D. RAIL TRANSIT

EXISTING CONDITIONS

The subway lines in the study area are shown in Figures 9D-1 through 9D-5. As shown, most of the lines either serve only portions of the study area in the north-south direction or serve the study area in an east-west direction. Only one line, the Lexington Avenue line, serves the entire study area in the north-south direction. More importantly, subway service on the East Side of Manhattan is concentrated on Lexington Avenue and west of Allen Street, while most of the population on the East Side is concentrated east of Third Avenue. As a result, a large portion of the study area population is underserved by the current subway service. The following sections describe the study area's primary, secondary, and other subway service.

SERVICE PROVIDED

Primary Subway Service

The Lexington Avenue line (Nos. 4, 5, and 6 routes) is the only rapid transit service that traverses the entire length of the East Side of Manhattan in the north-south direction. Within Manhattan, southbound service on the Nos. 4, 5 and 6 routes begins at 125th Street (fed from points in the Bronx). Local service on the southbound No. 6 route ends at the Brooklyn Bridge station and the last express stop within Manhattan on the Nos. 4 and 5 routes is at the Bowling Green station (service continues into Brooklyn). Nine of the 23 stations on the Lexington Avenue line within Manhattan are express stops. Five of these express stations also provide transfer opportunities to the other subway lines within the study area. The Nos. 4 and 5 routes provide express service during peak travel periods and reduced express or local service during off-peak periods. The No. 6 route provides local service in the corridor and provides three additional opportunities for transfers to other subway lines.

Secondary Subway Service

The Broadway line (N and R routes) also provides significant north-south subway service within the study area. N and R routes from Queens enter the study area at the Lexington Avenue/59th Street station and provide service to the Fifth Avenue/59th Street station in East Midtown. These trains on the Broadway line then enter West Midtown, traveling along Broadway and making stops at 57th Street, 49th Street, Times Square, 34th Street, and 28th Street. The Broadway line reenters the primary study area at the 23rd Street/Broadway station. Service on the Broadway line south of the 23rd Street/Broadway station parallels the Lexington Avenue line as it continues through the Lower East Side and Lower Manhattan. Transfers to the Nos. 4, 5, and 6 routes are available at the Lexington Avenue/59th Street and Union Square stations. Transfers to the No. 6 route are also available at Canal Street. Whitehall Street is the southernmost station on the Broadway line within Manhattan, south of which service extends into Downtown and western Brooklyn. Service on the Broadway line is currently reduced, with no express service from Brooklyn, due to ongoing construction on the Manhattan Bridge. All Brooklyn express service is currently either operated via Sixth Avenue or Montague Tunnel as local service. The New York City Department of Transportation projects full bridge service will be restored in 2004.

Other Subway Service

In addition to the Lexington Avenue and Broadway lines, there are several other subway lines that bring patrons into the study area. These routes generally run crosstown or along the west side of Manhattan and provide service to only a few stations in the study area.

The Seventh Avenue line (Nos. 1, 2, 3, and 9 routes) brings patrons into the study area from the western portion of the Bronx, the West Side of Manhattan, and central Brooklyn. This line provides north-south service to the World Trade Center, Bowling Green, and Wall Street areas within the Lower Manhattan zone of the study area. Transfers to the Lexington Avenue line (Nos. 4 and 5 routes) from the Nos. 2 and 3 routes can be made at Fulton Street.

The Eighth Avenue line (A, C, and E routes) brings patrons into the East Side of Manhattan from Queens, the West Side of Manhattan and Brooklyn. It crosses the study area twice: once in the East Midtown zone (E route) and once in the Lower Manhattan zone (A, C, and E routes). Within the study area it serves north-south and east-west travel in Lower Manhattan. Transfers to the Lexington Avenue local No. 6 route can be made at the Lexington Avenue/51st Street station (E route only) and to the express No. 4 and 5 routes at the Fulton Street station.

The Nassau Street line (J, M, and Z routes) enters the study area from northern Brooklyn and eastern Queens via the Williamsburg Bridge. Service closely parallels the north-south Lexington Avenue line within the Lower East Side and Lower Manhattan zones of the study area. Transfers to the Lexington Avenue local No. 6 route can be made at Canal Street and Chambers Street/ Brooklyn Bridge and to the express Nos. 4 and 5 routes at Fulton Street and Chambers Street/ Brooklyn Bridge. Transfers can also be made at Canal Street to the Broadway N and R routes.

The Sixth Avenue line trains provide service to the Upper East Side zone of the study area via the 63rd Street line (B or Q trains) and to the Lower East Side zone via Houston Street (B, D, F, and Q trains). Transfer opportunities in the midtown area are provided at the Lexington Avenue/51st Street station for the F route with the Lexington Avenue local No. 6 route, and at the 34th Street station for all four routes (B, D, F, and Q) with the Broadway N and R routes. In the Lower East Side zone, two more transfer locations are available, one for all four routes at the Broadway-Lafayette Street station with the downtown No. 6 route (at Bleecker Street), and another for the F route only at the Delancey Street station with the Nassau Street line.

The Flushing line (No. 7 route) provides service from Queens into the East Midtown zone of the study area along 42nd Street. Transfers can be made at Grand Central Station with the Lexington Avenue line and at Times Square with the Broadway line.

The 42nd Street Shuttle (S route) travels between the Grand Central and Times Square stations. Transfers can be made to the Lexington Avenue line at Grand Central.

The 14th Street line (L route) provides service from Brooklyn to the Lower East Side zone of the study area. Transfers are available to the Lexington Avenue and Broadway lines at the Union Square station.

Underserved Areas

Numerous subway lines provide rapid transit service in the East Side of Manhattan, but most only serve areas west of Lexington Avenue (and, farther south, Lafayette, Centre, and Nassau Streets) and all but two lines provide primarily east-west service. Most of the study area's population lives in areas east of Third Avenue. As a result, a walk of 10 or more minutes is required for many residents living in the eastern edge of Manhattan to the nearest subway station. Although portions of the eastern edge of the study area are served in the east-west direction by other subway lines, transfers to the Lexington Avenue line (the primary north-south service in the study area) are either not available or are inconvenient. For example, transfers to the northbound Lexington Avenue line are not available from the B, D, F, and Q routes at the Broadway-Lafayette Street station. Also, passengers on the J, M, and Z routes need to travel southbound from the Bowery and Essex Street stations to the Canal Street station in order to transfer to the northbound Lexington Avenue line. Figure 9D-2 shows the locations and the residential population within the study area relatively inaccessible to the Lexington Avenue line or to other lines in the study area.

Although other areas of the city—such as Staten Island, Queens, and Brooklyn—have greater numbers of people living farther away from subway lines, the underserved areas of the study area are among the most dense. Almost 50 percent of the study area's population resides more than a 10-minute walk from the subway. Most of the underserved population lives on the Upper East Side (an estimated 108,000 residents more than 10 minutes from the subway) and the Lower East Side (an estimated 113,000 residents). Together, these East Side residents represent about 30 percent of the total population in the East Side of Manhattan. The Lower Manhattan zone has the least number of people living more than a 10-minute walk from the subway.

Some residents living within areas that are far from subway service choose to walk the long distances. Others choose to ride a crosstown bus to get to the nearest subway station, or ride a bus to their destinations altogether. Although there are numerous bus routes on the major east-west streets in the study area, no free transfers were available between buses and subways until the summer of 1997. On July 4, 1997, free bus/subway transfers were implemented, giving monetary relief to these two-fare zones. Prior to implementation of the free transfer program, the comparatively high cost of using transit in these two-fare zones may have been one reason why these potential passengers chose not to use the subway. In addition to being more expensive than other trips in the study area, travel times from areas within the two-fare zones were and continue to be significantly higher.

RIDERSHIP CHARACTERISTICS

Volumes

Historical subway ridership information was obtained from MTA New York City Transit (NYCT) station registration data (i.e., turnstile entry counts) and New York Metropolitan Transportation Council (NYMTC) Manhattan hub-bound data. The station registration summaries provide subway entry volumes, whereas the hub-bound data provide cordon volume counts at river crossings and at the 60th Street screenline. Since passenger exit and transfer volumes are not regularly collected, the available information (registration and hub-bound data) does not allow precise determination of ridership levels on specific links of a particular route. The available information does, however, help to determine the level of usage for a station and is very useful in understanding the overall ridership characteristics, especially south of 60th Street in Manhattan (the "Hub"). Although mention is made of other lines, the following discussion focuses primarily on the Lexington Avenue line (Nos. 4, 5, and 6 routes) and, secondarily, on the Broadway (N, R routes) line.

Systemwide Trends. The total annual subway entry volumes within New York City and the study area for the period between 1989 and 1995 are tabulated and graphed in Figure 9D-6. Entry volumes are also shown by borough and sub-region. As shown, during this 7-year period, New York City subway ridership had decreased and recovered to about the same level. Within Manhattan, total ridership experienced a slight decrease, largely due to a noticeable reduction in entry volumes in the Manhattan CBD. Along the Lexington Avenue line, entry volumes decreased by over 13 percent south of the 60th Street cordon while increasing by nearly 10 percent north of the 60th Street cordon. Other areas in northern Manhattan and the Bronx also experienced similar increases.

Table 9D-1 shows the hub-bound travel volumes on an average weekday for the total day (1960-1996) and for the AM and PM peak periods (1980-1996). Hub-bound travel refers to the ridership destined for the area in Manhattan south of 60th Street. Volumes are separated into three screenline locations: 60th Street and the river crossings to Queens and Brooklyn.

The registration and hub-bound data indicate a general decline in subway ridership on the entire NYCT system. Ridership was greatest in the 1960's, bottomed out in 1975 and then increased into the late 1980's when the economy strengthened again. The recession in the beginning of the current decade, however, again reversed the ridership trend in most areas. Subway volumes from the most recent years show that ridership is increasing again.

Lexington Avenue Line. Table 9D-2 shows the average weekday registrations for the Lexington Avenue line, by station, from 1960 to 1995. Two events significantly affected registration patterns during this period. In 1989, the 53rd Street/Third Avenue station was combined with the 51st Street/Lexington Avenue station, making free transfer possible between the E and F routes and the No. 6 route. For analysis purposes, the registrations prior to 1989 at these two stations were combined to better evaluate the historical growth trends over the 35-year period. The other service change that significantly affected ridership was the rerouting of the B, D, and Q routes from the Grand Street station to the Canal Street station in 1984 due to construction activities on the Manhattan Bridge. As a result, between 1984 and 1988, transit usage at the Grand Street and Canal Street stations displayed opposite growth patterns.

Weekday registrations within six Lexington Avenue line segments (South Bronx CBD, Harlem, Upper East Side, Midtown, “Valley” (the area between Midtown and Downtown), and Downtown) were summarized and are presented in Figure 9D-7. Each segment, with the exception of Harlem and the Upper East Side, experienced similar changes in station registrations, with the Midtown stations undergoing the greatest volume swings. The passenger entry volume of a station reflects the type of area the station is located in and the economic characteristics associated with it. For example, areas with high commercial and office usage would be affected more by a change in economy than residential areas like Harlem and the Upper East Side. Ridership growth in residential segments has, in contrast to other segments, increased each year except between 1989 and 1990.

The greatest absolute growth occurred at the 86th Street station where average weekday registrations grew by some 6,400 registrations (16 percent) over 1989, and almost 14,000 (43 percent) over 1965. This coincides with the rapid residential growth in the area. Other growth took place at the Bleecker Street and Canal Street stations, where ridership doubled and increased by 47 percent, respectively, since 1965. Among the 23 stations along the Lexington Avenue line in Manhattan, individual station entry volumes vary greatly. In 1995, the 42nd Street-Grand Central station contributed nearly 18 percent of the more than 647,000 people using stations on the Lexington

Table 9D-1

Subway Hub-Bound Travel Passengers

	Inbound				Outbound			
Year	60th St.	Queens	Brooklyn	Total	60th St.	Queens	Brooklyn	Total
DAY TOTAL								
1960	715,000	448,000	699,000	1,863,000	725,000	474,000	688,000	1,887,000
1963	739,000	463,000	723,000	1,925,000	749,000	490,000	711,000	1,950,000
1971	660,000	414,000	646,000	1,721,000	668,000	437,000	634,000	1,738,000
1975	639,000	405,000	566,000	1,610,000	624,000	414,000	554,000	1,592,000
1980	570,000	371,000	558,000	1,499,000	554,000	364,000	522,000	1,440,000
1985	582,000	379,000	579,000	1,540,000	527,000	364,000	521,000	1,412,000
1988	687,000	385,000	622,000	1,695,000	616,000	364,000	549,000	1,528,000
1989	672,000	418,000	643,000	1,733,000	616,000	386,000	599,000	1,602,000
1990	605,000	394,000	595,000	1,594,000	584,000	395,000	560,000	1,540,000
1991	621,000	428,000	576,000	1,625,000	591,000	374,000	540,000	1,505,000
1992	608,000	400,000	593,000	1,601,000	573,000	364,000	558,000	1,495,000
1993	615,000	399,000	600,000	1,614,000	589,000	388,000	566,000	1,543,000
1994	656,000	418,000	588,000	1,662,000	627,000	377,000	564,000	1,569,000
1995	681,000	409,000	582,000	1,672,000	623,000	392,000	559,000	1,573,000
1996	679,000	408,000	603,000	1,690,000	626,000	385,000	563,000	1,575,000
AM PEAK PERIOD (7 to 10 AM)								
1980	291,000	235,000	356,000	881,000	63,000	20,000	28,000	111,000
1985	299,000	239,000	373,000	910,000	70,000	23,000	31,000	125,000
1988	309,000	221,000	374,000	904,000	87,000	25,000	42,000	155,000
1989	319,000	241,000	380,000	940,000	92,000	31,000	42,000	165,000
1990	266,000	225,000	321,000	811,000	90,000	38,000	48,000	176,000
1991	274,000	233,000	319,000	826,000	93,000	31,000	48,000	172,000
1992	275,000	214,000	322,000	812,000	102,000	34,000	52,000	188,000
1993	259,000	215,000	324,000	798,000	101,000	33,000	55,000	189,000
1994	270,000	218,000	313,000	801,000	103,000	32,000	53,000	188,000
1995	273,000	214,000	306,000	793,000	93,000	35,000	52,000	181,000
1996	279,000	202,000	318,000	799,000	100,000	35,000	51,000	186,000
PM PEAK PERIOD (4 to 7 PM)								
1980	76,000	32,000	44,000	152,000	272,000	212,000	291,000	775,000
1985	69,000	31,000	46,000	147,000	233,000	196,000	283,000	712,000
1988	101,000	41,000	57,000	199,000	260,000	181,000	275,000	716,000
1989	95,000	39,000	57,000	191,000	241,000	189,000	302,000	732,000
1990	94,000	46,000	67,000	206,000	230,000	188,000	263,000	682,000
1991	94,000	44,000	57,000	195,000	224,000	173,000	257,000	654,000
1992	90,000	44,000	62,000	197,000	206,000	155,000	254,000	615,000
1993	94,000	44,000	68,000	206,000	208,000	183,000	252,000	643,000
1994	115,000	50,000	64,000	230,000	220,000	168,000	255,000	644,000
1995	118,000	45,000	63,000	226,000	218,000	168,000	238,000	624,000
1996	111,000	51,000	65,000	227,000	225,000	160,000	243,000	628,000

Source: NYMTC Hub Bound Travel Reports.

Table 9D-2

Average Weekday Registrations:
Lexington Avenue Line Station Entry Volumes, 1960 to 1995

Station	1960	1965	'75-'76	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
125th Street	21,177	18,537	10,401	10,043	10,761	11,038	11,559	11,099	11,383	8,449	10,260	10,741	11,205	11,901	12,275
116th Street	14,302	14,274	7,821	5,932	6,202	6,417	6,763	6,911	7,188	5,995	6,265	6,549	6,747	7,223	7,366
110th Street	11,255	11,272	7,103	5,700	6,043	6,229	6,665	6,440	6,618	5,486	5,638	6,207	6,108	6,506	6,284
103rd Street	13,936	13,672	8,617	7,080	7,255	7,393	7,822	8,124	8,689	7,836	7,673	8,439	8,779	9,266	9,319
96th Street	12,985	13,258	10,548	10,976	11,554	12,183	13,894	14,359	14,936	14,183	13,721	14,427	15,452	16,380	17,141
86th Street	30,527	32,180	31,002	35,715	36,559	37,598	39,135	39,554	39,681	39,428	38,327	39,138	41,584	44,939	46,086
77th Street	16,850	21,852	19,207	19,949	20,120	20,851	22,641	23,080	23,141	22,457	22,642	22,481	23,595	25,067	25,501
68th Street	22,036	26,130	22,206	22,100	23,377	23,872	25,504	26,881	26,885	24,638	24,571	24,147	25,401	27,618	27,828
59th Street	34,369	45,688	45,223	48,921	49,439	50,604	52,992	52,783	50,690	45,002	41,239	37,506	38,121	39,690	40,373
51st Street	53,627	64,949	53,778	63,033	62,875	63,441	64,699	66,560	67,518	62,125	57,128	54,736	54,790	57,176	58,137
Grand Central	141,984	147,244	107,372	116,645	118,507	122,705	127,070	128,037	127,955	120,239	110,996	106,255	109,270	114,040	113,975
33rd Street	22,917	24,048	16,791	18,565	19,285	19,759	20,812	21,202	21,109	19,956	18,469	17,700	18,611	19,365	18,672
28th Street	21,398	21,895	16,662	16,800	17,419	18,135	18,866	18,915	19,442	18,328	16,725	15,980	16,449	17,137	17,054
23rd Street	30,277	30,434	23,463	21,150	21,077	21,365	22,697	23,929	24,888	23,918	21,751	20,675	21,053	21,434	21,168
Union Square	77,598	77,662	49,556	46,330	49,239	53,491	57,316	59,428	54,709	52,157	48,549	46,014	47,619	50,479	52,449
Astor Place	12,602	13,669	9,200	11,178	11,561	12,215	14,218	15,261	15,950	15,207	13,786	13,431	13,750	13,955	13,852
Bleecker Street	17,738	16,334	12,767	11,129	11,360	11,317	11,351	11,323	13,156	14,194	13,878	13,882	14,894	15,669	15,386
Spring Street	6,995	6,245	3,434	5,653	5,586	5,397	5,237	5,119	5,006	4,723	4,441	4,483	4,650	4,991	5,173
Canal Street	28,347	29,685	23,547	28,523	30,286	33,552	37,316	38,153	27,845	25,979	24,587	23,481	23,884	23,496	23,918
Brooklyn Bridge	32,769	27,822	26,854	32,778	33,921	34,699	35,389	34,906	35,533	34,657	32,351	31,120	32,721	31,893	30,521
Fulton Street	73,950	63,622	54,948	54,225	53,257	55,515	57,313	57,938	58,893	53,482	49,817	48,081	49,891	50,857	49,733
Wall Street	33,497	31,202	23,805	23,291	23,802	25,254	26,362	25,887	23,350	20,585	18,009	17,212	17,832	18,182	17,574
Bowling Green	23,012	23,518	20,536	25,601	27,090	28,677	29,185	27,065	24,555	21,182	18,665	17,820	18,170	18,079	17,569
Total	754,148	775,192	604,841	641,317	656,575	681,707	714,806	722,954	709,120	660,206	619,488	600,505	620,576	645,343	647,354
161st Street/ Yankee Stadium	19,185	19,122	14,421	13,329	13,536	13,654	13,789	13,486	14,326	14,560	14,353	14,198	15,006	15,077	15,487
149th Street/ Grand Concourse	6,003	5,733	4,578	5,670	6,130	6,172	6,264	6,186	6,323	6,088	5,857	5,930	6,210	6,414	6,335
149th Street/ Third Avenue	23,174	23,989	11,548	8,058	8,053	8,431	9,212	8,516	8,789	8,775	8,382	8,212	8,240	8,149	8,467
138th Street/ Third Avenue	7,380	6,869	4,287	3,645	3,668	3,906	4,050	4,079	3,865	3,708	3,545	3,384	3,434	3,449	3,458
138th Street/ Grand Concourse	2,178	2,312	1,573	1,232	1,367	1,354	1,306	1,254	1,292	1,299	1,189	1,186	1,255	1,315	1,266
Total	57,920	58,025	36,407	31,934	32,754	33,517	34,621	33,521	34,595	34,430	33,326	32,910	34,145	34,404	35,013
51st Street (Lex)	25,850	32,813	21,880	22,238	23,145	24,355	25,952	27,418	**Note:**	1960 Brooklyn Bridge volume also includes 8,350 entries from the Worth Street Station; 51st Street Station entry volumes for 1960 to 1988 also include entries at nearby E/F station.					
53rd Street (E/F)	27,777	32,136	31,897	40,795	39,730	39,086	38,747	39,142							

Source: NYCT Audited Summaries and Transit Records.

Avenue line in Manhattan. Other stations with high entry volumes include 51st Street, Fulton Street, Union Square, 86th Street, and 59th Street. All of these stations, with the exception of 86th Street, provide free transfers to and from other lines within the NYCT subway system.

Table 9D-3 shows the Lexington Avenue line share of the total subway hub-bound volumes at the 60th Street and Brooklyn screenlines. Hub-bound volumes are riders destined for the area of Manhattan south of 60th Street, the commercial and business center in Manhattan. In 1971, the Lexington Avenue line represented approximately 38 percent and 13 percent, respectively, of the total subway hub-bound volumes crossing the 60th Street and Brooklyn screenlines. Twenty-five years later in 1996, the hub-bound volumes on the Lexington Avenue line represented larger shares, at 44 and 15 percent, respectively. This trend of the Lexington Avenue line taking larger shares of the total subway volumes entering and leaving the hub signifies a growing need to examine the adequacy of rapid transit service on the East Side of Manhattan.

Table 9D-3

Lexington Avenue Line Hub-Bound Screenline Shares: Inbound and Outbound Day Totals

	Subway Screenline Totals		Lexington Avenue Nos. 4, 5, 6		Screenline Shares	
Year	60th St.	Brooklyn	60th St.	Brooklyn	60th St.	Brooklyn
1971	1,328,000	1,280,000	502,000	168,000	38%	13%
1975	1,263,000	1,120,000	498,000	151,000	39%	13%
1980	1,123,000	1,080,000	447,000	154,000	40%	14%
1985	1,109,000	1,099,000	471,000	178,000	42%	16%
1988	1,303,000	1,172,000	597,000	185,000	46%	16%
1989	1,289,000	1,242,000	565,000	220,000	44%	18%
1990	1,190,000	1,155,000	524,000	189,000	44%	16%
1991	1,212,000	1,116,000	527,000	172,000	43%	15%
1992	1,181,000	1,152,000	521,000	172,000	44%	15%
1993	1,204,000	1,166,000	503,000	181,000	42%	16%
1994	1,283,000	1,152,000	564,000	160,000	44%	14%
1995	1,304,000	1,141,000	561,000	176,000	43%	15%
1996	1,305,000	1,166,000	576,000	172,000	44%	15%

Source: NYMTC Hub Bound Travel Reports.

The weekday time of day (“temporal”) distribution of the existing station entry and exit activities on the Lexington Avenue line in Manhattan was estimated using the 1988 survey data gathered in the NYCT Weekday Rapid Transit Fare Evasion Study (2/22/89). As shown in Figure 9D-8, two "humps" occur during the peak periods of 7-10 AM and 4-7 PM. These are evident of morning and evening commuter periods typical in large business centers, such as the Manhattan CBD. The AM peak and PM peak entry/exit volumes at stations along the Lexington Avenue line are shown in Figure 9D-9. Because of the heavy influx of commuters from outside of Manhattan in the morning, exit volumes are considerably higher than entry volumes for locations south of 60th Street in the Manhattan business districts. As expected, the entry/exit activities during the PM peak period exhibit the opposite patterns.

Broadway Line. The Broadway line runs parallel to the Lexington Avenue line at close distances between 23rd and Whitehall Streets. As shown in Table 9D-4, the Broadway line totaled more than 150,000 passengers in this segment on an average 1995 weekday. This is considerably lower than the volumes registered at stations on the Lexington Avenue line for the comparable segment (250,000 registrations). There are several reasons for this difference: the perceived and actual travel times of the N and R trains are slower than the Lexington Avenue trains; without a transfer, service is unavailable between Lower Manhattan and Grand Central or the Upper East Side (major origins and destinations within the study area); and finally, the N and R routes are west of the Lexington Avenue route, thus farther from the eastern sections of the study area. The apparent decline in ridership between 1965 and 1975 was due, in large part, to the opening of the Chrystie Street link, and the diversion of some trains and passengers from Brooklyn to the Sixth Avenue line. The increase in Broadway ridership in 1987 and 1988, and the subsequent decline in 1989, was due to a phase of the Manhattan Bridge reconstruction which temporarily closed the Chrystie Street link and routed all trains from Brooklyn to the Broadway line.

Table 9D-4

Average Weekday Registrations: Broadway Line Station Entry Volumes, 1960 to 1995

Year	Stations in Study Area									
	23rd Street	Union Square	8th Street	Prince Street	Canal Street	City Hall	Cortlandt Street	Rector Street	Whitehall Street	Total
1960	19,290	77,598	12,530	6,694	14,663	8,983	16,038	10,376	13,280	179,452
1965	19,572	77,662	13,954	7,050	16,259	8,672	13,296	10,032	12,697	179,194
1975-6	12,360	49,556	9,040	3,897	13,182	6,931	11,014	7,175	14,993	128,148
1984	9,753	46,330	11,766	3,683	28,523	7,319	16,059	6,354	16,052	145,839
1985	10,030	49,239	12,356	4,029	30,286	7,029	15,163	5,769	14,715	148,616
1986	10,274	53,491	12,735	4,513	33,552	7,088	15,701	5,558	14,149	157,061
1987	10,837	57,316	13,629	5,091	37,316	7,424	16,503	5,742	14,450	168,308
1988	11,763	59,428	14,155	5,562	38,153	7,382	16,087	5,374	13,051	170,955
1989	11,828	54,709	14,189	5,646	27,845	7,996	16,436	4,913	12,637	156,199
1990	11,328	52,157	13,285	5,444	25,979	8,008	15,777	4,492	11,786	148,256
1991	9,952	48,549	12,312	5,242	24,587	7,927	15,395	4,679	10,932	139,575
1992	9,483	46,014	11,735	5,281	23,481	8,030	15,581	5,559	10,743	135,907
1993	10,258	47,619	12,564	5,844	23,884	8,404	16,090	5,900	10,368	140,931
1994	11,543	50,479	13,441	6,740	23,496	8,813	18,022	5,817	11,196	149,547
1995	12,447	52,449	14,277	7,732	23,918	9,322	18,686	5,552	11,872	156,255

Source: NYCT Audited Summaries and Transit Records.

Table 9D-5 shows the Broadway line share of the total subway hub-bound volumes at the Queens and Brooklyn screenlines. The N and R volumes at the Brooklyn screenline are combined with the M volumes because the N, R, and M routes all pass through the Montague tunnel at this screenline. In 1996, the N, R, and M lines combined to represent only 8 percent at the Brooklyn screenline, while the N and R lines alone represented 26 percent of the volumes crossing the Queens screenline. This large difference is partly attributed to more subway lines crossing the Brooklyn screenline (including the Lexington Avenue Nos. 4 and 5 lines) than the Queens screenline. By comparison, in 1971 these lines represented approximately 11 percent and 27 percent of the total subway hub-bound volumes crossing the Brooklyn and Queens screenlines, respectively. The data indicate that, overall, the Broadway line's shares of the Queens and Brooklyn screenlines are decreasing.

Table 9D-5
Broadway Line Hub-Bound Screenline Shares: Inbound and Outbound Day Totals

Year	Subway Screenline Totals		Broadway N, R*		Screenline Shares	
	Queens	Brooklyn	Queens	Brooklyn	Queens	Brooklyn
1971	851,000	1,280,000	229,000	144,000	27%	11%
1975	819,000	1,120,000	231,000	114,000	28%	10%
1980	736,000	1,080,000	208,000	132,000	28%	12%
1985	744,000	1,099,000	202,000	115,000	27%	10%
1988	749,000	1,172,000	226,000	98,000	30%	8%
1989	804,000	1,242,000	222,000	129,000	28%	10%
1990	790,000	1,155,000	200,000	84,000	25%	7%
1991	801,000	1,116,000	164,000	123,000	20%	11%
1992	763,000	1,152,000	177,000	126,000	23%	11%
1993	787,000	1,166,000	178,000	105,000	23%	9%
1994	795,000	1,152,000	186,000	105,000	23%	9%
1995	800,000	1,141,000	196,000	117,000	25%	10%
1996	793,000	1,166,000	209,000	99,000	26%	8%

Note: * Screenline volumes were taken at the Montague Tunnel. They include the N, R, and M lines from 1989 to present, and only the R and M lines prior to 1989.
Source: NYMTC Hub Bound Travel Reports.

Origin and Destination Patterns—Lexington Avenue Line

NYCT Subway Survey data from 1990 were obtained to determine station entry ("origin") and exit ("distribution") points and destinations for all subway riders who used the Nos. 4, 5, or 6 trains for any part of their trip. The data were summarized for the AM (5-10 AM) and PM (4-7 PM) peak periods in both the north- and southbound directions for 11 origin or destination points (see Table 9D-6): the Bronx, South Bronx, Harlem, Upper East Side, Upper Midtown, Midtown, West Midtown, Lower East Side, Lower Manhattan, Queens, and Brooklyn. The five zones in the MESA study area were subdivided for the purpose of better evaluating where congestion occurs. The East Midtown zone was divided into Upper Midtown (from north of 42nd Street to 59th Street) and Midtown (from 14th Street to and including 42nd Street). The Bronx was also divided into two segments: the South Bronx segment (including and south of Yankee Stadium), and the Bronx segment (all other stations in the Bronx).

The top 20 origin-destination pairs represent 70 and 56 percent of all trips made during the AM and PM peak periods, respectively. The AM peak ridership patterns give an indication of where passengers travel to work, while the PM peak patterns give an indication of where passengers

Table 9D-6
Top Twenty Origin-Destination Pairs: Lexington Avenue Nos. 4, 5, and 6 Trains*

AM PEAK PERIOD						PM PEAK PERIOD					
				Percent of						Percent of	
Rank	Trip Origin	Trip Destination	No. of Trips	Top 20 Trips	Total Trips	Rank	Trip Origin	Trip Destination	No. of Trips	Top 20 Trips	Total Trips
1	Brooklyn	East Midtown	40,792	14%	10%	1	East Midtown	Bronx	20,274	10%	6%
2	Bronx	East Midtown	33,298	12	8	2	East Midtown	Brooklyn	17,935	9	5
3	Brooklyn	Lower Manhattan	24,795	9	6	3	Lower Manhattan	East Midtown	15,672	8	4
4	Queens	East Midtown	24,564	9	6	4	East Midtown	Upper East Side	15,612	8	4
5	Bronx	Lower Manhattan	18,184	6	4	5	Lower Manhattan	Brooklyn	12,787	6	4
6	East Midtown	Lower Manhattan	17,531	6	4	6	Lower Manhattan	Bronx	11,461	6	3
7	Upper East Side	East Midtown	14,297	5	3	7	East Midtown	Queens	10,898	5	3
8	Queens	Lower Manhattan	12,836	4	3	8	East Midtown	Lower East Side	9,259	5	3
9	Queens	Upper East Side	12,599	4	3	9	East Midtown	East Midtown	8,950	4	2
10	Brooklyn	Upper East Side	11,689	4	3	10	Lower East Side	East Midtown	8,436	4	2
11	Bronx	Upper East Side	9,736	3	2	11	Bronx	Bronx	8,337	4	2
12	Bronx	West Midtown	8,880	3	2	12	Lower Manhattan	Upper East Side	7,740	4	2
13	Brooklyn	Brooklyn	8,265	3	2	13	Upper East Side	Brooklyn	7,568	4	2
14	Brooklyn	Lower East Side	8,100	3	2	14	Brooklyn	East Midtown	7,559	4	2
15	Bronx	Lower East Side	7,681	3	2	15	Upper East Side	Queens	7,456	4	2
16	Bronx	Bronx	7,206	3	2	16	Upper East Side	East Midtown	6,836	3	2
17	Upper East Side	Lower Manhattan	7,155	2	2	17	East Midtown	Lower Manhattan	6,564	3	2
18	Lower East Side	East Midtown	6,900	2	2	18	Brooklyn	Brooklyn	6,560	3	2
19	East Midtown	East Midtown	6,761	2	2	19	Upper East Side	Bronx	6,405	3	2
20	Lower Manhattan	East Midtown	6,123	2	1	20	West Midtown	Bronx	6,336	3	2
Total (Top 20 Trips)			287,392	100%	70%	Total (Top 20 Trips)			202,645	100%	56%
Total (All Trips)			413,416	**	**	Total (All Trips)			361,409	**	**

Notes:
* Table includes all trips that used the Nos. 4, 5, or 6 trains for any portion of the trip. The origin location refers to the area in which the trip maker entered the subway system. The destination location refers to the area in which the trip maker exited the subway system.
** Individual percentages may not add to total because of rounding.
Source: NYCT 1990 Subway Survey.

reside. Two of the origin-destination pairs, Brooklyn to Brooklyn and Bronx to Bronx, do not enter the study area for any part of their trip. Most of the other trips had either a trip origin or destination in East Midtown or Lower Manhattan, the two business centers in the study area.

During the AM peak period, southbound ridership is greater than that in the northbound direction. Passenger ridership from the Bronx segment represents at least 50 percent of the total southbound Lexington Avenue ridership until the Upper Midtown segment. Ridership peaks through the Upper Midtown segment before a significant portion of the ridership departs to Midtown. The greatest drop in southbound ridership occurs in Lower Manhattan, as ridership becomes minimal after the southbound trains leave Manhattan. In the northbound direction, trains are most crowded within Lower Manhattan and Midtown, the employment centers within the study area, but are also noticeably crowded within Brooklyn and the Lower East Side. This indicates that northbound trains are already crowded as they reach Lower Manhattan, the second largest employment center within Manhattan. Northbound ridership drops off after leaving Midtown, north of Grand Central Terminal (GCT). During the PM peak period, northbound ridership is greater than that in the southbound direction. Northbound ridership is greatest within Midtown, the Upper East Side, and Upper Midtown. Within the study area the greatest increase in ridership takes place between the Lower East Side and Midtown, indicating that many passengers board the Lexington Avenue line from work within the Midtown segment. Similarly, ridership drops off dramatically after the Upper East Side, indicating that many passengers exit the subway here and continue to their residences within this zone. In the southbound direction, PM peak ridership is greatest within Midtown. After this point, southbound ridership slowly declines as it leaves Manhattan en route to Brooklyn.

SERVICE CHARACTERISTICS

Subway service is characterized by its “throughput” (the number of trains that travel through a line) and capacity to carry passenger demand. The operational effectiveness of a service and its ability to meet its schedules are often dictated by demand peaks, regularity of train headway, dwell time and running time, and station crowding. The following sections include discussions on these characteristics and actual survey data collected on the Lexington Avenue and Broadway lines.

Headways and Dwell Times

Service throughout the city’s subway system differs by time of day to accommodate fluctuations in ridership demand. The most frequent service is provided during the AM peak period (approximately 7-10 AM) and the PM peak period (approximately 4-7 PM). Within these peak periods, even more frequent service is scheduled for the busiest 1-1½ hours. Service, like demand, usually tapers down at the shoulders of the peak period. Less service is provided on some routes during the midday and evening hours and limited service is provided in the late-night and early morning hours (Midnight to 6 AM). Ridership demand on weekends is generally lower than during weekday peaks, thus weekend service on most routes is similar to midday service. The following discussion is primarily focused on service characteristics during peak periods and during the most heavily traveled hours, the AM peak hour (8-9 AM) and the PM peak hour (5-6 PM).

NYCT schedules peak hour “headways” (frequency of trains, measured by the time between trains) that are usually not consistent along an entire route. Scheduled headways are determined by two components: the minimum time between trains as defined by safety and signal constraints, and station "dwell" times (the time a train sits in a station). Based on safety and signal constraints and allowing for a dwell time of 30 seconds, trains on the Lexington Avenue and Broadway lines can theoretically be operated at 120-second headways (i.e., one train every 120 seconds) for a total train throughput of 30 trains per hour. However, due to congestion and slower exiting and boarding times at certain stations, scheduled headways often tend to be slightly longer.

NYCT defines station dwell time as the time from when a train is fully stopped within a station to when it starts to move again. Scheduled dwell times are dependent on ridership levels, signalization, and transfer opportunities. Actual dwell times can vary significantly from those scheduled because of incidents such as train queuing, door holding, and especially heavy passenger boarding and exiting volumes. On a typical business day, the station dwell time tends to be the longest during peak periods, when passenger volumes are greatest and service is most frequent. When the passenger demand is high, more trains are needed to provide enough capacity. In addition, because of this higher demand, the actual time for passengers to load and unload a train increases. As a result, actual dwell times are likely to exceed scheduled dwell times. The longer the schedule "violation" becomes or the more frequently the violations occur, the fewer the number of trains can serve that line segment. Longer dwell times increase headways between trains, so that the maximum number of trains per hour cannot be processed. The fewer the trains serving the segment, the more crowded the trains and stations on that segment can become. As crowding increases in trains and on station platforms, the time needed for boarding and exiting increases, further contributing to the violation in scheduled headways. All of the above are part of a cyclical downward pattern that contributes to reduced throughput during peak travel periods.

Lexington Avenue Line. The current NYCT signal system on the Lexington Avenue line is designed to allow 90-second headways, including a 30-second allowance for station dwell times, with operating headways of 120 seconds. The additional 30 seconds in the operating headway is meant to allow trains to move far enough ahead of the following trains, so the following trains generally can run on green signals. Ideally, 30 trains per hour can be scheduled along this line. The system can absorb occasional dwell time aberrations, but if dwell times at more than a few stations along the line are 45 seconds or more, the train throughput is reduced. Along the heavily used Lexington Avenue line, the 120-second headways cannot be maintained during peak periods because of the excessive dwell times at stations. Field observations of weekday peak period headways and dwell times were made at a number of stations along the Lexington Avenue line during the AM peak period. Within short time intervals, headways deviated, sometimes significantly, from those scheduled. This was mainly attributed to delays in service and long station dwell times. Excessive dwell times were often the result of high exiting and boarding volumes, transfers across the platform, and train bunching. For example, when a train is delayed by more than 3 or 4 minutes, the next few trains upstream queue up at the approach to a station and arrive at the station at short headways. This phenomenon is the main reason why scheduled throughput could be met over a sufficiently long period of time, while falling short during heavily traveled peak periods. The data showed that actual arrival headways were as low as 1.5 minutes and as high as 10 or more minutes during the AM peak period. Actual dwell times varied from 15 seconds to more than 3 minutes. At 42nd Street-Grand Central station, the average headways were observed to average about 2.5 minutes for the express trains and 2.8 minutes for the local trains. These gaps translate to about 24 express and 21 local trains during the AM peak hour, when 27 express and 25 local trains are scheduled. Dwell times were observed to cluster in the 50- to 60-second range. Table 9D-7 shows the average headways and median dwell times (the median value is usually a better measure of dwell times) of southbound Lexington Avenue trains at selective surveyed stations on a typical weekday during the AM peak hour.

Table 9D-7
Average Headways and Median Dwell Times of Southbound Lexington Avenue Trains: AM Peak Hour

Station	Southbound Express		Southbound Local	
	Average Headway (minutes)	Median Dwell Time (seconds)	Average Headway (minutes)	Median Dwell Time (seconds)
149th St/Grand Concourse	—	—	4.57	41
138th St/Grand Concourse	4.91	14	—	—
Third Avenue/138th Street	—	—	3.08	19
125th Street	2.22	38	2.73	34
86th Street	2.52	41	2.69	37
68th Street	—	—	2.99	30
59th Street	2.43	44	2.79	61
51st Street	—	—	2.92	44
Grand Central	2.52	54	2.80	47
Union Square	2.74	49	3.12	35
Brooklyn Bridge	2.86	36	—	—

Source: Survey on Tuesday, May 14, 1996.

Broadway Line. Since the passenger demand on the Broadway line is lower than on the Lexington Avenue line, headways are scheduled at longer time intervals, giving the service less train throughput. Field observations were made at two stations along the line at 59th and 23rd Streets. Table 9D-8 summarizes the average headways and median dwell times at these stations.

Table 9D-8
Average Headways and Median Dwell Times of Southbound Broadway Trains: AM Peak Hour

Station	Southbound	
	Average Headway (minutes)	Median Dwell Time (seconds)
59th Street	2.89	48
23rd Street	3.00	47

Source: Survey on Thursday, June 19, 1997.

Travel Times and Travel Speeds

NYCT has in its schedules maximum travel times of each subway line. The maximum travel times during peak commuter periods take into account congestion at bottlenecks along the routes. Actual travel times largely depend on how scheduled headways are met. The more frequently trains are delayed at bottlenecks, causing train bunching upstream, the more travel times tend to fluctuate.

Lexington Avenue Line. The Nos. 4 and 5 express trains travel along the same route in Manhattan. Stretching from 125th Street to Bowling Green, the Lexington Avenue express line is approximately 8.5 miles long and contains a total of nine stops. The maximum scheduled travel time for the express trains varies from 22.0 to 32.0 minutes (15.9 to 23.2 mph) on weekdays. Peak period travel is slower than off-peak travel because of higher station loadings and longer station dwell times. Actual travel times were surveyed in the field. In the AM peak, southbound travel times between 125th Street and Bowling Green ranged between 18½ and 26 minutes. The No. 6 local trains make 20 stops between 125th Street and Brooklyn Bridge. The route is approximately 7.7 miles long and has maximum scheduled travel times of 27.0 to 33.5 minutes (13.8 to 17.2 mph) on weekdays.

Broadway Line. The maximum scheduled weekday travel time on the approximately 5.5 miles of track on the N and R line between 59th Street and Whitehall Street ranges from 23 to 28 minutes (12.1 to 14.7 mph). Since scheduled headways are longer on the Broadway line and less congestion occurs along the route, the actual travel times tend to remain stable and not fluctuate as much as the Lexington Avenue line.

Capacity vs. Usage

NYCT specifies a minimum standing space of 3 square feet per standing passenger. The number of passengers this translates to is the guideline capacity. For the Lexington Avenue line, which carries Division A cars, each subway car has a guideline capacity of 110 passengers and a maximum loading of 160 passengers (crush capacity). For the Broadway line, which carries Division B cars, the guideline and crush capacities range from 145 to 175 passengers and 230 to 260 passengers per car, respectively. The usage of each of these subway services is defined by the relationship of passenger demands versus train capacities as well as station conditions where trains load and unload passengers, discussed below.

Leave Load Analysis. "Leave load" survey data were used to assess the operating conditions and comfort level on the Lexington Avenue and Broadway lines. Leave load refers to a visual observation of the number of people in a subway car as the train leaves a station. Based on historical leave load survey data, NYCT has identified the 86th Street, 68th Street, 59th Street, 51st Street, Grand Central, Union Square, and Bowling Green stations as locations on the Lexington Avenue line that have the highest passenger volumes passing through the station. On the Broadway line, the peak load point in Manhattan is located at the 59th Street station, where transfers are available with the Lexington Avenue line.

In the three years from 1995 to 1997, NYCT and Vollmer Associates made several peak period observations at the above stations and other key locations to assess leave loads. Summaries of field data along with the corresponding volume-to-guideline capacity (v/c) ratios were prepared for all observations made. The v/c ratio indicates the extent of passenger crowding on a train. A v/c ratio greater than 1.00 indicates that the standing passengers have less than 3 square feet per person, representing a level of crowding during the peak hours unacceptable to NYCT. Presented in Table 9D-9 are summaries of these observations in the southbound direction during the AM peak hour for the Lexington Avenue and Broadway lines, respectively.

Table 9D-9
AM Peak Hour Leave Load Summary of Southbound Lexington Avenue and Broadway Trains

Station	Express			Local		
	No. of Trains	Average Leave Load	Average V/C Ratio	No. of Trains	Average Leave Load	Average V/C Ratio
LEXINGTON AVENUE LINE						
149th Street/Grand Concourse	—	—	—	13	663	0.60
138th Street/Grand Concourse	13	668	0.61	—	—	—
Third Avenue/138th Street	—	—	—	20	614	0.56
125th Street	27	812	0.74	21	342	0.31
86th Street	27	1,271	1.16	23	585	0.53
68th Street	—	—	—	20	870	0.79
59th Street	25	1,195	1.09	21	991	0.90
51st Street	—	—	—	22	879	0.80
Grand Central	24	1,119	1.02	21	615	0.56
Union Square	22	952	0.87	21	334	0.30
Brooklyn Bridge	22	902	0.82	—	—	—
BROADWAY LINE						
59th Street	Express tracks not in use			20	914	0.65
23rd Street	Express tracks not in use			19	342	0.24

Source: Surveys from 1995 to 1997.

As shown in the table, express trains were generally more crowded than local trains. Leaving Grand Central, about two-thirds of the express and only 5 percent of the local train cars during the AM peak hour were observed to fill over the guideline capacity. One reason passengers prefer the express train service is that local service terminates at Brooklyn Bridge, thereby forcing passengers destined for locations in the Lower Manhattan financial district and Brooklyn to transfer. Another reason is the perceived travel time loss associated with using the local train. The local train stops over 2.5 times as often as the express train; each stop adds over 1 minute to the total travel time.

The average leave load volumes and v/c ratios shown in Table 9D-9 could sometimes be deceiving when evaluating the adequacy of a subway service. Survey data from the 1988 NYCT Weekday Rapid Transit Fare Evasion Survey Study indicated that there was a large variation in demand for individual 15-minute periods within peak periods. The field data obtained from the leave load counts further supported this, as noticeably higher peaking occurred among individual trains. Irregular headways because of incidents, high transfer volumes, and passengers platooning are often the causes for high leave load volumes on trains. Frequently after a train with a large leave load has left a station, the train that follows is not as nearly as crowded. In general, when the average peak hour v/c ratio exceeds 0.85, it is likely that some trains during that hour have leave loads greater than the guideline capacity.

<u>Pedestrian Circulation at Subway Stations</u>. In addition to passenger crowding on subway trains, severe crowding on station platforms and queuing at stairways also characterize the condition of a "normal" peak period. When headways become irregular, the already congested

state of transit service is exacerbated by service failures. The heavily used stations are affected more by these service irregularities. For example, on the southbound express platform at the 86th Street and Lexington Avenue station, passengers frequently pass up several trains before boarding to travel in a less crowded car during the morning commuter peak period.

The longer passengers wait to enter a train, the more crowded platforms become. Several factors contribute to the overcrowding of stations on the East Side of Manhattan. These include, but are not limited to, inadequate platform, stairwell, and subway car designs; the presence of high volumes and transfer movements that may not have been anticipated in the original designs; and excessive train delays. Platform and stairwell observations were made at several stations on the Lexington Avenue and Broadway lines; these represent either the most congested stations or a typical station type.

The following is a description and evaluation of station elements in these stations during the AM peak period, with focus given to elements in the southbound direction. The level-of-service (LOS) determination of the platforms was based on the calculated effective space of the platforms in relation to the observed walking and queuing spaces. The LOS determination of the stairways was based on the volume of people ascending and descending the stairway in relation to the width of the stairway. Table 9D-10 presents the criteria used to determine the LOS of subway station platforms and stairways. Performance level of the fare zones was noted quantitatively based on the number of people observed queuing at the token booth and turnstile areas during the AM peak hour.

Table 9D-10

Platform and Stairway LOS Criteria

LOS	Platform (sq. ft./person)		Stairway (V/C Ratio)
	Walkway	Queuing Area	
A	≥130	13 or more	0
B	≥40	10-13	0.505
C	≥24	7-10	0.705
D	≥15	3-7	1.005
E	≥6	2-3	1.305
F	≤6	2 or less	1.705

Source: *Highway Capacity Manual*.

Stairway LOS was calculated as follows:

$$V/C = \frac{\text{number of persons descending and ascending stairway during 5-minute period} \times 12}{(\text{width of stairway} - \text{width of obstruction}) \times 0.9 \text{ (friction factor)} \times 600}$$

where 12 = number of 5-minute periods in an hour
600 = capacity of 1 foot of stairway width per hour

Using those criteria, the pedestrian circulation at platforms and stairways at key stations on the Lexington Avenue and Broadway lines are described below.

125th Street/Lexington Avenue Station: 4, 5, and 6 Trains. This station has a mezzanine and two track levels (northbound trains on the upper level and southbound trains on the lower level) and currently handles a large across-the-platform transfer between the local and express trains. Access to the station is made via four stairways and one elevator to a fare zone (token booth) in the mezzanine level. Very few patrons were seen using the elevator. About 70 percent of the total pedestrian traffic originated from the west stairways, and more than half of that from the northwest stairway. During the AM peak period, this staircase operated at LOS C/D, while the others functioned at LOS A/B.

The fare zone was observed to be uncongested as well, as no more than five people were seen queuing at the token booth. On the subway platforms, queuing space was observed to be sufficient for waiting, walking, and across-the-platform transfers between express and local trains.

86th Street/Lexington Avenue Station: 4, 5, and 6 Trains. This station has two levels. The upper level contains the turnstile areas and local tracks for north- and southbound No. 6 trains, while the lower level provides passage for the north- and southbound express No. 4 and 5 trains. Access from the street to the station is made via seven stairways, four on the west side and three on the east side of Lexington Avenue.

During the AM peak period, of the people using the stairways connected to southbound trains, about 90 percent enter and 10 percent exit the station. Sample counts performed at the station show that the northwest stairway handled volumes of 500 to 600 patrons during peak 5-minute periods in the morning, which translate to LOS F conditions. The turnstile area for southbound riders was quite congested because of patron queues. On the southbound local platform, the most severe crowding occurs near the turnstile area and stairways to the lower level. Toward the ends of the platform, people are more spread out. Sample counts were also obtained at the stairways connecting to the southbound express trains. As many as 375 patrons per 5 minutes were counted, 85 percent of whom were heading down to the express trains on the lower level. These stairways were estimated to operate at LOS D. On the lower level, crowding conditions for express riders were similar to those seen on the local platforms; riders tend to stand at the center of the platform rather than toward the front or rear. During the AM peak period, crowding on the southbound express platform ranges between LOS C and D conditions; approximately 17-22 sq. ft. per person for walking and 6-8 sq. ft. per person for queuing. Determination of the LOS for all platforms are based on estimation of the walking and queuing spaces derived from calculation of the effective platform space (total platform space minus all occupied space, including columns, stairways, and benches) and field reconnaissance.

59th Street and Lexington Avenue Station: 4, 5, and 6 and N and R Trains. This station has three levels plus mezzanine landings and provides transfers between the Lexington Avenue and Broadway lines. The upper level consists of fare zones and local tracks for north- and southbound No. 6 trains, while the lowest level provides passage for the north- and southbound express No. 4 and 5 trains. In between at mid-level and running east-west at this junction are the N and R trains. Access to the station is made via numerous stairways on both sides of Lexington Avenue, and at 60th Street and Third Avenue.

During the AM peak period, the fare zone areas were all very active, but adequate to handle the passenger demand. Unlike the previous two stations, the most congested stairs were not those connecting the surface to the subways, but rather those facilitating transfers between the Lexington and Broadway line trains. Although on an hourly or 15-minute basis, the capacity of these stairs was determined to be adequate, actual observations showed that serious congestion occurs during and right after trains stop at the station. When trains from both the Lexington Avenue and Broadway lines arrive at about the same time, maneuverability on these stairways becomes very difficult and near-LOS F operating conditions exist. Following the near-simultaneous arrival of trains, queuing onto the respective platforms persists for as long as 2 to 3 minutes. Both the upper and lower level Lexington Avenue line platforms were adequate in handling waiting and moving passengers. On the Broadway line platform, however, crowding conditions were observed. This center platform, between the Manhattan- and Queens-bound trains, is about 30 feet wide with columns, stairwells, and escalators along its entire length. Only about half of the platform's area can be occupied by passengers. In addition, because of all the obstructions, passenger maneuvering was seen to be difficult at times. The Broadway line platform is estimated to be borderline LOS D/E during the AM peak period, with approximately 6-11 sq. ft. per person for walking and 3-5 sq. ft. per person for queuing.

Grand Central: 4, 5, and 6; 7 and S Trains. This station has multiple levels (mezzanine and fare zone areas, Lexington Avenue and Flushing trains) and a separate area for the 42nd Street Shuttle (S). The upper level consists of fare zones and a center mezzanine that connects to all trains. The middle level contains four tracks and two center platforms for the Lexington Avenue line, while the lower level provides passage for the Flushing No. 7 line. Access to the station is made via stairways and escalators from within GCT and the Chrysler Building, as well as the south side of 42nd Street and at Lexington and Vanderbilt Avenues.

During the AM peak period, the fare zone areas were all very active, with occasional queuing of five or more passengers at token booths. Turnstiles were also heavily used. Conflicting entry and exit movements were typical during the AM peak period, especially at the main concourse escalator fare zone area. Stairway traffic to/from the center mezzanine and to/from the Lexington Avenue subway platforms is generally heavy and estimated to operate near LOS D/E. On the southbound platform of the Lexington Avenue line during the AM peak period, crowding is severe along the express track (between LOS E and F), with approximately 6 sq. ft. per person for walking and 2 sq. ft. per person for queuing. Along the local track platform, pedestrian traffic conditions are moderate (LOS C), with approximately 22-28 sq. ft. per person for walking and 6-9 sq. ft. per person for queuing. The more restrictive areas, where there are large obstructions such as stairwells and benches, are at/near capacity. Long headways between trains can exacerbate the crowding condition, making movement along the platform extremely difficult.

23rd Street and Broadway Station: N and R Trains. This station has one single level and is typical of most stations on the Broadway line. Stairways to/from street level and fare zones were observed to be uncongested. Platform holding areas were also observed to be adequate with very occasional conflicts in pedestrian movements.

EQUIPMENT AND INFRASTRUCTURE CHARACTERISTICS

The NYCT subway system was constructed in many stages to provide rapid transit service to four of the five boroughs in New York City. Consequently, the equipment and infrastructure used for the different subway lines vary in age, size and capacity. The following passages give a description and inventory of these characteristics.

Rolling Stock

Divisions. The NYCT subway system is composed of two groups of lines, Division A and Division B. The two divisions were originally operated by three separate operating organizations. Division A has its origins in the Interborough Rapid Transit (IRT) company. Most of the Division A lines operate with 10-car trains, except the Flushing line (7 line), which regularly operates 11-car trains and the No. 3 line on the Seventh Avenue line, which operates 9-car trains. All of the Division A lines are labeled with numbers. The Lexington Avenue No. 4, 5, and 6 lines on the East Side of Manhattan are serviced with Division A cars. Division B has its origins in two separate systems: the Brooklyn-Manhattan Transit (BMT) company and the publicly operated Independent Subway (IND). These systems were built to similar specifications and use similar rolling stock. Division B lines generally run 8-car trains if the car length is 75 feet or 10-car trains if the car length is 60 feet (except on the J/Z and M lines where trains consist of eight 60-foot cars). Division B lines are labeled with letters instead of numbers. The Broadway N and R lines within the study area are run with Division B cars. A fleet summary of the vehicles contained in both Divisions A and B is shown in Table 9D-11.

Table 9D-11
NYCT Fleet Summary

Vehicle	Division	Number of Vehicles	Year in Service
R26	A	110	1959/60
R28	A	100	1960/61
R29	A	236	1962
R33	A	494	1962/63
R33S	A	39	1962/63
R36	A	424	1963/64
R62	A	325	1984/85
R62A	A	825	1985/87
R110A	A	10	1992
R32	B	595	1964/65
R38	B	196	1965/67
R40M	B	100	1968/69
R40S	B	295	1968/69
R42	B	392	1969/70
R44	B	278	1972/74
R46	B	752	1975/77
R68	B	425	1986/88
R68A	B	200	1988/89
R110B	B	9	1992

Sources:
New York City Subway Cars, by Clifford Geller.
NYCT Car Equipment Department, *Revenue on Non-Revenue Car Drawings*.

The two divisions use similar technology for signals and traction power but are incompatible because of different clearance standards for tunnels and stations. Division A tunnels were built to smaller specifications than those for Division B. In general, the Division A lines were built so their rights-of-way conformed to city streets. Division B lines were not similarly restricted. Division B vehicles, which are 60 or 75 feet in length, are longer than Division A vehicles, which are 51 feet in length. The 75-foot vehicles cannot run on all of the Division B lines. Since Division B vehicles are also heavier and wider than Division A vehicles, elevated structures built for the Division A lines may not be able to support Division B trains. A new rapid transit line could either be integrated into the Division A or the Division B system, but not both.

Vehicle Fleet. Table 9D-12 summarizes the NYCT rolling stock by division. As shown, the Division A vehicles are smaller than Division B vehicles and have fewer sets of doors per side. The R33 and the R62 cars operate on the No. 4 line. Only R33 vehicles operate on the No. 5 line, while R29, R36, and R62A vehicles are used on the No. 6 line. The R33 and R36 fleets were built in the early 1960's and rebuilt between 1987 and 1991. That restoration is expected to extend the life of the vehicles into the beginning of the next century. Division B vehicles have four doors per side, and are larger in size and have greater passenger capacities. The R32 cars operate on both the N and R lines. The N line also uses R68 vehicles, while the R line also uses R46 vehicles.

Table 9D-12

NYCT Rolling Stock

Vehicle	Div	Train Crew Size	Passenger Loading/Car			Doors/ Side	Current Type	Power Collection	Vehicle Parameters*		
			Seated	Guide-line	Crush				Weight (pounds)	Length (feet)	Width
DIVISION A FLEET											
R26	A	2	44	110	165	3	DC	3rd rail	72,000	51'-4"	8'-9½"
R28	A	2	44	110	165	3	DC	3rd rail	72,000	51'-4"	8'-9½"
R29	A	2	44	110	165	3	DC	3rd rail	72,000	51'-4"	8'-9½"
R33	A	2	44	110	165	3	DC	3rd rail	77,000	51'-4"	8'-9½"
R36	A	2	44	110	165	3	DC	3rd rail	72,000	51'-4"	8'-9½"
R62	A	2	44	110	165	3	DC	3rd rail	74,000	51'-4"	8'-9½"
R62A	A	2	44	110	165	3	DC	3rd rail	75,328	51'-4"	8'-9½"
DIVISION B FLEET											
R32	B	2	50	145	230	4	DC	3rd rail	68,000	60'-6"	9'-9"
R38	B	2	50	145	230	4	DC	3rd rail	68,000	60'-6"	9'-9"
R40M	B	2	50	145	230	4	DC	3rd rail	72,000	60'-6"	9'-9"
R40S	B	2	50	145	230	4	DC	3rd rail	68,000	60'-6"	9'-9"
R42	B	2	50	145	230	4	DC	3rd rail	72,000	60'-6"	9'-9"
R44	B	2	74	175	260	4	DC	3rd rail	86,000	75'-0"	9'-9"
R46	B	2	74	175	260	4	DC	3rd rail	89,000	75'-0"	9'-9"
R68	B	2	70	175	255	4	DC	3rd rail	91,500	75'-0"	9'-9"
R68A	B	2	70	175	255	4	DC	3rd rail	91,500	75'-0"	9'-9"

Note: * Weight refers to empty weight; length is over coupler facers; width is over thresholds.
Sources: NYCT Car Equipment Department, *Revenue on Non-Revenue Car Drawings*.
NYCT Division of Operations Planning/Facilities & Equipment Planning, *Subway Vehicle Passenger Capacities,* December 18, 1992.

NYCT has ordered new technology subway cars: R142 and R142A for Division A and the R143 for Division B. These cars include a variety of new technologies, ranging from performance-oriented AC traction and dynamic braking, to customer-oriented computerized public-address systems. The characteristics of these vehicles are shown in Table 9D-13.

Table 9D-13
New Technology Subway Cars

Vehicle	Div	Train Crew Size	Passenger Loading*: Seated Capacity	Passenger Loading*: Crush Capacity	Doors/ Side	Propulsion Type	Power Collection	Vehicle Parameters**: Weight (Empty)	Vehicle Parameters**: Weight (Loaded)	Vehicle Parameters**: Length	Vehicle Parameters**: Width
R142 R142A	A	1 or 2	Cab Car: 34 Non-Cab Car: 40 376/Train	182/car (Average) 1,820/Train	3	AC	3rd rail DC	70,000 lbs. (Average)	98,028 lbs. (Average)	51'6"	8'-9½"
R143	B	1 or 2	Cab Car: 36 Non-Cab Car: 44 408/Train	240/car (Average) 2,400/Train	4	AC	3rd rail DC	74,500 lbs. (Average)	111,500 lbs. (Average)	60'6"	10'

Notes:
* Assumes 10-car trains, consisting of four cab cars and six non-cab cars.
** Length is over coupler faces; width is over thresholds. Loaded weight assumes a crush load per car at 154 pounds/person.
Source: R143 Draft Technical Specifications, 4/30/97.
R143 Technical Specifications, Addendum #5, 2/2/98.

The R142 and R142A cars will be delivered in five-car sets consisting of two cab cars and three non-cab cars; two such sets comprise a 10-car Division A train. The R143 cars will be delivered in four-car sets consisting of two cab cars and two non-cab cars, for operation on lines that are restricted to eight-car (480-foot-long) Division B trains. The R143 cars or a subsequent car class could also be configured into five-car sets consisting of two cab cars and three non-cab cars; two such sets would comprise a 10-car (600-foot-long) Division B train for operation on those lines than can accommodate longer trains.

Passenger Loading Policy. Division A and B trains have different loading capacities. Because of their greater width and length, Division B vehicles have significantly higher passenger carrying capacities than Division A vehicles. Even though Division B trains usually have fewer cars than Division A trains, Division B trains can still carry more passengers than Division A trains. Depending on the car type, a fully loaded Division B train can carry between 20 and 27 percent more passengers than a Division A train. The seated and rush hour guideline capacities and maximum crush loads for all Division A and B vehicles are summarized in Table 9D-14.

Table 9D-14
NYCT Loading Policies

Division	Seated Capacity: Per Car	Seated Capacity: Per Train	Guideline Capacity: Per Car	Guideline Capacity: Per Train	Crush Load: Per Car	Crush Load: Per Train
A	44	440-484	110	1,110-1,210	165	1,650-1,815
B	50	500	145	1,450	230	2,300
	70	560	175	1,400	255	2,040
	74	592	175	1,400	260	2,080

Source: NYCT Division of Operations Planning/Facilities & Equipment Planning, *Subway Vehicle Passenger Capacities*," December 18, 1992.

For all the vehicles running on the Lexington Avenue No. 4, 5, and 6 lines, the maximum number of seated passengers is 44 per car. It is standard practice on rapid transit systems for the majority of passengers on a peak period train to be standees. The maximum physical (crush) capacity of a Division A train is reached when the number of passengers per car reaches 165. The guideline capacity refers to the NYCT criteria of 3 square feet per standing passenger, used to evaluate crowding conditions during peak hours. On Division A trains, the guideline capacity is 110 passengers per car. For the Broadway N and R lines, which carry all three types of Division B cars, seated, guideline, and crush capacities range from 50 to 74, 145 to 175, and 230 to 260 passengers per car, respectively.

Trackway Infrastructure

The current specifications used for the design and construction of track and contact rail are furnished in NYCT 's *MW-1 Track Standards and Reference Manual*. That document provides design standards for clearances, weight limits, speed limitations, and maintenance/yard facilities, etc. These factors are described below.

History of Construction. The original IRT subway was built north from City Hall to GCT, then west to Broadway along the path of the present-day 42nd Street shuttle, and finally up the west side of Manhattan along Broadway. The IRT extension along Lexington Avenue on the East Side of Manhattan was designed under city sponsorship as part of a municipal Triborough Subway. The actual construction and operation of the subway was turned over to the IRT as part of the Dual Contract system. However, because the extension was designed under city sponsorship, it was designed to “Triborough standards” (Division B). The platforms were widened to accommodate Division A trains. The BMT Broadway subway was also designed as part of the Triborough system and the original conception considered a link between the two lines. This link was never built and the designs were turned over to the two separate private operators (IRT and BMT) for construction.

Clearances. For Division A lines, the minimum horizontal clearance from the centerline of track to a platform edge is 4'-8¼". The minimum vertical clearance from the top of rail to the low point above the centerline of track is 12'-1½". All of the clearances for the Lexington Avenue No. 4, 5, and 6 lines meet these requirements. For Division B lines, the minimum horizontal clearance from the centerline of track to a platform edge is 5'-2". The minimum vertical clearance from the top of rail to the low point above the centerline of track is 12'-4½". The Broadway N and R lines follow these Division B standards. Table 9D-15 summarizes the clearance envelope for each of the divisions.

These different clearance standards create several incompatibilities among different transit vehicles. For example, although Division A trains are smaller, because of the gap between the platform and the car, they cannot use Division B stations. Likewise, Division B trains cannot fit into Division A tunnels. The Division B tunnels were originally designed to accommodate larger subway cars. Also, at the time of design, some consideration was given to making the tunnels wide enough to carry commuter rail cars, which were smaller than they are now. Because the Division B standards were relaxed during construction, the idea of building the tunnels large enough for commuter rail cars was abandoned, and because commuter rail cars have gotten larger, modern commuter rail cars would not fit into subway tunnels. An MTA specification M-1 car requires more than 13'-2" of height clearance, whereas Division B tunnels have minimum height clearances of only 12'-4½”.

Table 9D-15
NYCT Line Infrastructure

Train Line	Division	Clearances*		Signal Types
		Horizontal	Vertical	
1/9	A	4' 8¼"	12' 1½"	Wayside Signals/Manual Control
2	A	4' 8¼"	12' 1½"	Wayside Signals/Manual Control
3	A	4' 8¼"	12' 1½"	Wayside Signals/Manual Control
4	A	4' 8¼"	12' 1½"	Wayside Signals/Manual Control
5	A	4' 8¼"	12' 1½"	Wayside Signals/Manual Control
6	A	4' 8¼"	12' 1½"	Wayside Signals/Manual Control
7	A	4' 8¼"	12' 1½"	Wayside Signals/Manual Control
A	B	5' 2"	12' 4½"	Wayside Signals/Manual Control
B	B	5' 2"	12' 4½"	Wayside Signals/Manual Control
C	B	5' 2"	12' 4½"	Wayside Signals/Manual Control
D	B	5' 2"	12' 4½"	Wayside Signals/Manual Control
E	B	5' 2"	12' 4½"	Wayside Signals/Manual Control
F	B	5' 2"	12' 4½"	Wayside Signals/Manual Control
J	B	5' 2"	12' 4½"	Wayside Signals/Manual Control
L	B	5' 2"	12' 4½"	Wayside Signals/Manual Control
M	B	5' 2"	12' 4½"	Wayside Signals/Manual Control
N	B	5' 2"	12' 4½"	Wayside Signals/Manual Control
Q	B	5' 2"	12' 4½"	Wayside Signals/Manual Control
R	B	5' 2"	12' 4½"	Wayside Signals/Manual Control
S	B	5' 2"	12' 4½"	Wayside Signals/Manual Control
Z	B	5' 2"	12' 4½"	Wayside Signals/Manual Control

Note: * Horizontal: center line of track to platform edge. Vertical: top of rail to low point above center line of track.

Source: NYCT Division of Track, *MW-1 Track Standards and Reference Manual*.

Weight Limits. The weight limits for each division pertain only to elevated rail structures. Most of the elevated structures in the Bronx that support the Lexington Avenue No. 4, 5, and 6 lines were designed according to the structural specifications of the Dual Contract. These are the same standards used for the later BMT and IND lines (Division B standards).

The weight limits of the elevated structures could limit links between any new subway structures in Manhattan and older elevated structures in the Bronx, regardless of the date of construction. Even elevated structures built to Division B standards of the Dual Contract would still need their platforms cut back in order to accommodate Division B cars. The actual weight limits and specifications of the Bronx elevated structures would require further structural investigation in the future, if a decision is made to implement a new Manhattan/Bronx subway connection. A new connection is not proposed now, but it is not precluded.

Speed Limitations. Factors contributing to speed limitation problems, restrictions, and inconsistencies are explained in NYCT 's "Speed Policy Report, June 1991." These factors include signal design standards, lack of speedometers on older equipment, and train operations through territories controlled by grade time (GT) signals.

NYCT uses wayside signaling, a system in which signals along the side of the track control train movements between fixed signal blocks. An automatic tripping device that causes a train to make an emergency stop if it overruns a red signal is also incorporated. More modern signal systems (currently not used by NYCT) display the signal aspects inside the cab of the transit vehicle. The newest signaling systems do not have fixed signal blocks. The blocks move with the vehicles so the distance between transit vehicles operating on the same tracks can vary according to the speeds of the trains.

Maintenance and Yard Facilities. NYCT has maintenance facilities and storage yards throughout New York City to service and store their transit vehicles. NYCT has plans to expand both the Jamaica (24 tracks) and Canarsie (8 tracks—construction completed) yards. It is also considering long-term plans to build a new subway yard in Sunnyside.

Second Avenue Subway—Underground Segments Completed

As described in 2, a Second Avenue subway was planned and designed beginning in the 1950's and construction of the new route began in the 1970's. Three segments of the Second Avenue subway, designed to Division B standards, were constructed in the 1970's. At that time, the line was planned to pass under the Harlem River into the Bronx. No construction of the Bronx extension was ever started. Two of the constructed sections are located in northeastern Manhattan, beneath the right-of-way of Second Avenue. The third section of completed tunnel is in Lower Manhattan, near the approaches to the Manhattan Bridge. Table 9D-16 lists the locations where these tunnel sections were built, their segment lengths and numbers of vent flues.

Table 9D-16

Completed Tunnel Sections of the Second Avenue Subway

Line Section	Location	Length (feet)	No. of Vent Flues
132A-13	110th St.—120th St.	2,556	5
132A-11	99th St.—105th St.	1,815	2
132C-5	Division St.—Canal St.	738	2

Source: Reports on the Second Avenue Subway System, prepared in September 1972 and June 1973, by DeLeuw Cather.

All three tunnel sections were constructed by means of traditional cut-and-cover construction. Section 132A-13 was cut through the underlying rock line, which interfered with the tunnel's vertical alignment. The plans specified the use of the cut-and-cover methods to construct the entire tunnel between 92nd and 126th Streets.

Metro-North Railroad

The Metro-North Railroad transports many passengers into and out of the study area each day via its 125th Street station and GCT. Because Metro-North functions mainly as a feeder service into the study area versus within and throughout the study area, it relies on the transportation system within the study area and also affects the transportation needs within the study area.

Metro-North's Harlem, Hudson, and New Haven Lines converge and run between the 125th Street station in East Harlem and GCT in East Midtown. Grand Central is the railroad's primary Manhattan station and most important AM peak destination (only 2,000 Metro-North passengers exit at the 125th Street station each day). The following generally describes its service into the study area.

Metro-North Railroad, with a mileage-based zone fare policy, carries commuters from Westchester, Putnam, Dutchess, and Bronx Counties and western Connecticut into GCT. Metro-North also serves commuters in Orange and Rockland Counties west of the Hudson River. These services are provided in concert with New Jersey Transit. The vast majority of Metro-North riders' destinations lie within the study area. The Metro-North Railroad, during the average AM weekday peak period, carries 76,500 southbound passengers (currently, the Metro-North Railroad train service does not face severe capacity constraints at GCT). Some 93 percent of these passengers ride to GCT. Of the Metro-North passengers who arrive in GCT, 61 percent walk to their final destination and 29 percent transfer to the NYCT subway system. This translates to some 20,000 Metro-North passengers entering the NYCT subway system at GCT during the morning peak period.

Metro-North riders at GCT have the choice of three subway lines, the 42nd Street shuttle, the Flushing No. 7 line, and the Lexington Avenue No. 4, 5, and 6 line. For destinations on the East Side of Manhattan (the choice for over 66 percent of Metro-North riders), the Lexington Avenue line is the only alternative. Clearly a large part of GCT's pedestrian system furnishes vital access to the Lexington Avenue line.

FUTURE CONDITIONS COMMON TO ALL ALTERNATIVES

SYSTEMWIDE SUBWAY RIDERSHIP

Subway ridership has been on the rise in the past five years after a sharp decline in the beginning of the 1990's followed by a short stagnation period. The growth in subway ridership was further stimulated by the implementation of the free transfer program in July 1997. Total subway ridership in 1997 reached a 25-year high of 1.13 billion, up 2.1 percent from 1996. Another growth spurt is expected to occur with the introduction of the transit pass in the middle of this year. Long-term growth, however, is likely to show a lesser annual increase than that of recent years. The MTA, in its Strategic Business Plan for 1998-2002, anticipates an average annual growth rate of less than 1.0 percent in the next four years. Over the long term, the city's subway ridership is expected to grow annually by 0.5 to 1.0 percent.

CHANGES TO SUBWAY SERVICE

In the future, several changes to existing subway service are anticipated. The 63rd Street Connection will provide the Queens Boulevard F line with another East River crossing option on the Upper East Side, thus improving its throughput. The completion of the Manhattan Bridge construction will give the Broadway line the capability to again operate its express service. Changes to equipment and infrastructure, such as new technology trains, are also expected to occur as part of the MTA's continuing effort to improve transit service and renew its vehicle fleet, trackways, and storage facilities.

63rd Street Connection

One of the primary rapid transit projects expected to be completed as part of the No Build is the 63rd Street Tunnel Connection. NYCT is currently constructing a two-track connection between the Queens Boulevard station at Queens Plaza and the tunnel's existing terminal at Queensbridge/ 21st Street. This connection to both the express and local tracks of the Queens Boulevard line is expected to be completed in 2001 at a cost of about $612 million. After the completion of the connection, potential improvements to subway service between Manhattan and Queens can be made via rerouting trains from the Queens Boulevard line to the 63rd Street Tunnel and extending the 63rd Street B and Q service to Queens Boulevard. Both of these potential service improvements would help to enhance overall passenger capacity across the East River and reduce passenger crowding on the E and F lines.

Manhattan Bridge Reopening

The Manhattan Bridge has two sets of rapid transit tracks: the tracks on the north side of the bridge are designated "AB," and the tracks on the south side are designated "H." Since 1987, the New York City Department of Transportation (NYCDOT) has been conducting inspections and heavy maintenance work on Manhattan Bridge. This has resulted in temporary closure of either the "AB" or the "H" tracks or both to accommodate maintenance work. Currently, the "H" tracks are still closed to rapid transit trains. As a result, the Broadway N line was diverted to using the Montague Street Tunnel. NYCDOT anticipates that the bulk of the rehabilitation work will be completed by 2004, and both sets of tracks will be reopened to rail traffic. At that time, the Broadway BMT could again operate its express service via the Manhattan Bridge. The N line, along with a new Broadway line train to be designated as the "T" train, will run express in Manhattan between 57th and Canal Streets, while the R line will continue to provide local service to all stations.

It is expected that the N route would operate between Ditmars Boulevard in Queens and Coney Island in Brooklyn via 60th Street line, Broadway express, and the Manhattan Bridge with 11 trains per hour north- and southbound during the AM peak. The T route would operate between 57th Street/Seventh Avenue and Bay Parkway in Brooklyn via the 60th Street line, Broadway express, and the Manhattan Bridge with eight trains per hour north- and southbound during the AM peak. The R route would operate between Continental Avenue in Queens and 95th Street/4th Avenue in Brooklyn via the 60th Street, Broadway local, and Montague Street tunnel with 11 trains per hour north- and southbound during the AM peak. However, only six R trains per hour would traverse the Montague Street tunnel in the southbound direction between Manhattan and Brooklyn. One southbound R train would short-turn at Canal Street and four southbound R trains would short-turn at Whitehall Street. (More information on this conceptual service plan is provided later in this chapter, in the table comparing service under the No Build, TSM, and Build Alternatives, Table 9D-19.) The final service plan for when the Manhattan Bridge is fully open would be decided based upon public input occurring closer to the bridge's 2004 reopening date, and would also reflect other operating constraints, including subway car requirements.

In the northbound direction, 10 R trains in the AM peak would traverse the Montague Street tunnel between Brooklyn and Manhattan. With the southbound trains turning back, this would increase to 14 northbound trains per hour between Whitehall Street and City Hall and to 15 trains per hour from Canal Street northward.

MTA LONG-RANGE PLANNING FRAMEWORK

As described in more detail in Chapter 1, the MTA has developed a Long Range Planning Framework to create a unified program of future improvements to its subway and commuter rail systems. As part of this long-term strategy, MTA is undertaking seven coordinated but independent major investment studies, including the MESA study. The other six studies are as follows:

- East River Crossing Study, assessing alternative strategies to improve transit service between Brooklyn and Manhattan. The Draft MIS Report for the project concluded that the preferred alternative would construct a connection at Rutgers Street/DeKalb Avenue to allow trains now limited to the Manhattan Bridge to also use the Rutgers Street tunnel, accompanied by various operational changes.
- Long Island Rail Road East Side Access Project, evaluating alternatives for improving mobility between Long Island and Manhattan's East Side. The locally preferred alternative would bring some LIRR trains directly to Grand Central Terminal rather than Penn Station.
- Access to the Region's Core, which examines means to improve access and mobility from New Jersey to Long Island through Manhattan's CBD.
- Lower Manhattan Access, identifying and evaluating alternatives to improve access to Lower Manhattan for New York's suburban commuters.
- Metro-North Penn Station Access, considering options for bringing some Hudson Line commuter trains down the West Side and into Penn Station rather than Grand Central Terminal.
- LaGuardia Subway Access Study, a study to develop an airport access link from Lower and Midtown Manhattan to LaGuardia Airport, emphasizing an extension of the Broadway Line "N" train.

PROBABLE IMPACTS OF THE PROPOSED ALTERNATIVES

Chapter 2 of this document ("Alternatives Considered") describes the new transportation service proposed by the project alternatives. This section provides an evaluation of the subway impacts of the four project alternatives—the No Build Alternative, the TSM Alternative, Build Alternative 1, and Build Alternative 2. Ridership, operational changes, equipment and infrastructure modifications, and compatibility with the MTA/LIRR East Side Access project are evaluated and assessed. Impacts during construction are discussed separately in Chapter 15, "Construction and Construction Impacts." In addition, greater detail on each alternative's ability to improve the transit system and improve mobility, system capacity, and transit accessibility as well as effects on travel time and peak period crowding is provided in Chapter 20, "Comparative Benefits and Costs."

EVALUATION METHODOLOGY

A mode-choice transit model was used to assign projected AM peak hour ridership volumes to future transit networks that were coded to specific requirements of the four future alternatives. The outputs from the assignment runs provide volume information on subway links, station on/off and transfer activities, and summary statistics on passenger hours and miles traveled by mode. These data were used to compare ridership changes and service operations. Potential improvement and decline in service were compared in such terms as v/c ratios, number of crowded trains, and passenger hours in congested conditions.

SYSTEMWIDE RAIL RIDERSHIP

Table 9D-17 presents a summary of the estimated 2020 AM peak hour and average daily subway trips for each of the four alternatives*. As shown in the table, Build Alternative 2 shows the highest number of subway trips, followed by Build Alternative 1, followed by the TSM Alternative, with the No Build Alternative having the lowest number of trips.

Table 9D-17
2020 AM Peak Hour and Average Daily Subway Trips

Trip Type	Alternative	AM Peak Hour Trips		Average Daily Trips	
		Volume	Comparison with No Build	Volume	Comparison with No Build
CBD-Bound Trips	No Build	373,730	—	2,989,800	—
	TSM	373,879	+149	2,991,000	+1,200
	Build 1	374,583	+853	2,996,700	+6,900
	Build 2	374,827	+1,098	2,998,600	+8,800
Non-CBD-Bound Trips	No Build	233,657	—	1,869,300	—
	TSM	233,676	+20	1,869,400	+100
	Build 1	233,783	+126	1,870,300	+1,000
	Build 2	233,790	+133	1,870,300	+1,000
Total Trips	No Build	607,386	—	4,859,100	—
	TSM	607,555	+169	4,860,400	+1,300
	Build 1	608,365	+979	4,866,900	+7,800
	Build 2	608,617	+1,231	4,868,900	+9,800

Source: NYCT Model Output.

SERVICE CHARACTERISTICS

Service Changes to Rail Lines

Tables 9D-18 through 9D-20 show the scheduled train arrivals of the analyzed transit routes at selected stations for each alternative. These changes are described below.

No Build Alternative. Under the No Build Alternative, no changes are proposed for the subway system by the MESA project. The changes anticipated in the future in any case (described above under "Future Conditions Common to All Alternatives") would occur.

* The AM peak hour subway trips were direct outputs of the NYCT Model. Average daily trips were estimated by applying a daily expansion factor of 8.0. Volumes presented for Build Alternative 2 also contain LRT trips.

Table 9D-18
Southbound AM Peak Hour Arriving Trains for the Lexington Avenue Subway

Route	Station	Alternative							
		No Build		TSM		Build 1		Build 2	
		Express	Local	Express	Local	Express	Local	Express	Local
Lexington Avenue	125th Street	29	24	29	24	29	20	29	20
	116th Street	—	24	—	24	—	20	—	20
	110th Street	—	24	—	24	—	20	—	20
	103rd Street	—	24	—	24	—	20	—	20
	96th Street	—	24	—	24	—	20	—	20
	86th Street	29	24	29	24	29	20	29	20
	77th Street	—	24	—	24	—	20	—	20
	68th Street	—	24	—	24	—	20	—	20
	59th Street	27	24	27	24	29	20	29	20
	51st Street	—	24	—	24	—	20	—	20
	Grand Central	26	24	26	24	28	20	28	20
Park Avenue South	33rd Street	—	24	—	24	—	20	—	20
	28th Street	—	24	—	24	—	20	—	20
	23rd Street	—	24	—	24	—	20	—	20
	Union Square	23	24	23	24	27	20	27	20
Lafayette Street	Astor Place	—	24	—	24	—	20	—	20
	Bleecker Street		24		24		20		20
	Spring Street		24		24		20		20
	Canal Street		24		24		20		20
	Brooklyn Bridge	23	24	23	24	27	20	27	20
Broadway	Fulton Street	23	—	23	—	27	—	27	—
	Wall Street	23	—	23	—	27	—	27	—
	Bowling Green	23	—	23	—	27	—	27	—
Joralemon St. Tunnel	Enroute to Brooklyn	21	—	21	—	25	—	25	—

Source: NYCT Operations Planning and Vollmer Associates.

Table 9D-19
Southbound AM Peak Hour Arriving Trains for the East Side Subway Extension and Broadway Lines

Route	Station	Alternative							
		No Build		TSM		Build 1		Build 2	
		Express	Local	Express	Local	Express	Local	Express	Local
Second Avenue	125th Street	—	—	—	—	25	—	25	—
	106th Street	—	—	—	—	25	—	25	—
	96th Street	—	—	—	—	25	—	25	—
	86th Street	—	—	—	—	25	—	25	—
	72nd Street	—	—	—	—	25	—	25	—
63rd Street	Lexington Avenue	—	—	—	—	25	—	25	—
60th Street	Lexington Avenue	11	11	11	11	—	22	—	22
	Fifth Avenue	11	11	11	11	—	22	—	22
Broadway	57th Street	19	11	19	11	25	22	25	22
	49th Street	—	11	—	11	—	22	—	22
	Times Square	19	11	19	11	25	22	25	22
	34th Street	19	11	19	11	25	22	25	22
	28th Street	—	11	—	11	—	22	—	22
	23rd Street	—	11	—	11	—	22	—	22
	Union Square	19	11	19	11	25	22	25	22
	8th Street	—	11	—	11	—	22	—	22
	Prince Street	—	11	—	11	—	22	—	22
	Canal Street	19	11	19	10	25	22	25	22
Manhattan Bridge	Enroute to Brooklyn	19	—	19	—	—	22	—	22
Broadway	City Hall	—	10	—	10	25	—	25	—
	Cortlandt Street	—	10	—	10	20	—	20	—
	Rector Street	—	10	—	10	20	—	20	—
	Whitehall Street	—	10	—	10	20	—	20	—
Montague St. Tunnel	Enroute to Brooklyn	—	6	—	6	10	—	10	—

Source: NYCT Operations Planning.

Table 9D-20
AM Peak Hour Southbound Arrivals for the LRT

Station	Build 2
Union Square	20
First Avenue	20
Avenue B	20
13th Street	20
8th Street	20
E. Houston Street	20
Grand Street	20
Straus Square	20
Chambers Street	20
Fulton Street	20
Wall Street	20
Whitehall Street	20

Source: NYCT Model Output.

TSM Alternative. Service frequency on the Lexington Avenue line is proposed to increase with the TSM Alternative. The express No. 4 and 5 lines south of 59th Street would experience an increase from 23 to 24 trains per hour during peak periods due to minor signaling improvements on the Lexington Avenue line and the application of platform management techniques at Grand Central. The local service is proposed to increase from 24 to 28 trains per hour.

Build Alternative 1. The new East Side subway extension between 125th and 63rd Streets would provide a new option in rapid transit service and add five new stations in East Harlem and on the Upper East Side. South of 59th Street, the new line would follow the route of the Broadway line and run on its express tracks to Lower Manhattan. It is anticipated that the East Side subway extension would be referred to as the "R" route, and the R train in Queens would be redesignated as the "T" train. Both the N and the future T routes would operate on the local tracks and cross the East River over the Manhattan Bridge. The future R route would use the Broadway line's express tracks, and continue to Lower Manhattan. Some trains would terminate in Lower Manhattan during the peak hour and others would continue to Brooklyn via the Montague Street tunnel. Consequently, riders on local trains wishing to continue to Lower Manhattan or to cross into Brooklyn through the Montague Street tunnel (the current route of the N and R trains) would have to change trains at Union Square or Canal Street to the express service.

The future R route would operate between 125th Street/Lexington Avenue in Manhattan and 95th Street/4th Avenue in Brooklyn via Second Avenue, 63rd Street, the Broadway express, and the Montague Tunnel with 25 trains per hour north- and southbound. Only 10 R trains would traverse the Montague Street tunnel between Manhattan and Brooklyn in each direction. Five southbound R trains would short-turn at City Hall station (lower level) and 10 southbound R trains would short-turn at Whitehall Street. The N route would operate between Ditmars Boulevard in Queens and Coney Island in Brooklyn via the 60th Street line, Broadway local, and Manhattan Bridge with 11 trains per hour in the north- and southbound directions during the AM peak. The T route would operate between Continental Avenue in Queens and Bay Parkway in Brooklyn via the 60th Street line, the Broadway local, and the Manhattan Bridge with 11 trains per hour southbound and 8 trains per hour northbound during the AM peak. Table 9D-19 summarizes this conceptual service plan in the southbound direction for Build Alternatives 1 and 2 during the AM peak hour. (The table also summarizes NYCT's conceptual AM peak hour service plan for the No Build and TSM Alternatives.)

The net result would be that Build Alternatives 1 would have 22 southbound Broadway local trains crossing the Manhattan Bridge during the 2020 AM peak hour compared with 19 southbound Broadway express trains under the No Build. There would also be 10 southbound Broadway express trains using the Montague Street tunnel compared with six southbound Broadway local trains in the No Build. Therefore, southbound Broadway Line subway service between Manhattan and Brooklyn via the Manhattan Bridge and Montague Tunnel would have increased service levels under the Build alternatives of 16 and 67 percent, respectively.

In the northbound direction, between Brooklyn and Manhattan, there would be no change in service across the Manhattan Bridge or through the Montague Street tunnel. The northbound T service via the Manhattan Bridge and northbound R service via the Montague Street tunnel would operate at 8 and 10 trains per hour, respectively, the same as the No Build.

During the AM peak period, the new subway service would be scheduled to run 25 trains per hour, which is expected to attract a significant number of existing riders from the Lexington

Avenue line and north-south bus routes. Because of reduced demand and improved station dwell times, throughput on the Lexington Avenue express service would increase from 23 to 27 trains per hour south of Grand Central. On the Lexington Avenue local, scheduled service would be reduced from 24 to 20 trains per hour, due to a shift of East Harlem and Upper East Side riders to the new East Side subway service.

Build Alternative 2. In addition to the new subway, Build Alternative 2 would add an LRT to serve the Lower East Side and Lower Manhattan. Current plans show 12 stations along its route from Water Street to Union Square. This new service would run 20 LRT trains an hour in each direction during peak periods. Several subway connections would also be included as part of this new transit system. Access to the Lexington Avenue and Broadway lines would be available at Union Square, and access to the Canarsie line would be available along 14th Street and at Union Square. On the Lower East Side, a transfer to the F line could be made at East Broadway. Within Lower Manhattan, transfer opportunities would be available within short walking distances to several subway stations.[*]

Capacity vs. Usage

NYCT guidelines are expected to remain the same for both the Lexington Avenue and Broadway lines. The new subway in Build Alternatives 1 and 2 is currently designed to follow Division B standards (described earlier in the discussion of existing conditions, under "Rolling Stock") and run on the Broadway line tracks south of 59th Street. The cars on the East Side subway extension are expected to have guideline capacities of 145 or 175 passengers and crush capacities of 230 and 260 passengers (see Table 9D-12, above). The proposed LRT included in Build Alternative 2, which would operate in two married pairs, has a guideline capacity of 177 passengers per married pair. More information on each alternative's effect on peak period crowding is provided in Chapter 20.

Loadings.

Lexington Avenue Subway. Based on the transit model outputs on future subway link volumes and existing peak hour distributions, leave load levels were estimated for southbound express trains at key stations along the Lexington Avenue line. These are graphically shown in Figures 9D-10 through 9D-15. Substantial improvements to crowding were found for both Build alternatives, while little or no improvements were realized for the TSM Alternative. For example, in Figure 9D-11, 15 of the 29 AM peak hour southbound express trains leaving 125th Street are expected to have a volume-to-capacity (v/c) ratio of greater than 1 under the No Build Alternative. If either Build Alternative 1 or Build Alternative 2 is implemented, fewer trains would experience this crowding condition. In addition, crowding conditions on the remaining trains would also improve. Table 9D-21 shows a comparison of the simulated crowding conditions on southbound Lexington Avenue express trains at key stations for the four potential future alternatives.

* At the Brooklyn Bridge/Chambers Street station, transfers between the LRT and the Lexington Avenue and Jamaica subway lines can be made within the fare zone.

Table 9D-21

**Estimated Number of Trains Over Capacity,
AM Peak Hour Simulated Crowding Conditions
for Southbound Lexington Avenue Express Trains**

Station	Alternative	No. of Trains	Peak Hour Leave Load	Average V/C Ratio	No. of Trains over Capacity
125th Street	No Build	29	31,260	0.98	15
	TSM	29	31,284	0.98	15
	Build 1	29	28,843	0.90	13
	Build 2	29	28,556	0.90	10
86th Street	No Build	27	34,594	1.16	21
	TSM	27	33,459	1.13	20
	Build 1	29	29,711	0.93	14
	Build 2	29	29,615	0.93	13
59th Street	No Build	26	29,211	1.02	20
	TSM	26	29,330	1.03	20
	Build 1	28	28,400	0.92	7
	Build 2	28	28,115	0.91	7
Grand Central	No Build	23	30,403	1.20	20
	TSM	24	31,036	1.18	20
	Build 1	27	29,577	1.00	17
	Build 2	27	29,267	0.99	15
Union Square	No Build	23	28,698	1.13	19
	TSM	24	30,263	1.15	19
	Build 1	27	26,389	0.89	5
	Build 2	27	26,295	0.89	5
Brooklyn Bridge	No Build	23	24,580	0.97	8
	TSM	24	26,388	1.00	9
	Build 1	27	22,468	0.76	0
	Build 2	27	19,892	0.67	0

Source: NYCT Model Output.

Substantial reductions in crowding on the Lexington Avenue express would be realized with either Build Alternative 1 or Build Alternative 2. The TSM Alternative does not appear to be effective in alleviating crowding on the Lexington Avenue express, but its benefits would be more noticeable on the Lexington Avenue local service. As shown in Table 9D-22, with added trains provided by the TSM Alternative, the Lexington Avenue line, both express and local combined, would carry a larger number of riders than the No Build at lower crowding levels.

East Side Subway Extension and Broadway Lines. The new subway would connect with the Broadway line at the 57th Street station. South of this connection, subway service and ridership along Broadway would vary among the four future alternatives. Table 9D-23 shows the usage levels predicted by the NYCT model at key stations along the East Side subway extension and Broadway BMT lines.

Table 9D-22
AM Peak Hour Combined Line-Haul for Southbound Lexington Avenue Express and Local Trains

Station	Alternative	No. of Trains	Peak Hour Leave Load	Average V/C Ratio	Estimated No. of Trains over Capacity
125th Street	No Build	53	35,614	0.61	15
	TSM	57	35,609	0.57	15
	Build 1	49	30,526	0.57	13
	Build 2	49	30,335	0.56	10
86th Street	No Build	51	47,174	0.84	21
	TSM	55	46,790	0.77	20
	Build 1	49	34,164	0.63	14
	Build 2	49	34,051	0.63	13
59th Street	No Build	50	47,354	0.86	25
	TSM	54	49,685	0.84	22
	Build 1	48	36,980	0.70	7
	Build 2	48	36,402	0.69	7
Grand Central	No Build	47	44,844	0.87	20
	TSM	52	47,940	0.84	20
	Build 1	47	40,023	0.77	17
	Build 2	47	39,298	0.76	15
Union Square	No Build	47	33,943	0.66	19
	TSM	52	36,217	0.63	19
	Build 1	47	30,234	0.58	5
	Build 2	47	29,990	0.58	5

Source: NYCT Model Output.

Table 9D-23
AM Peak Hour Line-Haul for Southbound East Side Subway Extension and Broadway Lines

Route	Station	Alternative	No. of Trains	Peak Hour Leave Load	Average V/C Ratio
East Side Subway Extension	125th Street	No Build	—	—	—
		TSM	—	—	—
		Build 1	25	10,095	0.29
		Build 2	25	10,181	0.29
	86th Street	No Build	—	—	—
		TSM	—	—	—
		Build 1	25	21,933	0.62
		Build 2	25	21,929	0.62
	72nd Street	No Build	—	—	—
		TSM	—	—	—
		Build 1	25	26,032	0.74
		Build 2	25	26,159	0.74
	Lexington Avenue	No Build	—	—	—
		TSM	—	—	—
		Build 1	25	30,250	0.86
		Build 2	25	29,576	0.84
Broadway	57th Street	No Build	30	13,447	0.27
		TSM	30	11,824	0.24
		Build 1	47	33,367	0.44
		Build 2	47	33,285	0.44
	Times Square	No Build	30	12,814	0.26
		TSM	30	11,023	0.22
		Build 1	47	28,780	0.38
		Build 2	47	29,257	0.39
	34th Street	No Build	30	12,813	0.26
		TSM	30	10,973	0.22
		Build 1	47	27,226	0.36
		Build 2	47	27,567	0.36
	Union Square	No Build	30	8,658	0.18
		TSM	30	7,533	0.15
		Build 1	47	21,375	0.28
		Build 2	47	20,853	0.28

Source: NYCT Model Output.

LRT. Build Alternative 2 includes a light rail option in Lower Manhattan and the Lower East Side. Its projected volumes and volume to capacity ratios are presented in Table 9D-24.

Table 9D-24
AM Peak Hour Line-Haul for Southbound LRT

Station	No. of Trains	Peak Hour Leave Load	Average V/C Ratio
Union Square	20	478	0.09
First Avenue	20	377	0.06
Avenue B	20	1,057	0.19
13th Street	20	1,050	0.19
8th Street	20	1,224	0.21
E. Houston Street	20	1,518	0.26
Grand Street	20	2,044	0.36
Strauss Square	20	2,517	0.45
Chambers Street	20	4,915	0.86
Fulton Street	20	3,403	0.60
Wall Street	20	370	0.06
Source: NYCT Model Output.			

Pedestrian Circulation at Subway Stations

Future pedestrian circulation at subway stations would vary with each alternative. Circulation patterns for the No Build and TSM Alternatives are expected to be similar to those seen today with slightly higher activities due to growth in ridership. Build Alternatives 1 and 2, however, are expected to exhibit noticeable changes in transit usage and in pedestrian movements at different subway stations. Station entries/exits and subway-to-subway transfers obtained from model outputs were examined to evaluate these changes. Tables 9D-25 through 9D-27 present comparisons of these statistics for the four alternatives.

Table 9D-25
AM Peak Hour Station Entry/Exit Volumes at Lexington Avenue Express Stops

	No Build			TSM			Build 1			Build 2		
Station	Entry	Exit	Total	Entry	Exit	Total	Entry	Exit	Total	Entry	Exit	Total
Brooklyn Bridge	637	6,557	7,194	627	6,769	7,396	669	5,449	6,118	367	4,784	5,151
Union Square	2,614	5,019	7,633	2,654	5,470	8,124	2,251	4,716	6,967	2,814	4,870	7,684
Grand Central	5,569	23,495	29,064	5,439	23,482	28,921	6,118	23,299	29,417	6,349	23,704	30,053
59th Street	917	7,758	8,675	847	7,306	8,153	747	7,960	8,707	785	8,170	8,955
86th Street	6,737	3,299	10,036	6,196	3,278	9,474	2,604	2,349	4,953	2,600	2,446	5,046
125th Street	1,571	1,936	3,507	1,521	1,921	3,442	1,047	1,654	2,701	997	1,655	2,652
Total	18,045	48,064	66,109	17,284	48,226	65,510	13,436	45,427	58,863	13,912	45,629	59,541
Source: NYCT Model Output.												

Table 9D-26
AM Peak Hour Station Entry/Exit Volumes at East Side Subway Extension and Broadway Line Express Stops

Station	No Build			TSM			Build 1			Build 2		
	Entry	Exit	Total	Entry	Exit	Total	Entry	Exit	Total	Entry	Exit	Total
Canal Street	41	710	751	39	660	699	232	3,656	3,888	239	3,609	3,848
Union Square	1,042	8,567	9,609	995	7,834	8,829	2,254	9,976	12,230	3,152	10,189	13,341
34th Street	85	4,160	4,245	73	3,984	4,057	217	6,111	6,328	230	6,533	6,763
Times Square	147	4,229	4,376	138	4,032	4,170	292	7,809	8,101	297	7,996	8,293
57th Street	597	7,664	8,261	576	7,523	8,099	1,250	11,409	12,659	1,227	11,425	12,652
Lexington Ave.	N/A	N/A	N/A	N/A	N/A	N/A	389	410	799	358	516	874
72nd Street	N/A	N/A	N/A	N/A	N/A	N/A	4,323	2,318	6,641	4,132	2,207	6,339
86th Street	N/A	N/A	N/A	N/A	N/A	N/A	4,067	278	4,345	4,064	244	4,308
96th Street	N/A	N/A	N/A	N/A	N/A	N/A	3,564	285	3,849	3,561	274	3,835
106th Street	N/A	N/A	N/A	N/A	N/A	N/A	1,076	344	1,420	1,069	344	1,413
125th Street	N/A	N/A	N/A	N/A	N/A	N/A	308	298	606	319	293	612
Total	1,912	25,330	27,242	1,821	24,033	25,854	17,972	42,894	60,866	18,648	43,630	62,278

Source: NYCT Model Output.

Table 9D-27
AM Peak Hour Transfer Volumes

Station	Route(s)	No Build		TSM		Build 1		Build 2	
		Fwd	Rev	Fwd	Rev	Fwd	Rev	Fwd	Rev
125th Street/Lexington Avenue	4/5 to ⏩	N/A	N/A	N/A	N/A	3,973	350	4,791	382
	6 to 4/5	15,114	4,487	15,638	4,261	14,228	5,116	14,125	4,445
	6 to ⏩	N/A	N/A	N/A	N/A	5,881	356	5,162	319
59th Street/Lexington Avenue	4/5 to ⏩	5,225	5,234	4,609	5,914	1,823	6,590	1,973	6,400
	6 to 4/5	151	909	141	1,242	54	1,464	48	1,217
	6 to ⏩	1,260	3,982	1,348	5,072	327	3,481	280	3,563
51st Street/Lexington Avenue	6 to E/F	1,138	2,113	1,243	2,832	378	2,029	315	1,765
Grand Central	4/5 to 7	2,936	5,907	2,331	6,455	2,174	6,711	2,362	6,617
	4/5 to S	360	182	338	217	109	88	85	89
	6 to 4/5	6,876	9,363	6,629	9,819	5,416	9,433	5,263	9,622
	6 to 7	1,562	5,545	1,573	5,369	1,060	5,896	963	5,839
	6 to S	337	277	373	251	52	139	193	217
Union Square	4/5 to ⏩	1,580	1,557	1,220	1,177	2,511	1,998	2,521	1,770
	4/5 to L	1,243	2,491	1,129	2,186	1,336	2,137	1,134	2,175
	6 to 4/5	3,128	6,269	3,854	5,931	2,425	7,414	2,111	6,166
	6 to ⏩	583	1,729	753	2,060	1,189	1,005	947	1,252
	6 to L	556	2,281	662	2,546	383	2,012	388	1,882
	4/5 to LRT	N/A	N/A	N/A	N/A	N/A	N/A	1,132	790
	6 to LRT	N/A	N/A	N/A	N/A	N/A	N/A	283	649
	⏩ to LRT	N/A	N/A	N/A	N/A	N/A	N/A	1,578	1,793
	L to LRT	N/A	N/A	N/A	N/A	N/A	N/A	27	1
Brooklyn Bridge/Chambers Street	4/5 to J/M/Z	191	731	238	793	218	674	832	626
	6 to 4/5	1,590	2,000	1,745	1,424	1,007	1,796	1,316	2,790
	6 to J/M/Z	61	339	47	201	103	322	339	292
	4/5 to LRT	N/A	N/A	N/A	N/A	N/A	N/A	1,634	947
	6 to LRT	N/A	N/A	N/A	N/A	N/A	N/A	1,416	659
	J/M/Z to LRT	N/A	N/A	N/A	N/A	N/A	N/A	3,746	149

Notes:
Fwd = Transfer direction as indicated under "Route(s). Rev = Transfer direction opposite of that indicated.
⏩ Signifies the East Side subway extension and/or the Broadway lines. Current plans have different designations for future subway lines operating on the Broadway tracks.
Source: NYCT Model Output.

The level of transfer activities at a subway station is often a good indicator for comparing operating conditions or congestion levels of several future alternatives. Table 9D-28 shows a qualitative assessment of 2020 AM peak hour transfer activities at key stations in the study area. In this table, transfer volumes for the TSM and Build alternatives were compared to those in the No Build. The ratings were determined by assessing conditions observed recently at the associated transfer elements (i.e., stairways, corridors, and platforms, etc.) and comparing them with those expected under the No Build alternative. In general the TSM Alternative would not have substantial changes in transfer movements at most Lexington Avenue stations when compared to the No Build. However, transfer activities are expected to be significantly higher at the 59th Street station between the 6 and R routes, and at the Bleecker Street station between the 6 and B/D/F/Q routes. For Build Alternative 1, transfer volumes are expected to be somewhat lower than those in the No Build, with the exception of those at the Union Square station between the 4/5/6 and N/R/T routes. For Build Alternative 2, transfer volumes are expected to be similar to those in Build Alternative 1, with the exception of higher transfer activities between the 4/5/6 and J/M/Z routes at the Brooklyn Bridge/Chambers Street station, where a light rail stop is proposed to be built within the existing subway station.

Current designs for new subway stations for the Build Alternatives 1 and 2 indicate typical stairway widths of 8 to 10 feet wide. As described in the analysis of existing subway station elements, the service capacity of subway stairs is about 600 persons per hour per feet. A 10-foot stairway with a center rail has an effective width of 7 feet. Taking into account a 10 percent flow reduction contributed by uneven bi-directional flow, the LOS C/D capacity of the typical subway stairs is about 3,800 persons per hour. The largest total AM peak hour station entry/exit volume predicted by the NYCT model is about 6,600 people, or 11,000 people after taking into account of the 0.60 peak hour factor, at the 72nd Street station. A stairway at this station would operate at LOS C/D condition if 35 percent of the total demand or 3,850 people chose to use one single stairway. South of its 125th Street terminus, the first transfer opportunity for the new subway would occur at the Lexington Avenue and 63rd Street station. The heaviest transfer movements, predicted by the NYCT model, would be those between the Q and R lines in the southbound direction. These would take place on the same platform and, as shown in Table 9D-28, they are expected to operate at satisfactory to borderline satisfactory conditions.

Comparison of Subway Passenger Hours and Miles

Subway passenger hours and miles consist of in-vehicle, access, egress and transfer travel taking into consideration walking and bus transfers to/from different neighborhoods. These statistics were estimated for each of the four alternatives and are presented in Table 9D-29. Chapter 20 of this document, "Comparative Benefits and Costs," provides more detailed information on travel time savings (see especially Tables 20-2, 20-8, and 20-9), as well as other evaluative measures, including improvements to mobility, system capacity, and transit accessibility.

Reductions in passenger hours over the future No Build are realized for the TSM and Build Alternatives 1 and 2. These reductions are attributed to service improvements and the implementation of new transit service (the new subway and the LRT). Passenger miles are expected to remain almost constant for the TSM Alternative but increase for Build Alternatives 1 and 2. These increases are mainly attributed to the introduction of new transit service, which is expected to shift some existing users of other travel modes to the subway. A better indicator of the time and distance spent in travel is the efficiency (speed) of travel. Dividing the total passenger miles by the total passenger hours gives the systemwide miles per hour of travel, as shown in Table 9D-30.

Table 9D-28

Qualitative Evaluation of 2020 AM Peak Hour Transfer Activities

Operational Comparisons of TSM and Build Alternatives to the Future No Build

Station	Route(s)	No Build Alternative				Volume Difference						Operational Ratings					
		Forward		Reverse		Forward			Reverse			Forward			Reverse		
		Volume	Rating	Volume	Rating	TSM	Alt. 1	Alt.2	TSM	Alt. 1	Alt.2	TSM	Alt. 1	Alt.2	TSM	Alt. 1	Alt.2
Lexington Ave - 63rd St	Q sb to R nb						1,342	1,191					□	□			
	Q sb to R sb						7,961	7,424		2,499	2,522		❖	❖		□	□
	Q nb to R nb						604	776		561	580		○	○		○	○
	Q nb to R sb									1,454	1,568					□	□
125th St - Lexington Ave	4/5 to R						3,973	4,791		350	382						
	6 to 4/5	15,114	◆	4,487	□	524	(886)	(989)	(226)	629	(42)	◆	❖	❖	□	□	□
	6 to R						5,881	5,162		356	319						
86th St - Lexington Ave	6 to 4/5	557	◆	1,080	◆	(82)	(271)	(187)	215	(573)	(599)	◆	❖	❖	◆	❖	❖
59th St - Lexington Ave	4/5 to N/R	5,225	⌘	5,234	⌘	(616)	(3,402)	(3,252)	680	1,356	1,166	⌘	◆	◆	⌘	◆	◆
	6 to 4/5	151	◆	909	◆	(10)	(97)	(103)	333	555	308	◆	❖	❖	◆	◆	◆
	6 to N/R	1,260	◆	3,982	◆	88	(933)	(980)	1,090	(501)	(419)	⌘	□	□	⌘	□	□
51st St - Lexington Ave	6 to E/F	1,138	❖	2,113	◆	105	(760)	(823)	719	(84)	(348)	❖	○	○	⌘	◆	❖
Grand Central	4/5 to 7	2,936	◆	5,907	⌘	(605)	(762)	(574)	548	804	710	◆	◆	◆	⌘	⌘	⌘
	4/5 to S	360	◆	182	◆	(22)	(251)	(275)	35	(94)	(93)	◆	❖	❖	◆	❖	❖
	6 to 4/5	6,876	💣	9,363	💣	(247)	(1,460)	(1,613)	456	70	259	💣	⌘	⌘	💣	⌘	⌘
	6 to 7	1,562	◆	5,545	⌘	11	(502)	(599)	(176)	351	294	◆	◆	◆	⌘	⌘	⌘
	6 to S	337	◆	277	◆	36	(285)	(144)	(26)	(138)	(60)	◆	❖	❖	◆	❖	❖
Union Square	4/5 to N/T	793	◆	1,243	◆	86	(59)	280	(273)	72	(209)	◆	⌘	⌘	◆	⌘	⌘
	4/5 to R	787	◆	314	◆	(446)	990	661	(107)	369	422	◆	⌘	⌘	◆	⌘	⌘
	4/5 to L	1,243	◆	2,491	◆	(114)	93	(109)	(305)	(354)	(316)	◆	◆	◆	◆	◆	◆
	6 to 4/5	3,128	⌘	6,269	⌘	726	(703)	(1,017)	(338)	1,145	(103)	⌘	◆	◆	⌘	⌘	⌘
	6 to N/T	297	◆	1,409	◆	(12)	280	46	132	(693)	(629)	◆	⌘	⌘	◆	⌘	⌘
	6 to R	286	◆	320	◆	182	326	318	199	(31)	152	◆	⌘	⌘	◆	⌘	⌘
	6 to L	556	◆	2,281	◆	106	(173)	(168)	265	(269)	(399)	◆	◆	◆	◆	◆	◆
Bleecker Street	6 to B/D/Q	680	❖	1,465	❖	297	(301)	(229)	490	(536)	(296)	◆	○	○	◆	○	○
	6 to F	1,067	❖	914	❖	(33)	(243)	(430)	(55)	(478)	(350)	◆	○	○	◆	○	○
Canal Street	6 nb to 6 sb	--		412	□	1	1	1	149	(266)	(292)	□	□	□	□	○	○
	6 nb to BMT	26	❖	2,288	❖	(9)	(13)	23	571	(279)	(12)	❖	❖	❖	◆	❖	❖
	6 sb to BMT	252	❖	522	❖	26	(182)	(197)	111	(21)	39	❖	□	□	❖	□	□
Brooklyn Bridge	4/5 to J/M/Z	191	❖	731	❖	47	27	641	62	(57)	(105)	❖	❖	❖	❖	❖	◆
	6 to 4/5	1,590	❖	2,000	❖	155	(583)	(274)	(576)	(204)	790	❖	□	□	□	□	◆
	6 to J/M/Z	61	❖	339	❖	(14)	42	278	(138)	(17)	(47)	❖	❖	❖	❖	❖	◆
Broad Street	1/9 to LRT																
	4/5 to LRT																
	R to LRT							1,171									
Chambers Street	6 to LRT							1,416			659						◆
	4/5 to LRT							1,634			947						◆
	J/M/Z to LRT							3,746			149						❖
14th St - 1st Ave	L to LRT							167			143						
Union Square	4/5 to LRT							1,132			790						
	6 to LRT							283			649						
	N/T to LRT							18			15						
	R to LRT							1,560			1,778						
	L to LRT							27			1						

AM Peak Hour Ratings

- ○ - Good Operating Condition
- □ - Satisfactory Condition
- ❖ - Borderline Satisfactory Condition
- ◆ - Moderate Crowding Condition
- ⌘ - Severe Crowding Condition
- 💣 - Extreme Crowding Condition

Table 9D-29
AM Peak Hour Subway Passenger Hours and Miles

Subway Summary Statistics	No Build	TSM	Build 1	Build 2
PASSENGER HOURS				
In Vehicle	276,555	275,803	275,169	274,754
Access	59,428	59,441	59,485	59,548
Egress	19,708	19,763	19,777	19,763
Transfer	12,671	12,607	12,859	12,692
Total	368,362	367,614	367,290	366,757
PASSENGER MILES				
In Vehicle	4,903,466	4,897,378	4,928,028	4,921,500
Access	114,743	114,781	114,809	114,966
Egress	37,567	37,709	37,704	37,691
Transfer	12,480	12,428	12,285	12,188
Total	5,068,256	5,062,296	5,092,826	5,086,345

Source: NYCT Model Output.

Table 9D-30
AM Peak Hour Subway Passenger Travel Efficiency

Measure of Efficiency	No Build	TSM	Build 1	Build 2
Travel Efficiency (mph)	13.759	13.771	13.866	13.868
Increase over No Build (mph)	N/A	0.012	0.107	0.110

Source: NYCT Model Output.

Clearly, both Build Alternatives 1 and 2 show a more noticeable efficiency improvement over the No Build than the TSM Alternative. Although the increments shown appear to be small, they would be significant for the individual passengers served by Build Alternatives 1 and 2. A more detailed discussion on the value of time savings is included in Chapter 20.

EQUIPMENT AND INFRASTRUCTURE CHARACTERISTICS

East Side Subway Extension Components of Build Alternatives 1 and 2

Rolling Stock. The proposed subway would be built to B Division standards and would operate with B Division rolling stock. The vehicles proposed for the new subway would likely resemble the new B Division R-143 cars and run in 8-car sets. However, the new route does not preclude the use of 10 60-foot car sets for its rolling stock. Table 9D-31 shows NYCT's scheduled net gains or losses in its rolling stock. Additional information on rolling stock is provided in Chapter 20.

Table 9D-31
Comparison of Project Alternatives:
Rolling Stock Summary by Project Alternative

	TSM	Build 1	Build 2
Subway Cars			
Second Ave./Broadway Service (B Division) Cars			
Peak Hour Service (86th St. station): 27 eight-car trains		216	216
Spares at 15.8%		36	36
Total		252	252
Lexington Ave. Service (A Division) Cars			
Peak Hour Service (86th St. station): 3 or 4 ten-car trains	30	-40	-40
Spares at 15%	5	-6	-6
Total	35	-46	-46
Non-Revenue Cars	0	0	0
Light Rail Cars			
Lower East Side/Financial District Service			
Peak Hour Service (Chambers St. station): 12 two-car trains plus 10 one-car trains			34
Spares at 12%			4
Total			38
Non-Revenue Motor Vehicles (LRT)			5
Articulated Buses			
Peak Hour Service (Buses)			
M15 bus route	28	-1	-5
Spares at 10%	3	0	-1
Total	31	-1	-6

Trackway Infrastructure. All track and tunnel construction for the new subway has been designed to conform to NYCT's *MW-1 Track Standards and Reference Manual*. The new subway would be constructed with clearances sufficient to accommodate the existing B Division rapid transit fleet, which typically operates eight 75-foot cars per train. The only exception to the MW-1 standards would arise in the reconstruction of the Canal Street interlocking. The existing interlocking includes an underpass that has curves and grades that do not conform to MW-1 standards. The new subway proposed as part of Build Alternatives 1 and 2 would involve reconstruction of this interlocking to allow express trains (including the new subway) onto the local tracks and local trains onto the express tracks. New ramps would have to be in place to connect the local tracks to the existing underpass. (This is described in more detail in 2 and in Appendix D). For this reason, the existing portions of the reconstructed interlocking would not conform to the MW-1 standards for new construction. Since the source of nonconformity is part of the existing system, the NYCT has deemed this reconstruction effort as acceptable without having to conform to MW-1 standards. A lower speed restriction would be required. Nonetheless, all rolling stock would be able to fit through this segment.

As described in 15, the proposed subway would be constructed primarily with deep-bore tunneling using tunnel boring machines (TBMs). This construction technique is very different from the cut and cover method used to construct most of the existing NYCT subway system. However, TBMs have been previously used in public works construction in New York City and are currently being used to construct Water Tunnel #3 in Manhattan and Queens. For station locations and some sections of the subway in northeast Manhattan, cut-and-cover construction would be required rather than the TBM tunneling technique. The two previously completed subway tunnels, Route Section 132A-11 and Route Section 132A-13, would be incorporated into the proposed subway for both revenue and storage tracks.

Storage/Maintenance Facility. Many possibilities exist for the maintenance and storage of East Side subway extension trains. Storage of subway trains can be provided along the line on storage tracks and at the reconstructed 36th-38th Street Yard. This yard is currently used by the Maintenance of Way division of NYCT for work train loading, unloading, and storage. As part of this project, the yard would be reconfigured, with up to 10 new storage tracks added and some loading and unloading operations relocated to a new set of team tracks. Between the storage tracks along the line, additional storage at the 36th-38th Street Yard, and trains needed to provide overnight service, sufficient storage is expected for all of the additional trainsets required for the East Side subway extension service. An alternative storage facility would be the new NYCT yard at Sunnyside, although the availability of that yard is not certain.

Light Rail Transit (Build Alternative 2)

Rolling Stock. The proposed LRT included in Build Alternative 2 would use low-floor, articulated light rail vehicles. Since the existing NYCT route network does not have light rail service, no similarity comparisons can be made to other NYCT vehicles. The light rail vehicles are expected to be powered through an overhead contact system (OCS) with a power source of either 600 vDC or 750 vDC. These vehicles would very likely be similar to those operating in Paris, Grenoble, and Rouen, in France and produced by GEC/Alsthom. They are 70 percent low-floor so as to allow level boarding from a low-level platform built into the sidewalk. The vehicle dimensions are expected to be approximately 96.4 feet long and 7.6 feet wide. The Grenoble married pair can carry up to 120 passengers, with a seated capacity of 54 passengers. The light rail vehicles designed to operate on the New York City street network in trains of two married-pairs would have slightly higher passenger capacities than the Grenoble trains. Additional information on rolling stock is provided in 20.

Trackway Infrastructure. The trackway would be imbedded in the roadway for the majority of the light rail alignment. For the non-exclusive LRT operating areas, the existing street traffic can operate on, or can cross directly over the light rail tracks. The track would be standard gauge (1435 mm) and would lie above the level of any utilities. Those segments of the light rail that are located in tunnel or existing subway would be constructed using direct fixation to the concrete on the tunnel floor. Direct fixation would be used so as to maximize the clearance for the overhead wires. The overhead wires would be strung over the street from a mixture of modified street lamp poles, overhead catenary system (OCS) poles and existing buildings, where possible. The poles would be spaced approximately 100 feet apart. The OCS would be powered at either 600 vDC or 750 vDC. Power would be supplied from five substations located along the line, each with two rectifiers.

Because much of the new LRT route would require mixed operation with auto traffic, the OCS would have to be suspended over the tracks from span wires. The span wires would be hung from curbside poles or building fixtures. Where possible, curbside poles used to support street lights, traffic signals, and signs could be used to carry span wires as well to eliminate unnecessary new poles. In stations with canopies, it may also be possible to string the wires from brackets on the canopy support poles. Except in these locations, center poles are generally not recommended because of their potential hazards to auto traffic and their impacts on available traffic lanes.

Two basic OCS systems are available: simple trolley wire and catenary. Trolley wire has the simplest overhead wiring scheme but requires relatively close pole spacing, with a single powered wire running the length of the street and span wires running across the street between two poles. Catenary has a more complex overhead wiring system, by suspending the powered wires from a series of suspension wires that run the length of the street. It, nevertheless, has the benefit of requiring less closely spaced poles. For the LRT, the simple trolley wire system is more appropriate. Because the city streets are already full of lighting and traffic signal poles, spatial clutter can be reduced by taking advantage of these existing poles for LRT overhead wire suspension.

Storage/Maintenance Facility. To provide the necessary storage and maintenance for the Lower East Side LRT, the project team has identified a potential site in the Seward Park Extension Urban Renewal Area. The entire site, including the Essex retail market and the rights-of-way of Norfolk, Suffolk and Clinton Streets, is approximately 188,000 square feet in size. The new facility would be located underground, beneath the grade of existing streets, and would not interfere with the development opportunities on the surface. Access to the site would be provided via a ramp that would descend along Delancey Street South between Kazan Street and Ridge Street. The underground yard facility would include 1) six storage tracks ranging between 600 and 700 feet long, providing total storage for approximately 40 light rail vehicles; 2) two shop tracks with a 100-foot-long pit for each shop track, as part of a 40,500-square-foot shop facility; and 3) one single run-around track, accessed by means of a 100-foot-long transfer table located behind the shop. Under the proposed scheme, the yard tracks would take up some of the space currently occupied by the abandoned trolley loop in the Essex-Delancey Street station. The facility would not impact any existing structures other than the Essex Street Retail Market building, which could be underpinned to remain in place during the construction of the underground facility. All of the properties that may require relocation are owned by the City of New York. The storage and maintenance requirements and possible facility along Delancey Street are discussed in more detail in Appendix D, “Final Engineering Report.”

EVALUATION OF COMPATIBILITY WITH MTA/LIRR EAST SIDE ACCESS PROJECT

As noted earlier, the study corridor includes the existing Lexington Avenue subway line, which serves Grand Central Terminal. MTA is also advancing the LIRR East Side Access project, which would provide new rail service to Grand Central Terminal via a planned connection to an existing tunnel at 63rd Street.

In addition to providing direct service to the east side of midtown Manhattan, the Grand Central Terminal link would be used by commuters destined for Lower Manhattan, some of whom currently transfer from the LIRR to the subway at either Penn Station in West Midtown or the Flatbush Avenue terminal in Brooklyn. Estimates of the LIRR customers bound for Lower Manhattan who would use the Lexington avenue line at Grand Central during the peak hour of travel are continuing to be developed as part of the LIRR East Side Access Draft Environmental Impact Statement (DEIS).

Both the MESA DEIS and the LIRR East Side Access DEIS are coordinated under MTA's Long Range Planning Framework. If LIRR ridership were considered in the MESA 2020 No Build condition, additional peak period customers would be added to the existing Lexington Avenue service, which, as already described in this report, does not meet current service crowding guidelines. Construction of either MESA Build alternative would, in addition to reducing crowding and improving reliability on the Upper East Side, significantly reduce the crowding of trains serving Grand Central Terminal, including the potential impact of the LIRR East Side Access Project.

A more detailed analysis of the travel patterns of LIRR customers traveling to Grand Central Terminal is being undertaken in the LIRR East Side Access DEIS and will be incorporated in the MESA planning effort as that information becomes available. ❖