week						
Heavy Rail (Red, Orange and Blue Lines)						
2005	$0.488	$0.931	$0.812	$0.758	$1.225	$1.175
2002	$0.361	$0.730	$0.635	$0.613	$0.949	$0.907
1996 adj.	$0.350	$0.640	$0.508	$0.501	$0.849	$0.834
Central Subway						
2005	$0.431	$0.922	$0.821	$0.794	$1.176	$1.128
2002	$0.416	$0.775	$0.693	$0.673	$0.914	$0.891
1996	$0.405	$0.675	$0.546	$0.545	$0.818	$0.802
Heavy Rail & Central Subway						
2005	$0.477	$0.929	$0.814	$0.765	$1.216	$1.167
2002	$0.371	$0.739	$0.645	$0.624	$0.941	$0.904
1996 adj.	$0.361	$0.647	$0.515	$0.508	$0.842	$0.826
Weekday						
Heavy Rail (Red, Orange and Blue Lines)						
2005	$0.468	$0.924	$0.812	$0.756	$1.221	$1.180
2002	$0.334	$0.724	$0.635	$0.614	$0.946	$0.917
1996 adj.	$0.333					
Central Subway						
2005	$0.393	$0.910	$0.821	$0.794	$1.170	$1.125
2002	$0.381	$0.768	$0.693	$0.674	$0.907	$0.893
1996 adj.	$0.356					
Heavy Rail & Central Subway						
2005	$0.454	$0.921	$0.814	$0.764	$1.212	$1.170
2002	$0.342	$0.732	$0.645	$0.624	$0.938	$0.912
1996 adj.	$0.337					
Weekend						
Heavy Rail (Red, Orange and Blue Lines)						
2005	$0.607	$0.972	$0.812	$0.768	$1.244	$1.156
2002	$0.527	$0.765	$0.635	$0.604	$0.961	$0.870
1996 adj.	$0.460					
Central Subway						
2005	$0.598	$0.976	$0.821	$0.797	$1.193	$1.138
2002	$0.556	$0.803	$0.693	$0.665	$0.934	$0.885
1996 adj.	$0.541					
Heavy Rail & Central Subway						
2005	$0.605	$0.973	$0.814	$0.775	$1.231	$1.152
2002	$0.535	$0.775	$0.649	$0.619	$0.953	$0.874
1996 adj.	$0.487					

Red, Orange, and Blue lines includes estimated shares of entries to these lines, but not transfers, at Central Subway stations

Average Farebox Deposit = cash fares÷total riders

True Average Fare includes pass revenue

Average Pass Ride Value = pass revenue÷pass riders

Average Adult Pass Ride Value = Adult Monthly pass revenue÷Adult Monthly pass riders

Results for 1996 other than average farebox deposit can be calculated only at weekly level from the data available

On the heavy rail lines, average farebox deposit increased by only 3.1%, from $0.350 to $0.361 between 1996 and 2002, but increased by another 35.1%, to $0.488 between 2002 and 2005. This made an overall gain of 39.4% from 1996, or somewhat less than the 47.1% increase in the basic fare. The average farebox deposit for the Central Subway increased only 2.7%, from $0.405 to $0.416 between 1996 and 2002, and increased by only 3.6%, to $0.431 between 2002 and 2005. This made an overall gain of 6.4% from 1996. In both 1996 and 2002, the average farebox deposit for the Central Subway had exceeded that for the heavy rail lines, even though they had the same basic fare, because the proportion of pass-users was lower for the Central Subway.

Between 1996 and 2002, the average cash fare (i.e. total cash-fare revenue/total cash-fare passengers) increased by 11.8% on heavy rail and 11.7% in the Central Subway, compared with the 17.6% increase in the full cash fare. Between 2002 and 2005, the average cash fare increased by another 29.1% on heavy rail and 28.7% in the Central Subway, compared with the 25.0% increase in the full cash fare. Compared with 1996, this made gains of 44.3% on the heavy rail lines and 43.7% in the Central Subway, versus the basic fare increase of 47.1%. Differences between increases in the average cash fare versus the full cash fare were attributable mainly to changes in the proportions of full-fare versus reduced-fare riders.

Between 1996 and 2002, the true average fare, which takes into account both cash fares and allocated pass revenue, increased by 14.1% on heavy rail and 14.8% in the Central Subway. This was also less than the increase in the full cash fare at basic-fare stations. Between 2002 and 2005, the true average fare increased by another 27.5% on heavy rail, but only 19.0% in the Central Subway. This made overall increases of 45.4% and 36.6% from 1996. The smaller increase for the Central Subway was a result of the shift toward use of passes, for which the average revenue contribution per trip is lower than the full cash fare.

Between 1996 and 2002, the average adult pass-ride value increased by 25.0% on heavy rail and 26.9% in the Central Subway. These increases were between the percentage increases in the price of the Subway pass and that of the Combo pass, as would be expected. This outcome was based in part on the assumption that the average number of trips per week with each pass form in both 1996 and 2002 was the same as was found in the 1999 pass-user survey. Between 2002 and 2005, the average adult pass-ride value increased by 27.9% on heavy rail, but only 18.5% in the Central Subway. These differences resulted from significant increases in the average number of trips per pass taken on the Green Line according to the 2005 survey compared with the 1999 survey. Some of this change probably occurred between 1999 and 2002, but no survey was taken that could confirm this.

Surface and Entire Green Line

Table 5-3 shows the percentage distributions of passengers by fare-payment method on the surface Green Line and the Central Subway as calculated from the 2005 and 2002 fare-mix study results and from the corrected 1996 results. In all three years, monthly passes were the most common method of fare payment. The monthly pass share on the surface lines increased slightly between 1996 and 2002, mostly because of a slight reduction in the adult cash fare share. Between 2002 and 2005 there was an even larger

Table 5-3
Surface, Subway, and Entire Green Line Fare Category Proportions in Percentages 2005 versus 2002 and 1996

	Adult Cash	Monthly Pass	Weekly Pass	Visitor Pass	Senior / Disability Cash	Senior / Disability Pass	Child / Student Cash	Student Pass	Newton Coupon	Author-ized Free	Unauthor-ized Free	Paper Trans.	10-ride Ticket
Week													
Surface													
2005	22.6	42.6	1.1	0.2	2.2	0.9	0.3	2.4	0.0	27.6	0.1	0.0	0.0
2002	31.3	35.9	1.3	0.4	3.9	0.5	1.0	0.5	0.1	24.7	0.4		0.1
1996 adj.	32.5	33.5	na		4.3	na	1.1	1.3	0.2	27.1			0.0
Central Subway													
2005	33.9	54.1	3.2	1.4	2.2	1.3	0.6	1.7	0.0	0.9	0.1	0.5	0.0
2002	40.1	47.6	2.9	0.9	4.4	0.5	1.1	1.4		0.9	0.3		
1996 adj.	47.3	49.3	na		1.5	na	0.8	0.2		1.0	0.0		
Entire Green													
2005	28.1	48.2	2.1	0.8	2.2	1.1	0.4	2.1	0.0	14.6	0.1	0.2	0.0
2002	36.1	42.2	2.2	0.7	4.1	0.5	1.0	1.0	0.0	11.7	0.3		0.0
1996 adj.	40.2	41.7	0.0		2.8	0.0	0.9	0.7	0.1	13.6	0.0		0.0
Weekday													
Surface													
2005	21.3	43.8	1.1	0.2	2.1	0.9	0.3	3.0	0.0	27.2	0.1	0.0	0.0
2002	29.9	37.4	1.4	0.4	3.8	0.4	1.0	0.6	0.1	24.6	0.3		0.1
1996 adj.	32.8	33.4	na		4.6	na	1.2	1.5	0.2	26.3			0.0
Central Subway													
2005	30.9	56.9	3.4	1.4	2.2	1.2	0.5	2.1	0.0	0.7	0.1	0.5	0.0
2002	36.6	51.6	2.9	0.6	4.4	0.5	1.1	1.7		0.4	0.2		
1996 adj.	43.2	54.2	na		1.3	na	0.5	0.3		0.6	0.0		
Entire Green													
2005	26.0	50.2	2.2	0.8	2.2	1.1	0.4	2.5	0.0	14.2	0.1	0.3	0.0
2002	33.6	45.2	2.2	0.5	4.1	0.5	1.0	1.2	0.0	11.3	0.3		0.0
1996 adj.	38.1	44.0	0.0		2.9	0.0	0.8	0.9	0.1	13.2	0.0		0.0
Weekend													
Surface													
2005	28.0	37.7	1.2	0.5	2.3	0.6	0.3	0.0	0.0	29.3	0.0	0.0	0.0
2002	37.1	29.4	0.9	0.5	4.6	0.6	1.2	0.0	0.1	25.1	0.6		0.0
1996 adj.	31.9	33.9	na		3.0	na	0.5	0.1	0.2	30.4			0.0
Central Subway													
2005	47.2	41.9	2.3	1.2	2.0	1.7	0.9	0.4	0.0	1.9	0.3	0.2	0.0
2002	54.2	31.6	2.9	2.1	4.3	0.6	1.0	0.0		2.8	0.5		
1996 adj.	57.0	35.9	na		2.3	na	1.8	0.0		3.0	0.0		
Entire Green													
2005	37.2	39.7	1.7	0.8	2.2	1.1	0.6	0.2	0.0	16.2	0.2	0.1	0.0
2002	45.9	30.5	1.9	1.3	4.5	0.6	1.1	0.0	0.0	13.6	0.6		0.0
1996 adj.	45.4	35.0	0.0		2.6	0.0	1.2	0.0	0.1	15.7	0.0		0.0

na=fare category was not offered in year indicated Blank entry indicates fare category was not recorded separately in year indicated

Surface includes inbound and outbound boardings at surface stops on B, C, D, and E Lines

Entire Green includes boardings at surface stops and at Central Subway stations, including estimated Green Line share of entries but not transfers at Park Street, Government Center, Haymarket, and North Station

shift from adult cash fares to monthly passes. (Patterns on the Central Subway are discussed along with heavy rail above.)

On surface segments of the Green Line, fares are collected only on inbound trains, (those going toward the subway) so all passengers boarding at outbound surface stops are classified as Authorized Free. The number of passengers boarding inbound at surface stops is, however, much larger than the number boarding outbound, because inbound boardings include both surface-only and surface-subway trips, but all outbound boardings are surface-only trips. A comparison of the Authorized Free total shown in the 1996 fare-mix study report with surface Green Line passenger counts conducted in 1995 indicated that the total in the fare-mix report was significantly overstated. Therefore, for purposes of comparison with the 2002 results, it was reduced.

The 2000 fare increase raised the full cash fare for inbound boardings at all surface stops on the B, C, and E branches of the Green Line by 17.6% from $0.85 to $1.00. The 2004 increase raised the full cash fare by an additional 25%, to $1.25. These were the same as the fares and fare increases at Central Subway stations in the same year. In 2000, the full fare at surface stops on the D Branch was raised by 25%. At inner-zone stations this was a change from $1.00 to $1.25. At outer-zone stations the change was from $2.00 to $2.50. In 2004 there were further increases of 20.0%, to $1.50 in the inner zone and to $3.00 in the outer zone.

The price of the Subway pass, which is the most commonly used pass form at surface Green Line stops (according to 1994 survey results) was raised by 29.6%. The price of the Combo pass, the second most commonly used pass form at surface Green Line stops, was raised by only 23.9%. In 2004 the prices of these passes increased by an additional 25.7% and 24.5%, respectively.

Table 5-4 shows the average farebox deposit, true average fare, and average pass-ride value for the Central Subway and Surface Green Line in 1996, 2002, and 2005. Results for the Central Subway are discussed above, with heavy rail. Between 1996 and 2002, average farebox deposit (total farebox revenue/total passengers) increased by 17.4%, from $0.347 to $0.407 at surface stops. However, between 2002 and 2005 the average farebox deposit dropped back to $0.341. This was a consequence of a shift from cash fares to monthly passes. Excluding, passes, transfers, and free riders, the average cash fare increased by 23.1% between 1996 and 2002, and by another 21.3% between 2002 and 2005. These results suggest that D Branch ridership increased more (or decreased less) than B, C, and E branch ridership between 1996 and 2002, with the opposite occurring between 2002 and 2005. However, these results could also be attributable to differences in the proportional representation of the branches in the various samples. The fare-mix data-collection methods and the MBTA's revenue accounting procedures do not allow very accurate estimates to be made of ridership on the individual Green Line branches.

Between 1996 and 2002, the true average fare, which takes into account both cash fares and allocated pass revenue, increased by 26.2% on the surface Green Line. This was slightly less than the increase of 26.7% in the average adult pass-ride value. Between 2002 and 2005, the true average fare increased by only 4.7%, while the average adult pass ride value increased by 15.8%. These changes resulted from a combination of

Table 5-4
Surface, Subway, and Entire Green Line
Average Fare in Dollars 2005 versus 2002 and 1996

	Average Farebox Deposit	True Average Fare	Avg. Adult Pass Ride Value	Avg. All Pass Ride Value	Avg. Cash Fare excl. Trans & Free	Avg. Cash Fare incl. Trans & Free
Week						
Surface						
2005	$0.341	$0.711	$0.821	$0.783	$1.360	$0.646
2002	$0.407	$0.679	$0.709	$0.704	$1.121	$0.663
1996 adj.	$0.347	$0.538	$0.560	$0.548	$0.911	$0.532
Central Subway						
2005	$0.431	$0.922	$0.821	$0.794	$1.176	$1.128
2002	$0.416	$0.775	$0.693	$0.673	$0.914	$0.891
1996	$0.405	$0.675	$0.546	$0.545	$0.818	$0.802
Entire Green						
2005	$0.385	$0.814	$0.821	$0.790	$1.253	$0.843
2002	$0.412	$0.731	$0.700	$0.685	$0.997	$0.771
1996 adj.	$0.377	$0.608	$0.551	$0.546	$0.857	$0.655
Weekday						
Surface						
2005	$0.315	$0.695	$0.821	$0.777	$1.325	$0.617
2002	$0.386	$0.669	$0.709	$0.704	$1.108	$0.646
1996 adj.	$0.330					
Central Subway						
2005	$0.393	$0.910	$0.821	$0.794	$1.170	$1.125
2002	$0.381	$0.768	$0.693	$0.674	$0.907	$0.893
1996	$0.356					
Entire Green						
2005	$0.354	$0.800	$0.821	$0.787	$1.236	$0.819
2002	$0.383	$0.723	$0.699	$0.685	$0.988	$0.761
1996 adj.	$0.334					
Weekend						
Surface						
2005	$0.451	$0.777	$0.821	$0.814	$1.476	$0.752
2002	$0.481	$0.702	$0.709	$0.705	$1.119	$0.700
1996 adj.	$0.412					
Central Subway						
2005	$0.598	$0.976	$0.821	$0.797	$1.193	$1.138
2002	$0.556	$0.803	$0.693	$0.665	$0.934	$0.885
1996	$0.541					
Entire Green						
2005	$0.522	$0.873	$0.821	$0.805	$1.305	$0.925
2002	$0.519	$0.754	$0.701	$0.682	$1.009	$0.791
1996 adj.	$0.467					

Average Farebox Deposit = cash fares÷total riders
True Average Fare includes pass revenue
Average Pass Ride Value = pass revenue÷pass riders
Average Adult Pass Ride Value = Adult Monthly pass revenue÷Adult Monthly pass riders
Results for 1996 other than average farebox deposit can be calculated only at weekly level from the data available

increases in the proportion of all trips accounted for by passes, and the average number of trips made per pass.

Bus and Trackless Trolley

Table 5-5 shows the percentage distributions of passengers by fare-payment method for the entire bus and trackless trolley system, as calculated from the 2005 and 2002 fare-mix study results and from the corrected 1996 results. In all three years, monthly passes were the most common method of fare payment, but there was a large drop in pass share between 1996 and 2002, and a small drop between 2002 and 2005. This was mostly a result of the introduction of free bus-to-bus transfers after the 2000 fare increase.

When the calculations for the 2002 fare-mix study were done, the most recent available information on pass-usage rates was that from the 1999 survey, which pre-dated the implementation of free bus-to-bus transfers. The pass form that would have been impacted most by free transfers was the Local Bus pass, because passengers requiring higher-level passes would still have needed them for other services they used.

Under the fare structure in effect in 1996 and 1999, the full cash fare for a single-zone local bus route was $0.60, and the Local Bus pass was priced at $20.00. Therefore, the break-even point between paying cash and getting a pass was an average of 33.3 boardings per month. In an average month, this would require about 1.4 boardings per weekday, allowing for some weekend use. The 1999 survey indicated that Local Bus pass users made an average of 2.98 boardings per day, well above the break-even point.

The 2000 fare increase raised the full cash fare 25.0% to $0.75, and also raised the price of the Local Bus pass 25.0%, to $25.00. This kept the break-even point between cash and pass for non-transfer trips at 33.3 boardings per month. However, with the introduction of free bus-to-bus transfers, the effective cost per boarding of a transfer trip became half the full fare. This raised the break-even point to 66.3 boardings per month, or about 2.8 per weekday.

In the absence of new survey data it was necessary to make some assumptions about the impact on Local Bus pass usage rates of diversions from pass use to use of cash and transfers. Overall, passengers making transfers would have made more boardings than passengers not making transfers, so it was assumed that the diversions would reduce the average pass-use rate. However, this assumption was made without taking into account transfer passengers who averaged more than 2.8 boardings per weekday, and would still have found passes less costly than paying cash. The overall average Local Bus pass usage rate of 2.98 trips per weekday could not have been attained without substantial numbers of passengers making more than 2.8 boardings per weekday. All of the passengers who switched from passes to cash with transfers would have made fewer than 2.8 boardings per weekday, which was below the average for all pass users. Therefore, these diversions would have raised, rather than lowered the average number of trips per day among those who continued using passes. Consequently, the calculations of pass rides, and pass share of total trips in the 2002 calculations were probably too low. This would also have made the average pass ride value and the true average fare too high, since the same amount of fare revenue would need to be distributed over a larger number of passengers.

The 2005 pass-users survey results showed an average use rate of 2.58 Local Bus pass trips per weekday on local buses. This was a decrease from the 2.98 average in the 1999 survey, so factors other than diversions of transfer riders to cash fares must have been involved. This was still greater than the average assumed in the 2002 fare-mix calculations, but the 2005 calculations show only a slight difference in the percent of riders using all forms of adult monthly passes combined compared with the 2002 calculations (38.5% versus 39.3%).

Table 5-5 indicates that the share of adult cash fares also decreased, from 31.5% to 23.4%, between 1996 and 2002 mostly as a result of an increase in Senior and Disability half fares. The fare-mix observations for both years included a category of "short fares" for passengers observed to be paying cash fares lower than what they should have paid. These accounted for 4.1% of bus riders in 1996 and for 4.6% in 2002. In 2005, with the full cash fare on local routes having been raised to $0.90, large numbers of passengers without correct change were found to be paying $1.00. The number of these was so large that it concealed short fares, and no separate accounting of these could be made. To compare the 2005 results with 2002 or 1996, short fares should be added to adult cash fares for the older years. In 2005, adult cash fares accounted for 24.9% of bus boardings, compared with combined shares of 28.0% for adult cash and short fares in 2002 and 35.6% in 1996.

The results in Table 5-5 indicate a large increase in Student pass use on the bus and trackless trolley system between 2002 and 2005. However, this was mainly a result of improved accuracy in the 2005 calculations. Use of Student passes is heavily concentrated during a few hours near the beginning and ending times of school days, and some routes have much higher numbers of student riders than others Student pass users appear to have been under-represented in the trips observed for several fare-mix studies. However, for the 2005 study, better control totals were obtained for the number of passes in circulation. The initial estimates from the fare-mix observations were adjusted accordingly.

Table 5-6 shows average farebox deposits, true average fares, and average pass ride values for the bus and trackless trolley system. These are combined averages for basic-fare and extra-fare bus routes. MBTA accounting procedures do not provide separate information on revenue collected from basic-fare and extra-fare routes, and federal reporting requirements do not call for any distinction between them. Basic-fare routes account for about 92% of the bus and trackless trolley system riders, so average fares would be expected to be strongly influenced by basic fares. The 2000 fare increase raised the full cash fare on basic-fare routes by 25% from $0.60 to $0.75. However, the free bus-to-bus transfers implemented in conjunction with the 2000 fare increase effectively reduced cash fares by 37.5% for transfer passengers, compared with what they would have paid before 2000. The 2004 fare increase raised full fares by another 20.0%, to $0.90. In 2000 the price of a Local Bus pass also increased by 25.0%, from $20.00 to $25.00, and in 2004 it increased by another 24.0%, to $31.00.

Table 5-5
Bus and Trackless Trolley Fare Category Proportions in Percentages
2005 versus 2002 and 1996

	Adult Cash	Short Fare	Monthly Pass	Weekly Pass	Visitor Pass	Senior/ Disability Cash	Senior/ Disability Pass	Child/ Student Cash	Student Pass	10-ride Ticket	Transfer	Author-ized Free	Unauthor-ized Free
Week													
2005	24.9		38.5	4.8	0.0	5.8	2.1	1.3	9.5	0.1	10.0	2.6	0.3
2002	23.4	4.6	39.3	3.2	0.1	11.4	0.7	3.3	3.8	0.1	6.0	3.3	0.8
1996 adj.	31.5	4.1	45.0	na		6.3	na	3.8	5.3		na	3.5	0.5
Weekday													
2005	24.6		38.2	4.6	0.0	5.7	2.3	1.4	10.8	0.1	9.6	2.4	0.3
2002	23.6	4.4	40.3	3.0	0.1	10.5	0.6	3.2	4.4	0.1	5.8	3.3	0.7
1996 adj.	31.2	3.9	44.9	na		6.1	na	3.5	6.3		na	3.6	0.5
Weekend													
2005	27.3		40.7	6.5	0.0	6.3	1.3	1.0	0.0	0.0	12.7	3.8	0.3
2002	22.3	5.9	32.9	4.5	0.1	17.3	0.9	3.9	0.1	0.0	7.4	3.6	1.1
1996 adj.	33.6	5.3	44.3	na		7.7	na	5.0	1.0		na	2.7	0.5

na=fare category was not offered in year indicated
Blank entry indicates fare category was not recorded separately in year indicated
Results from 2002 and 2005 include Silver Line Washington Street

Table 5-6
Bus and Trackless Trolley
Average Fares in Dollars 2005 versus 2002 and 1996

	Average Farebox Deposit	True Average Fare	Avg. Adult Pass Ride Value	Avg. All Pass Ride Value	Avg. Cash Fare excl. Trans & Free	Avg. Cash Fare incl. Trans & Free
Week						
2005	$0.264	$0.533	$0.582	$0.490	$0.821	$0.585
2002	$0.253	$0.492	$0.556	$0.507	$0.591	$0.478
1996 adj.	$0.229	$0.404	$0.369	$0.348	$0.500	$0.461
Weekday						
2005	$0.262	$0.531	$0.582	$0.481	$0.825	$0.594
2002	$0.252	$0.497	$0.556	$0.507	$0.603	$0.488
1996 adj.	$0.226					
Weekend						
2005	$0.275	$0.548	$0.582	$0.563	$0.794	$0.534
2002	$0.260	$0.458	$0.556	$0.513	$0.527	$0.423
1996 adj.	$0.253					

Average Farebox Deposit = cash fares÷total riders
True Average Fare includes pass revenue
Average Adult Pass Ride Value = Adult Monthly pass revenue÷Adult Monthly pass riders
Average All Pass Ride Value = All forms pass revenue÷All forms pass riders
Results for 1996 other than average farebox deposit can be calculated only at weekly level from available data
Results from 2002 and 2005 include Silver Line Washington Street

Senior and disability fares on basic-fare routes did not change in 2000, remaining at $0.15 per trip, but for travel on three-zone local buses the senior and disability fare was raised 20%, from $0.50 to $0.60. However, in 2004 the senior/disability fare on local buses was increased 66.7%, to $0.25. The charge for a three-zone trip was raised an additional 25.0%, to $0.75.

The 2000 increases in full cash fares on express buses varied. For the three fare levels, the increases were from $1.50 to $1.75 (16.7%), $2.00 to $2.50 (25.0%) and $2.25 to $2.75 (22.2%). Some express bus passengers had their fares reduced at that time because of changes in the zone structure. Specifically, on some 500-series routes, under the older fare structure a passenger riding through to Boston from points west of Newton Corner was supposed to pay both a $0.60 local fare and a $1.50 express fare, making a total of $2.10 each way. Under the 2000 fare structure, the same passenger was charged only the express fare of $1.75, or a reduction of 16.7%. In 2004, the $1.75 express bus fare was increased to $2.20 (25.7%). The $2.50 fare was raised to $3.10 (24.0%) and the $2.75 fare to $3.45 (25.5%).

In Table 5-6, the comparison of the 2002 fare-mix results with the adjusted 1996 results shows an increase of 10.5% in the average farebox deposit (total farebox revenue/total passengers) compared with the 25.0% increase in the basic full fare. This was the net result of decreases in the percentages of adult cash-fare and pass riders, an increase in senior/disability fares, and the implementation of free transfers. (With free transfers, each two-bus trip would be counted as one cash-fare trip and one transfer trip instead of two cash-fare trips.) As discussed above, the 2002 calculations may have underestimated the number of bus pass riders. In that case, the average farebox deposit in 2002 should have been even lower than indicated. Between 2002 and 2005, the Table 5-6 numbers for average farebox deposit show an increase of 4.3%, compared with the increase of 20.0% in the basic full fare. However, if the 2002 average was overestimated, then the increase to 2005 would be more than 4.3%.

According to the numbers in table 5-6, between 1996 and 2002, the true average fare, which takes into account both cash fares and allocated pass revenue, increased by 21.8%, or somewhat less than the increase in the full cash fare on basic fare routes. Between 2002 and 2005 the true average fare increased by an additional 8.3%, compared with the 20.0% increase in the basic full fare. Again, however, if pass use for 2002 was underestimated, the true average fare for that year shown in the table would be too high, so the increase from 1996 would be lower, and the increase to 2005 would be higher.

2005 FARE-MIX RESULTS AND COMPARISONS WITH 2002 AND 1996 - COMMUTER RAIL

Revenue Calculations

Ticket revenue for each commuter rail zone and fare category was determined by multiplying the price of each ticket by the number of tickets calculated using the steps described in previous sections of this chapter. The Revenue Ridership reports provided control totals for tickets sold off-train by zone and form. For on-train sales there were

only total monthly figures, but for the study these were broken down using the factors obtained from the 2002 ticket receipt sample.

Pass revenue was allocated to commuter rail using methods similar to those used for other modes. For the 2005 study, total revenue from sales of each form of pass was taken as an average from all of the Prepaid Pass reports for fiscal year 2005. For the 2002 study, revenue figures were taken from the from the May 2002 Prepaid Pass report. For the 2005 study, the pass-use rates obtained from the 2005 surveys were applied to active pass totals from the fiscal 2005 monthly average for each pass form to estimate the total number of trips per day on each mode using each form. Next, the amounts that passengers would have had to pay to make the same trips at full fare were calculated by multiplying the number of pass trips by the full cash fare on each mode. The sales revenue from each pass form was then divided among modes in the same proportion as the full cash fares that would have been required to make the same trips that the pass was used for. The 2002 study took pass use rates from the 1999 pass-user survey.

The Revenue Ridership reports do not show revenue per pass by zone, so it is unclear whether a portion of revenue has been allocated to the core system. In the MBTA Prepaid Pass reports for 2005, $10.00 of the price of each Zone 3 through 8 pass was allocated to the core system. (In 2002 the rate was $7.00 per pass.) As discussed previously, the Prepaid Pass reports assign 70% of Zone 1 and 2 passes sold through the employer pass program to commuter rail, but $10.00 from each of these is also allocated to the core. Since many passengers use their passes to transfer to rapid transit or bus lines in Boston, it is appropriate to allocate some of their pass revenue to those systems. Possible over-crediting of pass revenue to the commuter rail system in the Revenue Ridership reports is offset by the incomplete reporting of passes, especially those below Zone 3. For May 2002, the Revenue Ridership Report showed commuter rail pass revenue of $3,668,223 including Through and Interzone passes. The allocation method in the 2002 fare-mix study allocated pass revenue of $4,017,681 to commuter rail for the same month, or 9.5% more than shown in the Revenue Ridership Report. Added to combined ticket and pass revenue, it was an increase of 5.0%.

Ridership Estimates

The 2002 fare-mix calculations indicated that commuter rail monthly ridership was higher than shown by the Revenue Ridership reports. Reasons for this included incomplete information on pass sales, application of average pass-use rate factors lower than indicated by survey information, and underestimation of rides per ticket for on-train ticket sales in the Revenue Ridership reports. For May 2002, that report showed a system total of 1,968,184 riders. The results of the fare-mix study indicated that the total was 2,610,649, or 32.6% more riders. For this reason, the 2005 fare-mix study used selected information not obtainable elsewhere from Revenue Ridership reports, but did not try to use overall results of those reports as control totals.

Most widely published ridership information about the commuter rail system is taken from the Ticket Audit reports rather than from the Revenue Ridership Reports. The fare-mix calculations indicate that ridership is significantly lower than shown in the Audit Reports. For example, when the Audit figures for June 2002 were expanded by the number of days in May 2002, they indicated a total of 3,353,080 riders, or 28.4%

more than indicated by the 2002 fare-mix study results. Similarly, when the Audit figures for May 2005, were expanded by the number of weekdays, Saturdays, Sundays, and holidays in 2005 and divided by 12, they indicated an average of 3,167,613 riders per month. This was 27.0% higher than the average of 2,493,826 indicated by the 2005 fare-mix study results

Commuter rail ridership figures reported in the news media are based on the Audit reports, and usually refer only to weekday ridership. The May 2005 Audit report show 69,381 inbound riders on one weekday, 13,822 on one Saturday, and 8,975 on one Sunday. The 2005 fare-mix study estimates the average one-way totals to be 53,808 on a weekday, 14,137 on a Saturday, and 7,699 on a Sunday. As discussed in previous sections of this study, allocation of ticket and pass ridership between weekdays, Saturdays, and Sundays requires a number of assumptions, since only monthly totals are reported.

Ticket and pass revenue figures indicate that overall ridership in May 2005 would have been representative of fiscal year 2005. Ticket revenue in May was about 5% lower than the 12-month average, but pass revenue was about 2% above average, making combined ticket and pass revenue about 0.5% below the average. With normal day-to-day variation in travel patterns, ridership would have been above the average for the month on some days and below the average on others. Nevertheless, the weekday Audit figures differ too much from the ticket and pass sales figure to be considered representative.

Summary of Findings

Tables 5-7 to 5-9 present the results of the 2005 fare-mix study for commuter rail along with comparable figures from the 2002 and 1996 studies. The results shown for 1996 differ slightly from the figures that appeared in the 1996 report because of subsequent refinements to the calculation methods. Table 5-10 shows fiscal 2005 average weekday ridership by outer station zone by fare payment method.

As shown in Table 5-9, weekly commuter rail ridership increased by 34.0% between 1996 and 2002. This gain included a combination of growth on lines that were in operation in both years, and ridership on new extensions. Service on the two Old Colony lines was implemented in September 1997. The extension of the Ipswich Line to Newburyport opened in October 1998. The Worcester extension had only limited peak-period service in 1996, and the only station west of Framingham was Worcester. Since then, all-day service was phased in. Grafton Station was added in February 2000. In 2001, Yawkey Station on the Framingham/Worcester line became a regular stop instead of serving only events at Fenway Park, and JFK/UMass Station opened on the Old Colony lines. Additional stations opened in Westborough and Southborough in June 2002, and in Ashland in August 2002. Ridership at those stations is not included in the 2002 fare-mix totals. Also between 1996 and 2002, several off-peak trains that formerly terminated at South Attleboro were extended to Providence. Service frequency on the outer end of the Haverhill/Reading Line increased significantly. There were also some service improvements on other lines.

Table 5-7
Commuter Rail Fare Category Proportions in Percentages

	Week			Weekday			Weekend		
	2005	2002	1996	2005	2002	1996	2005	2002	1996
Adult Cash	28.0	29.8	33.4	26.2	27.9	30.2	50.3	52.3	63.5
Adult Pass	68.2	66.3	61.8	70.5	68.8	65.4	40.4	37.3	28.7
Senior /Disability	1.9	2.0	2.6	1.7	1.8	2.5	4.8	4.8	3.7
Child/ Student Half	1.9	1.9	1.5	1.6	1.6	1.2	4.5	5.6	4.1
Free	NA	NA	0.8	NA	NA	0.8	NA	NA	0.6

Table 5-8
Commuter Rail Average Fare in Dollars

		Avg. Farebox Deposit	True Avg. Fare	Avg. Pass Ride Value	Avg. Cash/ Ticket fare
Week:	2005	1.340	3.312	2.891	4.216
	2002	1.110	2.634	2.299	3.294
	1996	0.937	2.033	1.774	2.500
Weekday:	2005	1.243			
	2002	1.026			4.211
	1996	0.836			3.289
Weekend:	2005	2.532			4.248
	2002	2.082			3.320
	1996	1.895			

Table 5-9
Commuter Rail Weekly Passenger Boardings and Revenue

	Passenger Boardings	Total Revenue	Ticket Revenue	Pass Sales Revenue
2005	581,754	$1,926,747	$759,563	$1,147,184
2002	596,402	$1,571,072	$661,840	$909,232
1996	444,956	$904,737	$416,931	$487,806
Pct Change 2002-2005	-2.5%	22.6%	17.8%	26.2%
Pct Change 1996-2002	34.0%	73.6%	58.7%	86.4%

Between 2002 and 2005, weekly commuter rail ridership decreased by about 2.5%. This loss can be attributed at least partly to the 2004 fare increase, but was not as large as had been predicted before the increase was implemented. No new extensions to the commuter rail system were added in this time span, and there was little overall change in service frequency. (One limited-stops weekday round trip serving the outer end of the Fitchburg Line was added in 2004.)

Because of the combination of increased ridership and the fare increase implemented in the fall of 2000, commuter rail weekly revenue increased by 73.4% between 1996 and 2002. Ticket revenue rose by 58.7% and pass revenue by 86.4%. The larger increase in pass revenue was partly a result of a shift in the proportion of passengers using passes. Between 2002 and 2005, commuter rail weekly revenue increased by another 22.6%, including a 17.8% increase in ticket revenue and a 26.2% increase in pass revenue. As shown in Table 5-7, Adult passes were used for 68.2% of weekly commuter rail trips in 2005, compared with 66.3% in 2002, and 61.8% in 1996. The added pass shares were accompanied by nearly equal reductions in the shares accounted for by adult cash fares, but Senior/Disability fares also accounted for a decreasing portions of ridership in 2005 and 2002. The 1996 figures included a category for free riders. This was based on responses in the 1993 commuter rail survey, mostly from MBTA and railroad employees riding on passes. No comparable source of information on free riders was available for the 2005 and 2002 calculations, but the proportion would not be expected to have changed significantly since 1996.

As can be seen from the results in Table 5-8, the true average fare on commuter rail lines (total ticket and pass revenue divided by total passengers) increased by 29.6% between 1996 and 2002, and by another 25.7% between 2002 and 2005. The average farebox deposit (total ticket revenue divided by total riders) increased by 18.5% between 1996 and 2002, and by another 20.7% between 2002 and 2005. Like the true average fare, the average pass ride value (pass revenue divided by pass riders) increased by 29.6% between 1996 and 2002, and by another 25.7% between 2002 and 2005. The average revenue from passengers using tickets increased by 31.5% between 1996 and 2002, and by another 28.0% between 2002 and 2005.

The 2000 fare increase did not change all fares by the same proportion. Increases in adult one-way tickets ranged from 16.7% to 25.0%. Twelve-ride ticket prices went up between 28.3% and 37.5%. Pass prices increased between 24.2% and 30.8%. The 1996 figures above have been revised from those in the 1996 fare-mix study report in order to make the revenue allocation methods consistent with those used in the 2002 study. In the original 1996 calculations, all revenue from Zone 3 and higher passes was allocated to commuter rail, but the method derived from the 1999 pass user survey allocates some revenue from these passes to connecting modes.

The 2004 fare increase likewise did not change all fares by the same proportion. Increases in adult one-way tickets ranged from 20.0% to 33.3%, except that the consolidation of Zone 9 into Zone 8 gave former Zone 9 stations an increase of only 4.0%. Twelve-ride ticket prices went up between 30.9% and 45.5% as a result of the prices being changed to the equivalent of 12 one-way fares instead of 11. (The increase for former Zone 9 stations was 13.8%.) Pass prices increased between 24.5% and 25.7%, except that the increase for former Zone 9 stations was 17.2%

The average trip length increased only slightly between 1996 and 2002. In 1996 the true average fare for the commuter rail system as a whole was slightly lower than that of a trip from Zone 4 to Boston. In 2002 and 2005 the system true average fare was slightly higher than the Zone 4 true average.

The weekday totals in table 5-10 are for inbound and outbound ridership combined. Off-train ticket and pass sales figures do not provide any information on direction of travel, or route traveled on. Receipts from on-train ticket sales are supposed to include travel direction, but in the sample examined for this study, direction was often omitted. Past counts have found that ridership in each direction is about half of two-way ridership, but there is usually some directional imbalance. Ticket sales figures are reported separately for the North Side and South Side systems, but the majority of pass sales figures are allocated to North and South in proportion to ticket sales rather than from information on where the passes will be used.

Table 5-10 includes both Through trips (to or through downtown Boston or other stations in Zone 1A or 1B) and Interzone trips, but Interzone trips were also calculated separately. As in the past, the vast majority of commuter rail riders were making Through trips. Of the total 109,855 riders per day in 2002, and 107,616 in 2005, about 2,000, or 1.8% were making interzone trips. Past counts have shown that this proportion varies among routes, depending on such factors as route length, number of stations served and land use around stations. In 2002, the most recent year for which a detailed breakdown of Interzone fares was obtained, the average Interzone trip length on weekdays was 3.9 zones.

Table 5-10
Commuter Rail FY 2005 Average Weekday Ridership by Fare Category and Outer Zone

Outer Zone	1A	1B	1	2	3	4	5	6	7	8	Total
Fare Category											
Adult											
Single-Ride	52	144	952	2,450	2,356	2,066	1,817	2,519	1,588	2,606	16,550
Twelve-Ride	34	39	826	1,801	1,929	1,389	1,051	1,845	1,062	952	10,928
Family Fare	0	12	29	51	99	96	51	136	88	121	682
Pass	735	1,572	7,125	11,070	12,883	11,204	6,383	10,812	6,660	7,399	75,844
Subtotal	**822**	**1,766**	**8,932**	**15,372**	**17,267**	**14,754**	**9,302**	**15,312**	**9,399**	**11,079**	**104,004**
Senior/Disability											
Single-Ride	1	9	59	141	154	148	128	254	99	208	1,201
Ten-Ride	0	4	39	87	120	96	64	108	29	91	638
Subtotal	**1**	**13**	**98**	**228**	**274**	**244**	**192**	**362**	**128**	**299**	**1,839**
Child/Student Half											
Single-Ride	2	4	48	85	87	105	92	101	81	104	710
Ten-Ride	1	2	31	52	68	69	46	43	25	45	383
Family Fare	0	18	35	44	90	98	49	139	88	121	681
Subtotal	**3**	**24**	**114**	**182**	**245**	**271**	**187**	**282**	**194**	**271**	**1,774**
Total	**826**	**1,803**	**9,144**	**15,782**	**17,785**	**15,269**	**9,681**	**15,957**	**9,720**	**11,649**	**107,616**

Note: Totals are for combined inbound and outbound through and interzone ridership