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At Capacity:
The Need for More Rail Access to the Manhattan CBD

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EXECUTIVE SUMMARY

This report focuses on the need for new rail access to Manhattan to ensure that the economy of the Manhattan Central Business District (CBD) will retain its critical central function in the national and New York regional economy, and can expand the level of economic activity and jobs in this new century.

During the final 25 years of the 20th Century, total employment in Manhattan's Central Business District (CBD) increased by 422,000 jobs, a gain of 24%. This growth in jobs, which averaged 0.9% per year, occurred despite the significant loss of jobs in each of the two recessions during the period. By the year 2000, the Manhattan CBD remained the pivotal center of the New York City and tri-state metropolitan economy.

The prospects are favorable for a continuation of this long term growth trend in the CBD during the first 25 years of the 21st Century. The September 2004 regional forecasts of the New York Metropolitan Transportation Council (NYMTC) show total Manhattan employment increasing by 25% from 2002 through 2030, an average annual growth rate of 0.8%. This builds on New York City's on-going recovery from the most recent recession, which was triggered by the three-year stock market decline that began in March 2000 and accelerated by the destruction of the World Trade Center on September 11, 2001. NYMTC's new forecasts are consistent with the highest of the three scenarios of job growth for the Manhattan CBD – 0.9%, 0.6% and 0.3% – presented in this report.

All such scenarios for future CBD job growth assume that the work force serving the CBD will be able to access these additional jobs. This presents the city and region with a major challenge. One component of this challenge is to build enough new housing in the CBD so that its resident population can continue to staff the current 11% share of CBD jobs. Depending on which rate of job growth is achieved, this translates into adding from 22,000 to 71,000 housing units by 2025 to the present CBD total of 323,000.

The second component of this challenge is the critical need to provide sufficient transportation capacity for the 89% of the workforce that commutes to the CBD from the rest of the city and metropolitan region, a workforce whose high incomes generated by their CBD jobs are distributed throughout the city and regional economy. This means that by 2025, commuting capacity will need to expand to accommodate from 33,000 to 107,000 additional workers entering the CBD during the peak morning hour of 8 to 9 a.m.

The need for more transportation capacity to the CBD was underscored by the degree of crowding and congestion that prevailed on all modes of travel to the CBD during the later years of the 1990's economic boom. With the New York City economy showing strong evidence of renewed growth in 2004, it is important to begin implementing new rail projects such as those currently being planned by the region's public transportation agencies. These projects include connecting the Long Island Railroad to Grand Central Terminal; building the Second Avenue Subway down the length of a major Manhattan corridor that has lost two of the three rapid transit lines it had in 1940; constructing a third Trans-Hudson Rail Tunnel to Penn Station from New Jersey; and providing new rail access to Lower Manhattan from Long Island, Queens and Brooklyn.

Together with continued capital improvements to the existing rail network, the proposed new rail projects should be sufficient to accommodate the growth in CBD commuting volumes implied by the NYMTC forecasts and by the job growth scenarios discussed in this report. However, additional new capacity may be necessary by the 2025 horizon if growth occurs at the rate of the higher scenario posed by this report, and if efforts are initiated to address demands by the increasingly upscale work force for improved commuting comfort to the CBD during peak periods.

This report concludes that building these proposed rail projects (or others that meet the same needs) during the first quarter of the 21st Century is essential if the Manhattan CBD is to realize its job growth potential by 2025. Failure to expand the transportation capacity to the CBD could well result in blocking growth that would otherwise occur.

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1. INTRODUCTION

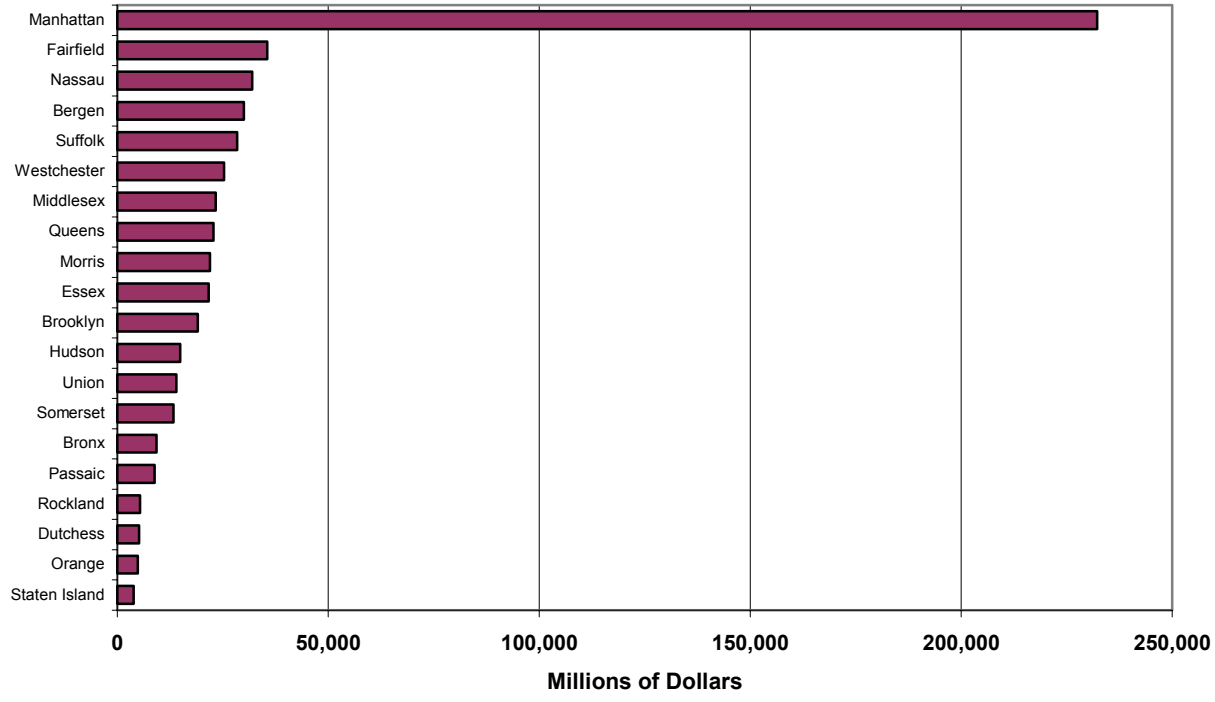
The purpose of this report is to document the need to build more passenger rail capacity to serve the Manhattan Central Business District (CBD).[1] New capacity will enable more residents of the Tri-State Region[2] to commute to jobs in the CBD. This capacity will provide the CBD with the larger work force it will need by 2025 to staff potential growth in job levels.

Since 1980, the region has invested massive amounts of money to restore its rapid transit and commuter rail infrastructure to a condition of good repair. Failure to do this would have seriously impaired the region's ability to maintain its existing job levels. The challenge of the first quarter of the 21st Century is to begin expanding the capacity of this transportation network to accommodate future job growth.

The Manhattan CBD is the largest in the U.S, the premium national center for banking, finance, media, communication, arts and culture, and attraction for business and tourist visitors. Despite the spread of suburbanization during the past half century, the CBD remains the vital economic center of the 31-county New York-New Jersey-Connecticut metropolitan region.

The importance of the Manhattan CBD in the metropolitan region economy is best demonstrated by earnings data on salaries, wages, and bonuses of workers and proprietors measured at their places of work. In 2000, the recent peak year for the Manhattan and New York City economy, earnings from Manhattan-based jobs totaled $232 billion, nearly seven times as much as the county with the next highest earnings by place of work (Connecticut's Fairfield, with earnings of $35.5 billion in that same year), as shown in Figure 1:

Figure 1. Personal Income, Where Earned, in NY Metro Counties in 2000



Source: U.S. Dept. of Commerce, Bureau of Economic Analysis

During the two strong economic growth cycles of the 1980s and 1990s, job levels in the CBD increased substantially.[3] Most of these jobs were filled by commuters from the surrounding boroughs and suburban counties, who brought much of the income generated by these CBD jobs home to the communities where they lived to fuel local job growth, business profits, and government tax revenues. Since there was no material expansion to the transportation system serving the CBD during these two decades, these periods of strong job growth in the CBD generated increased crowding and congestion in both city and

suburban travel corridors. This prompted calls for new investment in transportation to improve access to CBD jobs for city residents as well as for the region's suburban commuter work force in order to make possible prosperity growth in the future.

2. HISTORY OF TRANSPORTATION INVESTMENT IN THE NEW YORK REGION

Investment in transportation in New York City and its suburban counties during the past century has been highly uneven. It has been characterized by periods of extensive new construction, followed by decades of underinvestment in the existing system and lack of any new system expansion to keep pace with the growth of population and economic activity.

Between 1913 and the early 1920s, New York City spent today's equivalent of some $22 billion to more than double the size of its existing rapid transit system.[4] Investment in those years extended subway lines into the largely undeveloped hinterlands of the northern Bronx, southern Brooklyn, and northwest Queens. In the process, the city was dramatically changed. The real estate industry responded by constructing vast new communities of apartment buildings and row houses. During the years between the two World Wars, this led to wholesale relocations of upwardly mobile New York families, from overcrowded slum neighborhoods in Manhattan to the newer and less crowded communities built along the new subway lines.

At the same time, the subway expansion program made possible the development of the Manhattan CBD into the world commercial capital that we know today. Together with development of the commuter rail systems linked to the opening of Penn Station in 1910 and Grand Central Terminal in 1913, the new subway lines enabled CBD firms to tap a much larger and more highly skilled work force. This enhanced the attraction of the CBD as a prime location for business firms, especially for those firms locating in new office buildings and selling high-value intellectual and creative services, which would replace firms in the older lofts and warehouses that made and distributed physical goods.

By the late 1970s, when restoration of the region's existing transportation systems had become a critical need, New York's Governor Hugh Carey led other political leaders of the region in crafting long term capital and financial plans to carry out the investments that have been vital in restoring the region's transit and commuter rail infrastructure. The sheer magnitude of this reinvestment program (including more than $40 billion spent by the Metropolitan Transportation Authority alone during the past 22 years[5]) left no room for investments to expand the system in response to the pressures of economic growth.

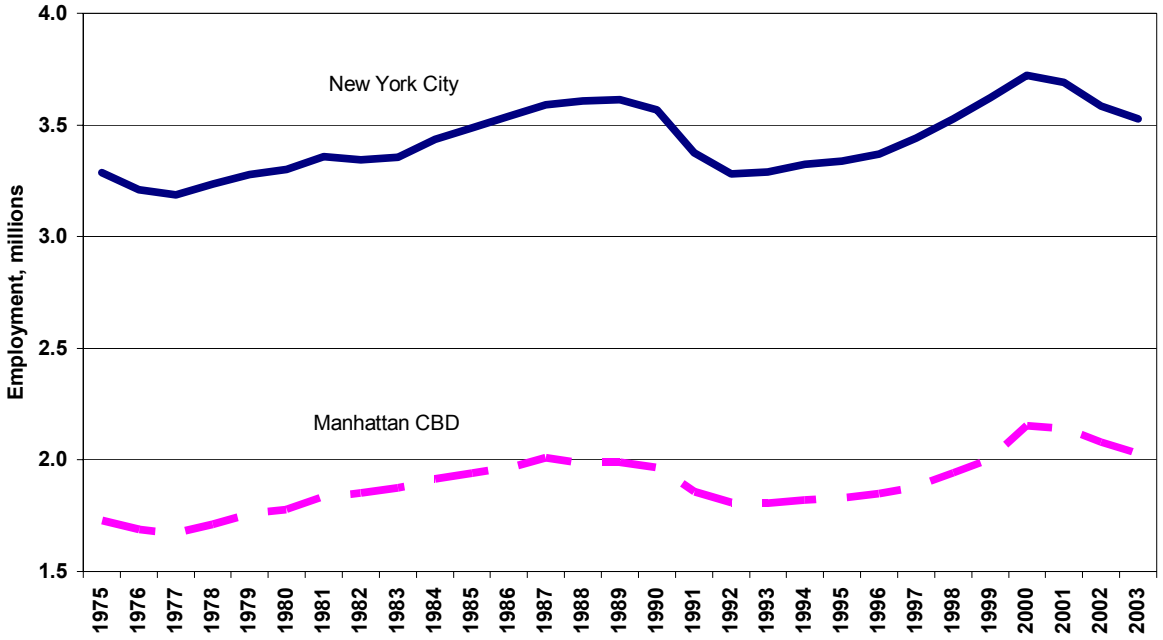
Job Growth in the CBD: 1975-2000

The pattern of business cycles in the CBD and throughout New York City during the past quarter century has been one of robust job growth during boom times followed by sharp losses during painful recessions. But job growth during the boom years was always more than sufficient to overcome the job losses that occurred during recessions.

Between 1975 and the year 2000, wage and salary jobs in the Manhattan CBD increased by some 24%, from 1.7 million to 2.15 million in the peak year of 2000.[6] The pattern of job growth during this period was highly cyclical, with the CBD economy in 1976 and 1977still mired in the long and severe recession of 1969-77, and suffering another round of substantial job losses during the recession of the early 1990s.

Figure 2 shows the pattern of the business cycle in the city and the Manhattan CBD from the mid-1970s through the end of 2003. The continued decline in 1976 and 1977 from the lengthy recession that began in 1969 is clearly evident, as is the shrinkage from the recession of the early 1990s and the downturn that began in early 2001.[7] Even more striking is the growth in jobs that occurred during the two strong recovery periods of 1983-88, and 1994-2000:

Figure 2. Employment Trends New York City and Manhattan CBD 1975 - 2003



Source: New York City employment data from New York State Dept. of Employment; see Note 3 for Manhattan CBD estimates.

During 1978 jobs in the CBD rose by 2.9%, and the New York economy entered a remarkable ten-year period of rising prosperity as the city's specialized business services and its arts and tourism sectors once again flourished. By 1980, Wall Street entered one of its periodic booms that helped to fuel widespread economic growth. Between 1977 and 1987, the CBD experienced a 20% growth in jobs, for an average gain of 1.9% per year, to bring total employment back to the two million plus level last reached in 1968.[8]

The stock market crash of October 1987 (regarded as the worst since 1929) brought an end to the 1980s boom. For the next six years the CBD experienced continuing job losses as total employment declined by more than ten percent. Once again, as during the mid-1970s financial crisis, the city's government had to increase taxes and cut services to deal with large budget deficits.

The economic turnaround that finally arrived in 1994 was initially more muted than that of the late 1970s. CBD jobs rose by 0.9% in 1994, and then dropped back to a gain of 0.4% in 1995.[9] But job growth soared for the remaining five years of the 1990s. During 1998 and 1999, the rate of job growth in New York City surpassed the national average growth rate for the first time in many years. By 1999, total jobs in the Manhattan CBD had again passed the two million-job threshold.

The CBD at Peak Economic Cycle in 2000

As the 2000 Millennium year began, New York was clearly the quintessential Global City, attracting new domestic and international business firms, new immigrants and ambitious young professionals by the thousands, and enjoying a favorable new image across the nation and around the world.

The booming stock market, characterized by the soaring indices in the telecommunications and internet technology sectors, contributed to exceptionally high wage levels that averaged over $164,000 in the finance, insurance and real estate sectors in Manhattan (all heavily concentrated in the CBD) compared to an average wage of $72,600 for all jobs in Manhattan.[10] Air traffic at the metropolitan region's three major airports increased to 92.4 million passengers during the year 2000 as the boom in business and visitor travel to the city continued to set new records.[11] Strong job growth in the office sector brought the

office vacancy rate down to nearly 4% in the prime Midtown sector, and to less than 6% in Lower Manhattan, generating a wave of new office construction following a seven-year drought during the early years of the 1990s when no new office buildings were constructed.[12]

TRANSPORTATION AND THE EMPLOYMENT CEILING

As the Regional Plan Association* and other analysts have noted, one particular aspect of the CBD business cycle during the 1980s and 1990s is that employment levels appeared to reach a ceiling of around two million jobs during both boom periods before falling back.

There could be a myriad of reasons for this apparent ceiling, but their repetitive nature suggests that there may be an artificial constraint on the total number of jobs that the CBD can accommodate.

One possibility is that this constraint is imposed by insufficient transportation capacity, which prevented the CBD from being able to sustain job totals beyond the two million level. Apart from the 63rd Street Tunnel under the East River (whose full capacity cannot be put to use until there is additional rail construction in Queens), no new rail capacity to serve CBD commuters has been built since 1940 when the Sixth Avenue IND subway opened. Meanwhile, two of the three rapid transit lines that served Manhattan's East Side corridor at the beginning of 1940 were shut down and dismantled during the 1940s and 50s. The last major expansion of motor vehicle entry capacity to the CBD was the third tube of the Lincoln Tunnel, which opened in 1957.

*Regional Plan Association, *The Far West Side and the Region's Future Development Needs* (February 2004), p. 2.

By early 2000, there were 2.1 million wage and salary jobs in the Manhattan CBD. This represented 58% of the 3.7 million jobs in all of New York City.[13] But in March 2000, the stock market began a rapid retreat from the 'bubble' levels of the late1990s, triggering the slide into the most recent years of recession and job losses throughout New York City.

Overall, from the recession trough year of 1977 through peak in 2000, jobs in the Manhattan CBD increased by 422,000, a total gain of 29% or 1.1% per year.[14] Despite the severe recession of the early 1990s, this is clear evidence of the underlying strength and resiliency of the Manhattan CBD as a generator of jobs and economic growth.

3. THE EFFECT OF BOOM TIMES ON NEW YORK CITY'S TRANSPORTATION SYSTEM

The boom times of the 1980s and 1990s were not without strain and rising costs. The supply of new and renovated housing in both the city and the region failed to keep pace with population growth and rising demand, resulting in substantial increases in the price of private sector housing. Also, the growth in city and suburban commuting to jobs in the CBD put intense pressure on the region's transportation systems, resulting in clogged vehicular traffic on streets, highways, and bridge-and-tunnel entry points to the Manhattan CBD, and crowding and congestion on the commuter rail system and the city's subway and bus networks.

Annual passenger volumes on the city's subway and bus systems grew rapidly during the 1990s and surpassed 2 billion passengers in 2000, a gain of over 600 million annual riders or 44% over 1992. Subway usage increased sharply after 1996 on the strength of the economic boom as well as the introduction of the MTA's MetroCard, which made multiple trips more affordable for leisure and shopping activities. The Long Island Railroad, Metro North and New Jersey Transit suburban commuter systems all experienced dramatic growth between the recession end year of 1992 and the peak year of 2000.[15]

The rapid growth in travel volumes from 1992 through 2000 is clearly evident in Table 1 and Figure 3.

Table 1. New York Metro Region Traffic and Transportation Trends: 1992-2000

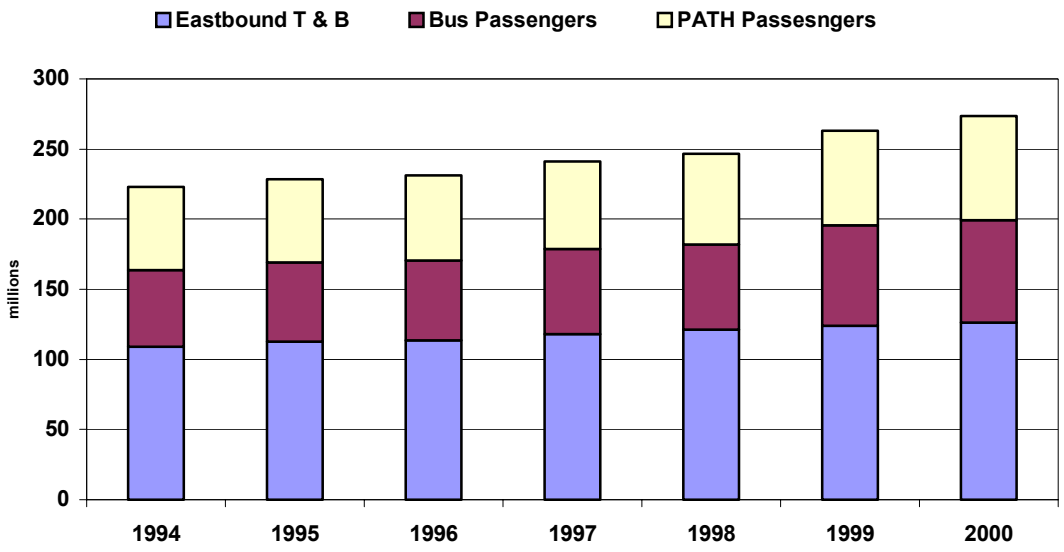
	1992	2000	% Change
NYCTA Bus & Subway Passengers	1,447,000	2,080,000	+44%
Regional Commuter Rail Passengers	168.1	215.2	+28%
Port Authority Facilities, Eastbound:			
Vehicles	110.9	126.3	+14%
Bus Passengers	54.0	73.1	+35.4%
PATH Passengers	53.0	74.1	+40%

Source: New York State MTA, Port Authority of NY&NJ, New Jersey Transit

The resulting congestion affected all of the major entry points to the CBD, leading to clogged traffic throughout much of the CBD and intense crowding on mass transit facilities. The Winter 2002 issue of *Travel Trends* noted that:

> By the end of 2000, record vehicular traffic volumes crossing into Manhattan had exacerbated the crowded conditions at the Trans-Hudson bridge and tunnel facilities. Drivers' attempts to circumvent congestion, especially during the morning peak crossing into Manhattan, have resulted in a broadening of the peak period, especially between the hours of 5 and 7 a.m.[16]

Figure 3. Port Authority Eastbound Facilities 1994 - 2000



Source: New York State MTA, Port Authority of NY& NJ, New Jersey Transit

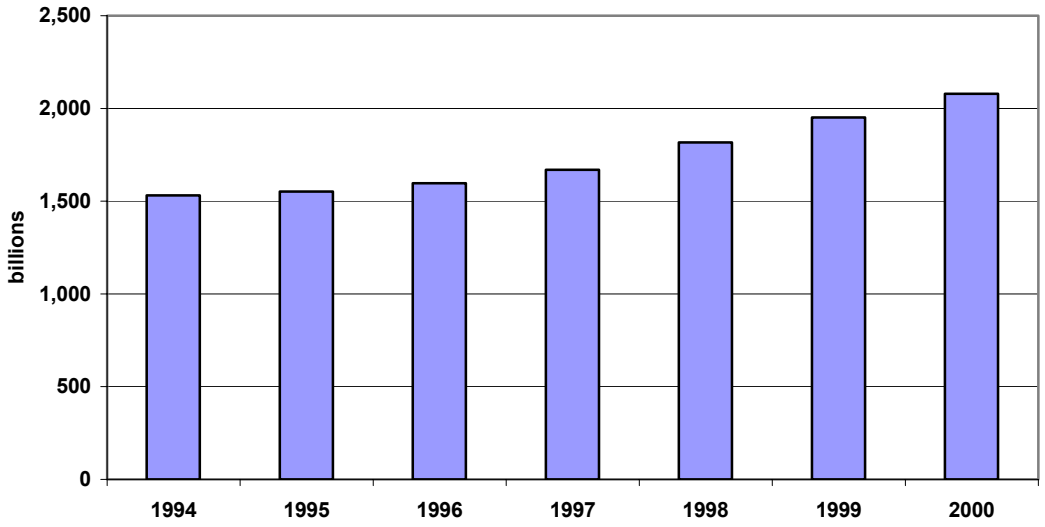
On the MTA's subway and city bus systems, crowding and congestion worsened noticeably as total ridership increased by 44% between 1992 and 2000.[17] The NYPIRG Straphangers Campaign reported in early 2000 that surveys conducted for the MTA in 1999 found that "this increased patronage has in turn resulted in more crowding, particularly during rush hours, and on occasion, delays." [18] In a June 2001 press release, the Straphangers Campaign further noted that:

> It's not your imagination. The subways and buses are more crowded than they've been in decades. Ridership is way up – but service is not. Subway ridership is up 29 percent since 1996, but subway service has only increased 11 percent. And bus ridership has outpaced service additions two to one. The subways and buses are moving an astonishing 1.2 million more riders on each weekday than they were just three years ago.[19]

In their July 2001 "State of the Subways Report Card," the Straphangers Campaign found that "crowding remained at intolerable levels"[20] due to the increasing passenger volumes. (See Figure 4.)

As Figure 5 indicates, ridership on New Jersey Transit trains to New York City increased by over 50% after 1992.[21] During the spring quarter of 2001, NJT reported 8,400 rail standees daily. The *Travel Trends* report noted that "during the morning business hour, 14 NJ Transit and four Amtrak trains virtually fill all the available capacity at Penn Station-New York."[12] Total ridership on PATH increased by 40% between 1992 and 2000, and the system was operating close to capacity on its Newark-World Trade Center line.[22] New Jersey Transit bus service, where ridership increased by 35% during the same time period, experienced added pressure on the already saturated capacity in the Lincoln Tunnel's Exclusive

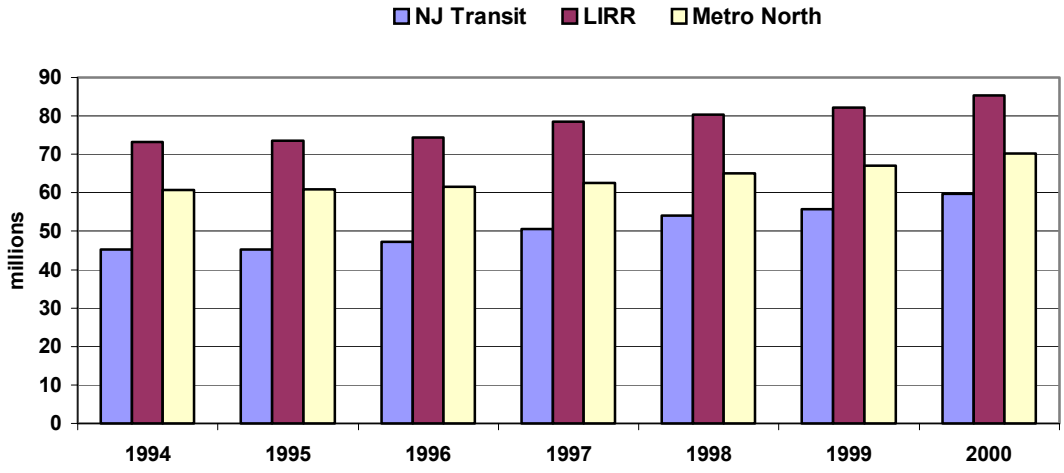
Figure 4. NYC Subway & Bus Passengers 1994 - 2000



Source: New York State MTA

Bus Lane, despite the introduction of new operational procedures such as EZ-Pass to speed up bus volumes during key rush hour periods.[23]

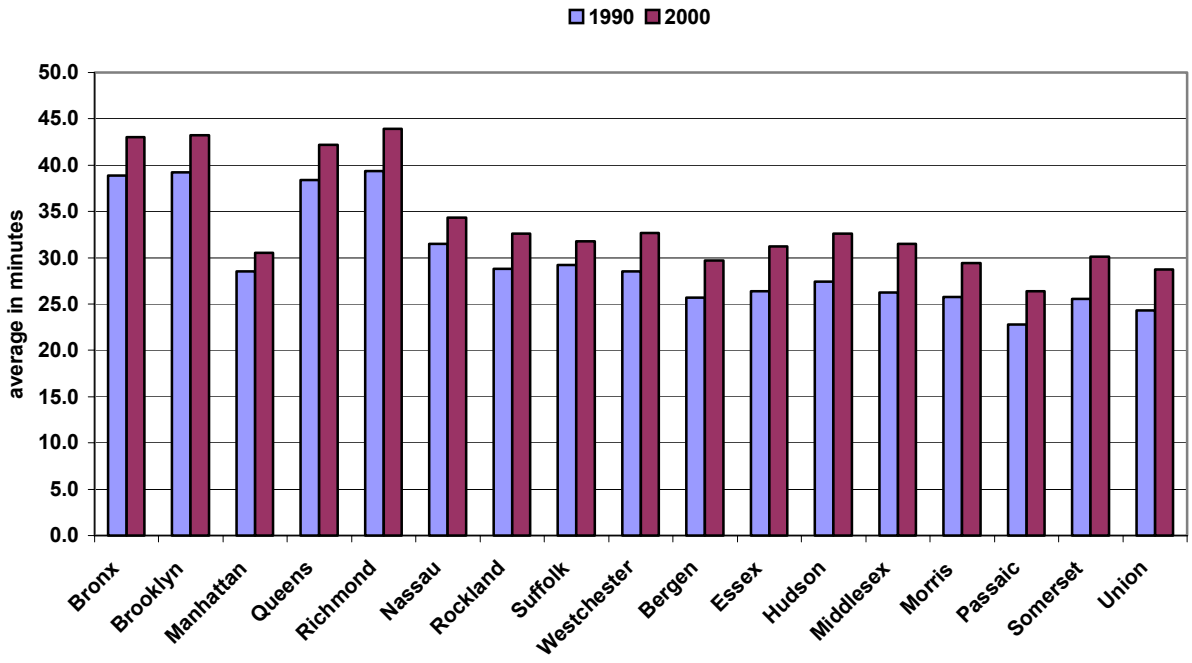
Figure 5. Regional Commuter Rail Passengers 1994 - 2000



Source: New Jersey Transit, New York State MTA

Travel times to work in the New York Metro region, as measured by the 2000 Census (see Figure 6), attested to the lengthening commutes in all of the region's counties, compared to average trip times in 1990.[24] The average duration of journey-to-work trips for the region was 35.2 minutes, an increase from the 31.4-minute average in 1990 and well above the national average of 25.5 minutes in 2000.

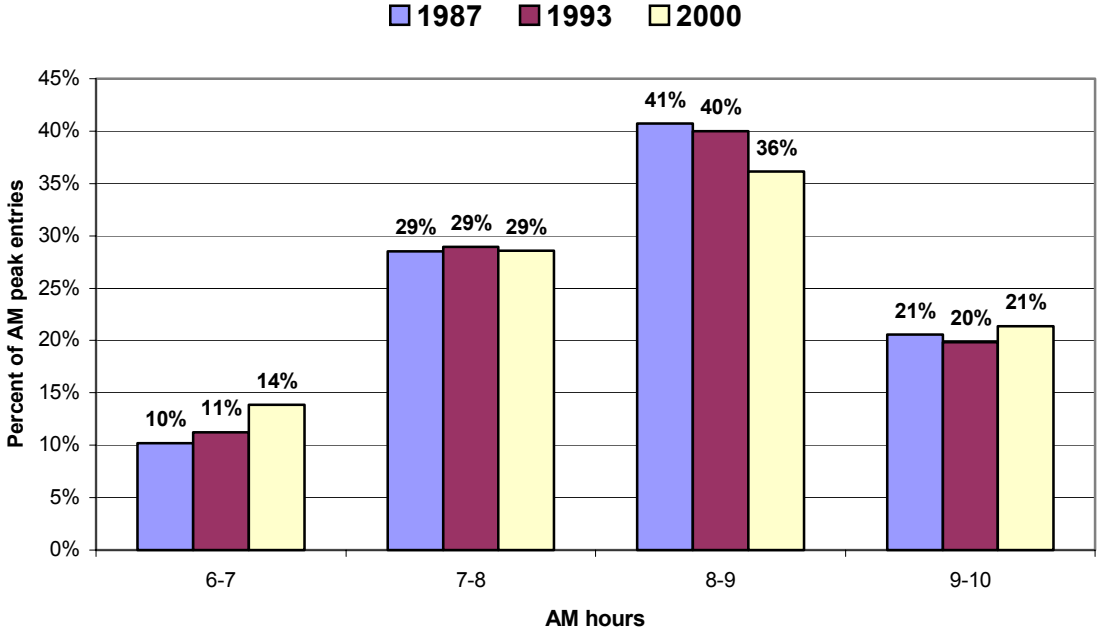
Figure 6. Travel Time to Work, NY-NJ Region



Source: U.S. Census Bureau; Port Authority of NY&NJ

These travel data clearly highlight the serious capacity constraints on city and suburban transit and vehicular systems for commuters trying to access the growing number of jobs in the booming economy of the CBD.

Figure 7. CBD AM Peak Period Entries: All Four Cordons



Source: New York Metropolitan Transportation Council (NYMTC)

One notable result of this congestion has been the apparent shift in commuter flows to the CBD from the traditional 8:00 to 9:00 a.m. 'peak hour' to the much earlier 6:00 to 7:00 a.m. period. Figure 7 shows the changes in peak period entries across the four main cordons of the Manhattan CBD for the years 1987, 1993, and 2000.

4. LOOKING AHEAD TO 2025

The premise of this report is that job levels in the Manhattan CBD can continue to increase over the next 20 years if there are no transportation constraints limiting the size of its work force. Before looking ahead, however, it is helpful to look back briefly since in the wake of any recession, it is always a challenge to talk about future growth. The lingering effects of the painful economic downturn that began in mid-2001 tend to obscure the strength of economic growth during the boom years of the 1990s and the resulting transit and vehicular congestion that plagued the city and regional transportation systems by the peak boom year of 2000.

New York City's economy was already affected by the plunge in the financial markets that began in March 2000, which caused the city's economy to slide into recession even before the catastrophic effects of the terrorist attack on September 11, 2001 that destroyed the World Trade Center and surrounding buildings, causing nearly 2800 deaths. But as in cities like San Francisco and Tokyo that have experienced major natural or man-made disasters, New York has responded with remarkable resilience, and recovery from this latest recession is now solidly underway.[25]

Even so, some people question whether recovery will be sufficient to restore all the jobs and economic activity lost since 2000, and whether additional growth can be assumed. While such concerns may be understandable, there are at least three reasons why the new recovery that began in the second half of 2003 could well follow the same positive patterns as the recoveries during the 1980s and 1990s:

- First: the all-important financial sector has rebounded with improved revenues, renewed profits, and spin-off effects to other industries since early 2003. The economic multiplier effects of these factors have replenished incomes and tax revenues throughout the city and the rest of the region.[26]

- Second: people have not moved out of New York City in the wake of 9/11, as many commentators had predicted. Instead, the City's population has continued to increase, growing by an estimated 84,000 people or 1% since the April 2000 Census.[27] Judging by the strong rise in housing prices, the attraction of Manhattan and the city as a vibrant working and living environment remains as strong today as it was during the 1990s when New York led an American renaissance among large cities toward living and working in urban downtowns.

- Third: the historical evidence of robust economic performance during the quarter century before 2000 is too compelling to ignore. Despite the impact of two severe recessions during this 25 year period, total CBD employment still increased overall by 422,000 jobs or 24% from 1975 through 2000.[28]

Taken together, these reasons suggest that the Manhattan CBD economy can recover strongly from even severe setbacks like the lengthy and demoralizing recession of the 1970s, and has the continued potential to increase its employment base during the first quarter of the 21st Century.[29]

The three scenarios summarized in Figure 8[30] illustrate the range of this job growth potential:

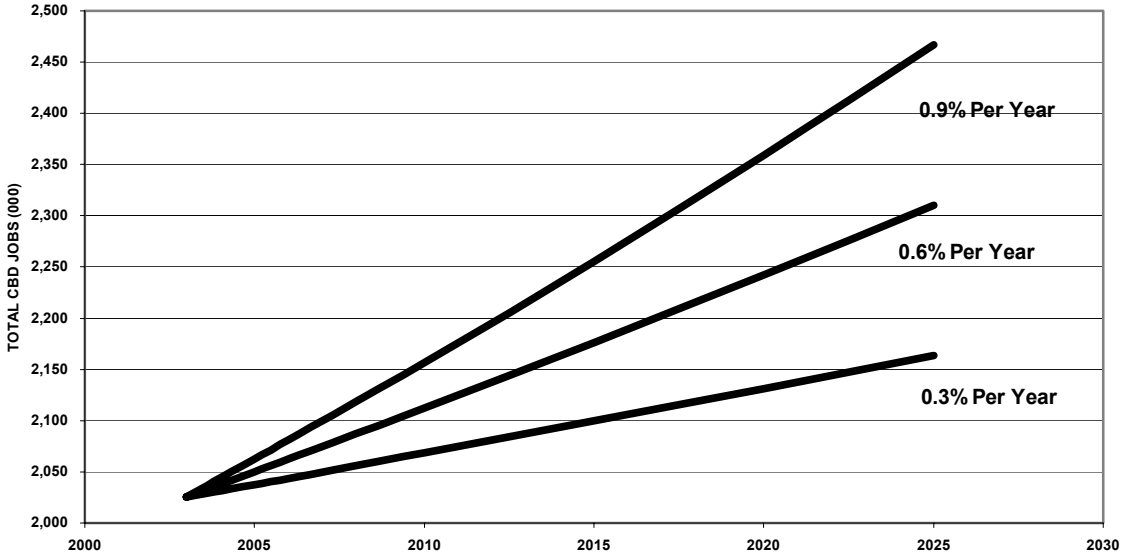
- **A 0.9% average annual job growth from 2003 through 2025**. This is in line with the September 2004 forecasts of the New York Metropolitan Transportation Council (NYMTC) of 0.8 % per year for all of Manhattan from 2002 through 2025.[31] Both these projected rates envision a robust economy for the Manhattan CBD, though both rates are slightly lower than

the actual 1.1% annual rate of job growth that occurred in the Manhattan CBD from 1977 through 2000.

- **A lower job growth rate of 0.3% annually**, on the assumption that growth in the economy and employment would be much below the patterns of the last quarter century. This lower job growth rate could also occur if lack of sufficient commuting capacity imposes an artificially low ceiling on the number of people who can access jobs in the CBD.

- **A 0.6% annual job growth**, which represents the midpoint of the two previous scenarios.

Figure 8. Three CBD Job Growth Scenarios: 2003 - 2025



Source: Scanlon & Seeley, At Capacity, Authors' estimates

What Will Be the Key Sectors of the Manhattan CBD Economy?
While much can change in the technological and structural underpinnings of work and in its global location patterns during the first quarter of the 21st Century, it is possible to identify the broad areas of work activities that are likely to continue driving Manhattan's economy during the next twenty years.

Finance will remain the most important industry sector in the CBD economy. The highly specialized, labor-intensive, high-wage investment banking and global financial activities can be expected to remain the hallmark of the industry in Manhattan. The important measures of the industry will continue to be the dollar value of the incomes and revenues generated rather than the actual number of new jobs that are directly created (a continuation of the trend toward high value-added functions locating in Manhattan). The widespread effects of this large income multiplier, together with the related *professional and business services* jobs that cluster around securities trading, investment underwriting, and commercial and international banking, will remain vital drivers of the future CBD economy.

The range of functions involving *media, communications, arts, and tourism* (including museums, music, theatre, dance, film and TV/video production, hotels, restaurants, and ancillary services) can be expected to remain vital to the Manhattan economy, and to be significant generators of new jobs.

As New York City launches major rebuilding and revitalization programs in the wake of 9/11, the *architectural, engineering, and construction-related industries* could play a more important role in the economy than during the past twenty years. Also, the aging of the Baby Boom generation over the next

two decades will likely bring further substantial job growth to the *health, hospital, and social service functions* that already constitute New York City's largest sources of employment.

More difficult to quantify, but still of vital importance, will be Manhattan's continued attraction for the educated young professionals whom management sage Peter Drucker has called "Young Knowledge Workers" and Carnegie Mellon professor Richard Florida has defined as "The Creative Class." [32] Their wealth-generating talents are increasingly needed by a widening range of business firms and other employers in the Manhattan CBD. The extent of Manhattan's attraction will largely be determined by the strength of the economy as well as by such traditional quality-of-life issues as good housing, schools, and cultural amenities. While some nervousness about personal security could well persist for years to come, the continued attraction of Manhattan and New York City for such professionals since the 9/11 disaster appears to be a good augury for the future.

Supporting a Larger CBD Workforce

Historically, the CBD work force has consisted of two basic components – those who live there, and those who commute in from Upper Manhattan, the four other boroughs, and the counties of suburban New York, New Jersey, and nearby Connecticut.

In 2000, CBD residents staffed approximately 11% of CBD jobs. The other 89% were staffed by workers who commute each day across the four cordons of the CBD.[33] These are: the 60th Street cordon crossing Manhattan from river to river; the Queens cordon running down the East River opposite Midtown Manhattan; the Brooklyn cordon running along the East River from Manhattan's Valley to the Battery; and the Hudson cordon separating Manhattan from New Jersey.

Increasing the Number of CBD Residents. If CBD residents are to retain the 11% share of the work force held in 2003, this report's three scenarios for CBD job growth indicate that the number of residents staffing CBD jobs need to increase by 15,000 to 48,000 by 2025.[34] Assuming no changes in the 2003 ratios for labor force participation and occupants per housing unit among CBD residents, this would require the addition by 2025 of 22,000 to 71,000 more housing units to the CBD's 2000 total of 324,000 housing units, for a total increase of between 7% and 22%.[35]

A smaller increase in the number of CBD housing units would have to be offset by higher ratios for either labor force participation or occupants per housing to avoid the need for a greater increase in the commuter component of the CBD work force. Conversely, increasing the resident worker component by more than the rate of job growth could somewhat reduce the amount of growth needed in the commuting worker component.

From 1980 through 2000, the number of housing units in the CBD increased at an average rate of 0.57% per year.[36] To match the rate of CBD job growth projected in the three scenarios for the 2003-2025 period, therefore, average annual housing unit growth in the CBD would have to be 0.52 times as much as during the 1980-2000 period for the 0.3% scenario, 1.03 times greater for the 0.6% scenario, and 1.55 times greater for the 0.9% scenario.[37]

The outlook for additional housing development in the Manhattan CBD appears to be favorable, based on the amount of development currently under way or on the planning horizon. But it is not yet clear whether the housing growth rate can be boosted sufficiently to materially reduce the necessary growth rate among commuting workers. Housing construction is primarily the responsibility of the real estate industry, although certain government initiatives such as zoning changes, tax assessment policies or residential conversion bonuses can influence development decisions by the private or non-profit sectors.

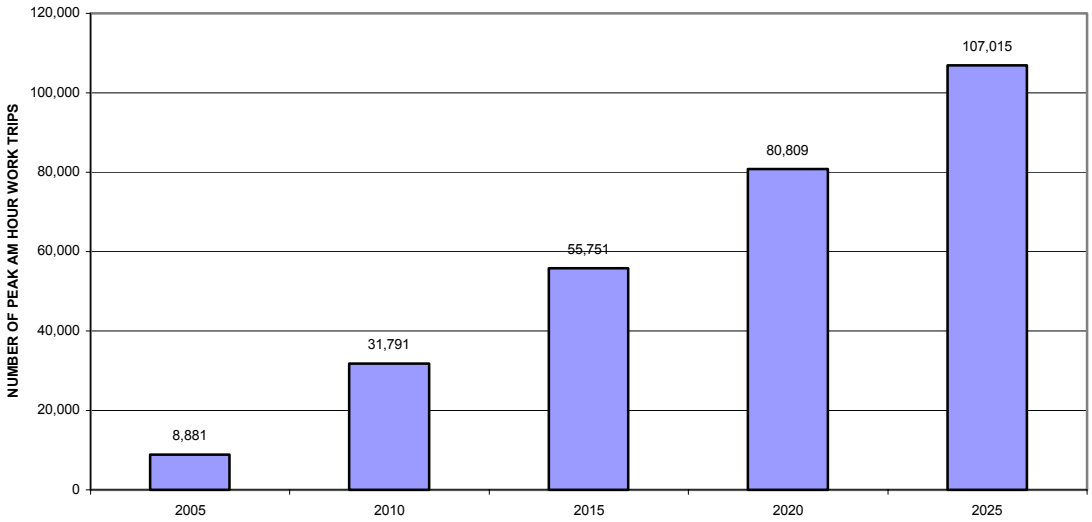
It remains to be seen whether more aggressive government initiatives to encourage housing development could generate sufficient capacity to increase the current 11 % resident share of CBD jobs, and in turn help to moderate somewhat the amount of new rail capacity that may have to be built across the four traditional cordons of the CBD.

Increasing the Number of Commuters. Since commuters currently account for some 89% of the CBD work force, providing capacity for growth in this component is the most important element in any strategy

to assure the CBD of enough workers to realize its job growth potential during the first quarter of the 21st Century.

The cumulative increase in the number of commuters to the CBD from 2003 to 2025, based on the highest of the three job growth scenarios, is illustrated in Figure 9.

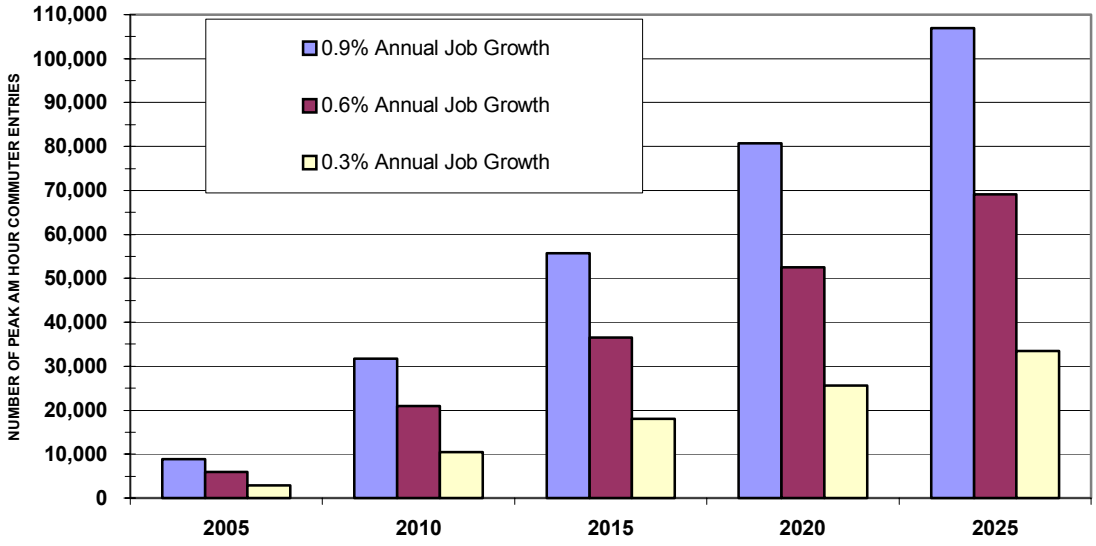
Figure 9. Cumulative Increases From 2003 in Peak Hour Work Trips to the CBD (Average Annual Growth = 0.9%)



Source: Scanlon & Seeley, At Capacity, Authors' estimates

Accommodating this growth involves providing enough additional commuting capacity by 2025 for between 33,000 and 107,000 additional commuters across the four CBD cordons during the critical 8:00 a.m. to 9:00 a.m. peak hour (or a range of 7 to 22% more than in 2003), as shown in Figure 10.

Figure 10. Increase From 2003 in Peak AM Hour Commuter Entries to the CBD



Source: Scanlon & Seeley, At Capacity, Authors' estimates

The second factor that needs to be considered is rising demand among the CBD's increasingly upscale workers for a more comfortable commuting environment. Since the end of World War II, the CBD's job

base has experienced profound demographic changes. From a predominant emphasis in the immediate postwar period on manufacturing and warehousing jobs held by low-wage blue collar workers, the CBD has evolved into today's high-wage center of managerial and professional jobs.

In recent years, discussions of commuting comfort have largely dealt with the need to provide new rail cars and buses, improved air conditioning, and better announcement systems. There has been little discussion about the basic issue of floor-space-per-passenger in the region's overcrowded subway and commuter rail cars, which is the most important determinant of commuting comfort. It can be argued that existing floor space ratios need to become more generous if the CBD is to attract enough high-wage managers and professionals in the future. This is a complex issue whose ramifications lie beyond the scope of this report, but it is one that may well become a more proximate issue in the next few years, particularly as the large (and articulate) baby boom generation enters their late 50s and early 60s and accelerates the demand for greater commuting comfort.

Figures 11 through 13[38] illustrate the implications of the new commuting capacity needed by 2025. They reflect the annual job growth scenarios of 0.9%, 0.6%, and 0.3% described earlier but do not include any allowance for increased commuter comfort.

Under these scenarios, total peak 8 to 9 AM hour work trip entries to the CBD would increase between 33,000 and 107,000 (or from 7% to 22%) by 2025. These scenarios assume that the 2003 values for certain input variables will remain unchanged during the 2003-2025 period. Such variables include the split between CBD residents and commuters staffing CBD jobs; the share of daily commuter entries that occur during the peak AM hour; and the relative distribution of these peak hour commuter entries among the four cordons.

Figure 11: Average Annual Job Growth = 0.9%

ACROSS THE 60TH ST. CORDON

2003 Pk. Hr. Work Trips (000)	155
2025 Pk. Hr. Work Trips (000)	188
% Of CBD Total	32%
Increase (000)	34
% Increase	22%
Subway Train Equivalents	25
CBD-Bound Tracks Needed	2

CBD TOTAL

2003 Jobs (000)	2,026
2025 Jobs (000)	2,467
Increase (000)	441
% Increase	22%
2003 Population (000)	560
2025 Population (000)	681
Increase (000)	122
% Increase	22%
Housing Units Increase (000)	71
% Increase	22%
2003 Pk. Hr. Work Trips (000)	491
2025 Pk. Hr. Work Trips (000)	598
Increase (000)	107
% Increase	22%
Subway Train Equivalents	79
CBD-Bound Tracks Needed	6

ACROSS THE QUEENS CORDON

2003 Pk. Hr. Work Trips (000)	108
2025 Pk. Hr. Work Trips (000)	131
% Of CBD Total	22%
Increase (000)	23
% Increase	22%
Subway Train Equivalents	17
CBD-Bound Tracks Needed	1

ACROSS THE HUDSON CORDON

2003 Pk. Hr. Work Trips (000)	72
2025 Pk. Hr. Work Trips (000)	87
% Of CBD Total	15%
Increase (000)	16
% Increase	22%
Subway Train Equivalents	12
CBD-Bound Tracks Needed	1

ACROSS THE BROOKLYN CORDON

2003 Pk. Hr. Work Trips (000)	157
2025 Pk. Hr. Work Trips (000)	191
% Of CBD Total	32%
Increase (000)	34
% Increase	22%
Subway Train Equivalents	25
CBD-Bound Tracks Needed	2

Figure 12: Average Annual Job Growth = 0.6%

ACROSS THE 60TH ST. CORDON

2003 Pk. Hr. Work Trips (000)	155
2025 Pk. Hr. Work Trips (000)	176
% Of CBD Total	32%
Increase (000)	22
% Increase	14%
Subway Train Equivalents	16
CBD-Bound Tracks Needed	1

CBD TOTAL

2003 Jobs (000)	2,026
2025 Jobs (000)	2,310
Increase (000)	285
% Increase	14%
2003 Population (000)	560
2025 Population (000)	638
Increase (000)	79
% Increase	14%
Housing Units Increase (000)	46
% Increase	14%
2003 Pk. Hr. Work Trips (000)	491
2025 Pk. Hr. Work Trips (000)	560
Increase (000)	69
% Increase	14%
Subway Train Equivalents	51
CBD-Bound Tracks Needed	4

ACROSS THE QUEENS CORDON

2003 Pk. Hr. Work Trips (000)	108
2025 Pk. Hr. Work Trips (000)	123
% Of CBD Total	22%
Increase (000)	15
% Increase	14%
Subway Train Equivalents	11
CBD-Bound Tracks Needed	1

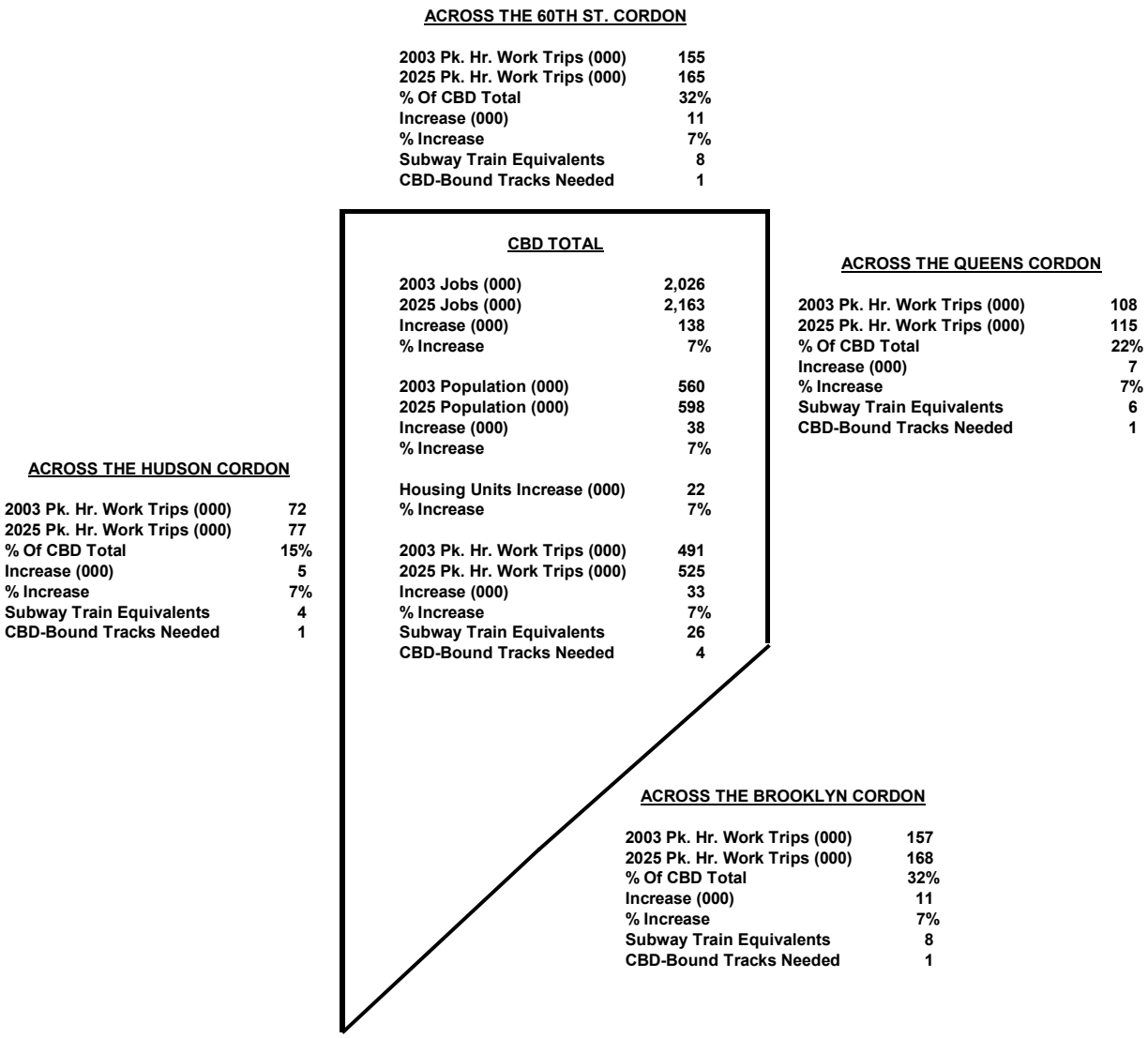
ACROSS THE HUDSON CORDON

2003 Pk. Hr. Work Trips (000)	72
2025 Pk. Hr. Work Trips (000)	82
% Of CBD Total	15%
Increase (000)	10
% Increase	14%
Subway Train Equivalents	8
CBD-Bound Tracks Needed	1

ACROSS THE BROOKLYN CORDON

2003 Pk. Hr. Work Trips (000)	157
2025 Pk. Hr. Work Trips (000)	179
% Of CBD Total	32%
Increase (000)	22
% Increase	14%
Subway Train Equivalents	16
CBD-Bound Tracks Needed	1

Figure 13: Average Annual Job Growth = 0.3%



5. THE IMPLICATIONS FOR NEW TRANSPORTATION CAPACITY

The projected increases in peak AM hour commuter entries based on the three scenarios are equivalent to between 26 and 79 more IND/BMT subway trains with full passenger loads.[39] The use of these *Subway Train Equivalents* is not meant to imply that all these additional work trips would be made by subway. They simply provide a readily understandable illustration of capacity needs. Four to six CBD-bound tracks would be needed to accommodate this many additional subway trains (in effect, four to six new two-track rail lines crossing the four cordons).

It is likely that there is a modest amount of peak hour reserve capacity available on some existing rail lines that serve the CBD, and this may increase somewhat in the years ahead if certain capital improvements can be completed.[40] However, the baseline estimates of four to six new rail lines across the CBD cordons provide a reasonable starting point for assessing the necessary size and shape of programs to build new rail lines.

Proposed CBD Rail Projects

During the past decade, the region's major public transportation agencies have been conducting detailed planning studies for a number of new rail-oriented projects. The four that directly involve additional commuting capacity to the CBD are described below.[41]

- ***East Side Access for the Long Island Railroad*** (estimated to cost about $6.3 billion) would connect the Long Island Railroad in Queens with Grand Central Terminal via the lower level of the existing 63rd Street Tunnel under the East River. This would enable the LIRR to increase its peak period commuting capacity to and from Midtown across the Queens cordon by 24 trains per hour, while bringing many of its passengers directly to the CBD's most popular and densely developed job location on Manhattan's East Side.

- ***The Second Avenue Subway*** (estimated to cost $16.8 billion) would run from 125th Street in gentrifying Spanish Harlem to the Lower Manhattan financial district.[42] It would provide badly needed new commuting capacity to the CBD from the Upper East Side across the 60th Street cordon in a major corridor that has lost two of the three rapid transit lines it had at the beginning of the 1940s.[43]

- ***A New Trans-Hudson Rail Tunnel*** (estimated to cost $4.5 billion) would provide a third commuter rail tunnel under the Hudson River to Penn Station to provide direct CBD access for New Jersey Transit from the rapidly growing bedroom communities of northern and central New Jersey.

- ***Improved Rail Access to Lower Manhattan*** (estimates range from $2 to $5 billion) would make use of a new rail tunnel under the East River and existing rail lines across Central Brooklyn to improve access to Lower Manhattan for Long Island commuters via Jamaica Station. This link could also provide a 'one-seat ride' for air passengers between John F. Kennedy International Airport and Lower Manhattan.[44]

These four construction projects (whose total costs are expected to exceed $30 billion) would build one new rail line across each of the CBD's four cordons. They would provide sufficient capacity to meet the job growth needs projected for 2025 by the 0.3% and 0.6% scenarios, with some reserve available to accommodate job growth after 2025 and to begin addressing the commuting comfort issue.

For the 0.3% scenario, this reserve capacity ranges from 14% of total peak AM hour commuter entries projected for the 60th Street and Brooklyn cordons to 23% for the Queens cordon and 38% for the Hudson cordon. For the 0.6% scenario, reserve capacity would be 6% of total peak AM hour commuter entries projected for the Brooklyn cordon, 7% for the 60th Street cordon, 15% for the Queens cordon, and 29% for the Hudson cordon.

The outlook is less promising in the case of the 0.9% growth scenario. There appears to be sufficient new capacity across all four cordons to meet projected 2025 job growth needs, plus some reserve capacity at the Queens and Hudson cordons (8% and 21% of their projected total peak AM hour commuter entries respectively). However, there would be no reserve capacity across the higher demand 60th Street and Brooklyn cordons, whose new rail lines are projected to be totally saturated by 2025.

Improving commuting comfort and accommodating future job growth after 2025 at these cordons would require tapping whatever reserve capacity already exists on existing lines. Some increase in this reserve capacity is possible if certain long-planned capital improvements can be completed in a timely fashion.[45] These could include conversion of subway signal systems to floating block technology (which could increase the number of trains per hour on each track of the lines affected by about 5%) and removing physical bottlenecks that limit track capacity (as at Nostrand Junction on the IRT beneath Eastern Parkway). Still other improvements would add tracks to existing rail corridors. An example would be construction of the Super Express Bypass through Central Queens in order to fully utilize the track capacity of the upper level of the 63rd Street Tunnel under the East River.

The question of increasing capacity by extending station platforms on existing rail lines so they can run longer trains is periodically raised. However, civil engineering challenges and high costs place such capital projects in the same category as construction of new rail lines.

It should be kept in mind that 0.9% average annual job growth is not quite as high as the actual 1.1% job growth rate that the CBD experienced during the 1977-2000 period. Therefore, the 0.9% scenario is more likely than it may at first appear to be if sufficient commuting capacity can be provided. This suggests that assuring full operation by 2025 of the four rail lines described above may be the minimum expansion program needed if the CBD is to realize its job growth potential. And it may not be too early to begin thinking about system expansion options for the period beginning in 2025.

The Potential for Less Costly Options

The substantial cost of the four new rail lines described above raises obvious questions about whether lower cost alternatives might exist by utilizing other transit modes or by relying on Transportation Demand Management (TDM) measures.

Modal Alternatives. The express bus and commuter ferry networks could be expanded at relatively low capital cost, especially during the near term. However, neither mode could reasonably accommodate more than a fraction of the CBD job growth projected by any of the three scenarios. Also, expanding both modes would present some serious problems. The most important problem may be their need for additional street space in the CBD to accommodate a vast increase in the number of buses during peak periods (commuter ferries require shuttle bus networks to distribute their passengers from shoreline piers to job locations in the CBD, most of which are beyond convenient walking distance from the rivers).

Existing street space in the CBD is already heavily congested during normal working hours. Providing additional street space for significantly more express buses and commuter ferry shuttle buses would probably mean curtailing taxi cruising and private auto use during commuting periods; shifting goods deliveries and pick-ups to nighttime hours; narrowing sidewalks to create additional traffic lanes; reducing (rather than increasing) local bus service within the CBD; and other measures that could complicate rather than resolve the issues of overcrowding and congestion.

Transportation Demand Management (TDM) Alternatives.[46] It is already evident that some CBD commuters have shifted their work trips from the peak AM hour in an effort to avoid congestion. This has led to questions about whether an ambitious program of staggered work hours (possibly including extensive peak-hour pricing on all the bridges and tunnels leading to Manhattan) could make more commuting capacity available by significantly shifting more travel demand to earlier and later hours.

Such TDM measures as staggered work hours may be very useful in smaller urban areas that rely primarily on private automobiles for commuting purposes. But in high-density areas like the Manhattan CBD where public transportation accounts for more than 80% of work trips, they could only be effective if significant portions of work activity volume were redistributed over a much broader portion of the 24-hour

day. This is scarcely practical in a CBD that functions as a global business and financial marketplace where face-to-face contact is critical.

6. CONCLUSIONS

Expanded transportation capacity is of vital importance to enable future economic and employment growth in the Manhattan CBD. More capacity will provide access for the larger work force needed to staff the potential increase in CBD jobs. Improved transportation access will also be necessary for all those traveling to the Manhattan CBD for non-work purposes such as shopping, entertainment, attending cultural and sports events, visiting friends and families, and for visitors from outside the region who come here on business or as tourists. At the same time, there must be access for the vast array of delivery, distribution, and repair service vehicles that keep the CBD provisioned and functioning on a daily basis.

Most important of course is access to CBD jobs, many of which generate some of the world's highest incomes. Nearly 90% of these jobs are held by people who live outside the CBD, who spend most of this income in the counties where they reside, and who therefore constitute the primary mechanism for distributing CBD prosperity throughout the region to support local jobs and local tax revenues.

The four new rail lines proposed by the region's transportation agencies for access to the CBD represent an essential step towards achieving this badly needed new transportation capacity. Together with capital improvements to increase passenger capacity on the existing transportation system, these new rail lines should be able to accommodate the growth in peak AM hour commuter entries needed by 2025 if the CBD is to fully realize the job growth potential projected by the three scenarios in this report. Further analysis will be required to address the issue of greater commuter comfort, and the need to accommodate potential job growth in the Manhattan CBD after 2025.

NOTES

[1] The Manhattan Central Business District (CBD) is defined as all of Manhattan south of 60th Street from the East River to the Hudson River. It is marked by four boundaries or *Cordons* that are crossed by transportation lines providing access to the CBD. These cordons are the 60th Street Cordon, which is the northern boundary of the CBD; the Queens Cordon bounding the CBD on the east side; the Brooklyn Cordon along the CBD southern boundary; and the Hudson Cordon, which separates the CBD from New Jersey to the west.

[2] The 31 counties included in the New York metropolitan region or the Tri-State Region are the five boroughs of New York City; Nassau and Suffolk on Long Island; Dutchess, Orange, Putnam, Rockland, Sullivan, Ulster, and Westchester in the Mid-Hudson Valley; Bergen, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Ocean, Passaic, Somerset, Sussex, Union, and Warren in New Jersey; and Fairfield, Litchfield, and New Haven in Connecticut.

[3] Historical 1975-2000 time series data for CBD wage and salary jobs are from Table 3 in New York Metropolitan Transportation Council (NYMTC), *2000 Hub Bound Travel Report: Transportation to the Manhattan Central Business District* (NY: NYMTC, May 2003). Note that, as originally published, Table 3 contained a typographical error for the 1999 jobs number. As a result of conversations with NYMTC, this error has been corrected for the time series used in this report and the correction is expected to appear in future issues of *Hub Bound Travel*. Data for 2000-2003 CBD Jobs are based on authors' estimates.

[4] For a comprehensive history of this landmark undertaking and its impact, see Peter Derrick, *Tunneling to the Future: The Story of the Great Subway Expansion that Saved New York* (New York and London: New York University Press, 2001).

[5] Dollar value of capital spending for transportation system restoration is from the Metropolitan Transportation Authority.

[6] For data on employment in the CBD, NYMTC, *2000 Hub Bound Travel Report*.

[7] NYMTC, *Hub Bound Travel 2000*. Also, U.S. Bureau of Labor Statistics, *Metropolitan series, Historical 1969-2003*, http://www.data.bls.gov/cgi-bin. Employment for all New York City is from New York State Dept. of Labor, *Current Employment by Industry(CES*), http://64.106.160.140.8080. Online, Accessed March 2004.

[8] NYMTC, *2000 Hub Bound Travel Report*.

[9] Ibid.

[10] Wage data are from the New York State Department of Labor, *Labor Market Information, Covered Employment and Wages (ES202)*, http://64.160.160.140.8080.NewYorkCounty. Online, Accessed March 2004.

[11] Annual air passenger data for John F. Kennedy, LaGuardia, and Newark airports are from the Port Authority of New York and New Jersey, *2002 Airport Traffic Report*, p. 31, http://www.panynj.gov.aviation/traffic/coverframe. Online, Accessed April 2004.

[12] Source: Cushman & Wakefield, www.cushmanwakefield.com/us/flyers/ny. Online, Accessed March 2004.

[13] NYMTC, *2000 Hub Bound Travel Report*.

[14] Ibid.

[15] Data for annual travel volumes are from the Metropolitan Transportation Authority, http://www.mta.gov. Check, in particular, Performance Indicators and Budget Watch.

[16] The Voorhees Transportation Policy Institute (VTPI), *Travel Trends: A Transportation Data Newsletter for the New York Region* 1, 1 (Winter 2002).

[17] See Note 15.

[18] The Straphangers Campaign," Subways and Buses More Crowded and Less on Time, According to Poll of 1,200 New Yorkers," *News Release* (March 23, 2000).

[19] The Straphangers Campaign, "Save Sylvia Sardine - and Yourself," *News Release* (June 2001).

[20] The Straphangers Campaign, *State of the Subways Report* (July 2001).

[21] *2000 Hub Bound Travel Report*.

[22] VTPI, *Travel Trends* 1, 1 (Winter 2002).

[23] Ibid.

[24] Travel Times to Work data are from the United States Bureau of the Census, *1990 Census* and *2000 Census*. Analysis and chart from the Port Authority of New York and New Jersey.

[25] Jason Bram, James Orr, and Carol Rapaport, "Measuring the Effects of the September 11 Attack on New York City," *Federal Reserve Bank of New York Economic Policy Review* (November 2002). The authors estimate the total cost of the destruction of the World Trade Center through June 2002 at between $33 and $36 billion. This includes property damage, cleanup and restoration of the site, and earnings losses. Although the loss of life and disruption of activity temporarily reduced New York City's productive capacity, they found that the attack's effect on employment and consumer confidence had largely run its course by mid-2002. Also see Jason Bram, "New York City's Economy Before and After September 11," *Federal Reserve Bank of New York: Current Issues in Economics and Finance* 9, 2 (February 2003). The analysis of local employment and economic trends concludes that the economic impact of the September 11 attack on New York City was somewhat less severe than originally thought. The attack created sizable job and income losses, but the city's 2001-2003 downturn appears to stem largely from normal cyclical factors involving the national economy and the financial markets. The findings of these two articles are consistent with the large body of literature that explores the true effects of urban disasters. Some highlights of this literature include: Christopher Morris Douty, *The Economics of Localized Disasters* (New York: Arno Press, 1979) documents the economic impact of San Francisco's 1903 earthquake and fire and its rapid recovery; Nancy Bolton, *The Impact of the Northridge Earthquake: A Year Later* (Los Angeles: UCLA Business Forecasting Project, 1995) on the economic effects of LA's 1994 earthquake; Carol T. West and David G. Lenz, "Modeling the Regional Impact of Natural Disaster and Recovery: Policy Implications of Recent Research and Recovery," *International Regional Science Review* 17, 2 (1994): 121-150 on the impact of Hurricane Andrew in Miami; Donald R. David and David E. Weinstein, *Bombs, Bones, and Break Points*, Working Paper 8517 (Cambridge: National Bureau of Economic Research, 2001) on the long term impact of the 1945 fire raids on Tokyo and other Japanese cities .These sources document the standard historical pattern for disaster and recovery and underscore the minimal impact that major disasters have on an affected city's long term economic growth.

[26] James Orr and Rae Rosen, "Job Declines in New York-New Jersey Region to Slow in 2003; Modest Growth Seen for 2004," *Federal Reserve Bank of New York: Current Issues in Economics and Finance* 9, 7 (July 2003). The authors see the region's two-year job decline that began in 2001 continuing at a slower rate through much of 2003, with job growth resuming in 2004. Also see Randal C. Archibold, "For New York, Economic News Is Good At Last," *New York Times* (3 May 2004): B1. This article quotes economists at the Federal Reserve Bank of New York, J. P. Morgan Chase, and the New York City Comptroller's Office to the effect that the city's latest recession ended during the second half of 2003.

Also see Alan B. Krueger, "The Commercial Resilience of New York Is Clear Three Years After the 9/11 Attacks", *New York Times* (16 September 2004): C2. Krueger is the Bendheim professor of economics and public affairs at Princeton University. This article reports on findings by the Russell Sage Foundation, the Federal Reserve Bank of New York, Franz Fuerst of the City University of New York, and Cordelia Reimers of Hunter College.

[27] From U.S. Bureau of the Census, *Current Population Estimates, 2004*.

[28] NYMTC, *2000 Hub Bound Travel Report*.

[29] Some urban scholars argue that the 1969-1977 recession was one of the worst in New York City's history. It was accompanied by severe losses of jobs and population, widespread neighborhood abandonment and arson, spiraling crime rates, and the near fiscal bankruptcy of the city's government. For further information on the widespread effects of the 1969-1977 recession, see Ken Auletta, *The Streets Were Paved With Gold* (New York: Vintage, 1980); and Fred Feretti, *The Year the Big Apple Went Bust* (New York: Putnam, 1976). Also see Ric Burns, Lisa Ades, and James Sanders, *New York: An Illustrated History* (New York: Knopf, 2003), which was originally prepared to accompany the eight hour Ric Burns PBS documentary *New York: A Documentary Film* (New York: Steeplechase Films, 1999) that contains an hour-long account of these dark years in New York City's history.

[30] The projected numbers for CBD jobs in 2025 for these scenarios were obtained by running the Compound Interest model forward.i.e.2025JOBS = 2003JOBS * ((1 + GRORATE) ^ YEARS) where 2003JOBS = 2,025,500; GRORATE = 0.009 (for the 0.9% scenario); and YEARS = 22; giving 2,466,823 for the number of jobs projected in 2025. Note that the figure for 2003JOBS is these scenarios includes all CBD jobs, not just wage and salary jobs as in the NYMTC time series discussed in Note 3. The all-jobs figure for 2003 is from the NYMTC September 2004 interim regional forecast for all of Manhattan, adjusted by the CBD coefficient.

[31] NYMTC, Program, Finance and Administration Committee (PFAC), "Adoption of Interim Adjusted Consensus 2030 Population & Employment Forecasts," September 23, 2004. NYMTC has been designated by the Federal Department of Transportation as the Metropolitan Planning Organization (MPO) for the New York State portion of Tri-State Region and is housed within the New York State Department of Transportation. One of its responsibilities is to prepare periodic long-term forecasts for employment and economic variables in each of the region's 31 counties.

[32] See Peter Drucker, "The Next Society," *The Economist* 361, 8246 (6 November 2001). In this Special Report, Drucker finds that developed nations (and many developing ones as well) are becoming dominated by Knowledge Workers, whose life styles and professional demands are reshaping social and corporate cultures in the urban centers (like the Manhattan CBD) where they congregate. Also see Richard L. Florida, *The Rise of the Creative Class* (New York: Basic Books, 2003). In this book, Florida, who is H. John Heinz II Professor of Regional Economic Development at Carnegie Mellon University in Pittsburgh, explores the growing importance and life style demands of people who "create" for a living and who now constitute more than one-quarter of the US work force. Their impact is no longer limited to such obvious fields as the traditional arts and advertising. To an increasing extent, their innovative talents are playing critical wealth-building roles in such fields as investment banking and other financial services, legal services, health care, marketing, and strategic management. Since their life style demands cause them to gather in stimulating urban centers like the Manhattan CBD, firms that need to make use of their services must locate in these centers.

[33] Derived from analysis of historical employment and work trip data obtained from NYMTC.

[34] See Note 30. The model used for projecting CBD jobs also projects CBD housing units, CBD resident population, and the number of CBD residents staffing CBD jobs.

[35] See Note 30. The model used to project CBD housing units shows the number of new CBD housing units needed for each of the three job growth scenarios. From these numbers, total percentage changes were computed.

[36] Historical housing data for the CBD courtesy of the New York City Department of City Planning. These data are based on the US Census for 1980, 1990, and 2000 for Community Districts 1 though 6, which constitute the CBD. 1980 CBD housing units = 288,987. 2000 CBD housing units = 323,609.

[37] See Note 36. The average annual percentage change in CBD housing units for the 1980-2000 period can be computed from these data by using the formula:

AV. AN. % CHANGE = ((2000 UNITS / 1980 UNITS) ^ (1 / 20)) - 1

The resulting percentage figure is then divided into the CBD jobs growth rate assumed for the 2003-2025 period in each scenario to compute the respective housing unit growth ratio.

[38] The numbers in these diagrams were generated by a multi-equation recursive model (see Notes 25 and 29) whose input variables used 2003 values for CBD jobs, population, and housing units; the job split between CBD residents and commuters; peak AM hour entries to the CBD as a percentage of daily entries; and the distribution of these entries among the CBD's four cordons. The model then projected CBD jobs for 2025 using the Compound Interest table, which in turn generated values for the other output variables in a sequential cascade. Changes in the variables between 2003 and 2025 and other coefficients were computed.

[39] Passenger capacity for each IND/BMT train composed of eight R44 through R68 cars reflects Metropolitan Transportation Authority standards of 1,400 seated and standing passengers. This number can be exceeded during what the MTA calls "crush load conditions" that often occur during the peak AM hour. Most standard transportation textbooks use the figure of 30 trains per hour as the train slot capacity of a typical rapid transit track. But informal conversations with New York City Transit Authority operating personnel and others having practical experience with the subway system indicate that the functional capacity of each New York City subway track is 24 trains per hour, with two train slots held in reserve for emergencies. This figure of 24 trains per hour per track is also used by the commuter railroads serving the CBD.

[40] Information about peak hour reserve capacity is from various private conversations during 2004with senior New York City Transit Authority operating personnel.

[41] Summary descriptions of these rail projects may be found in Michael Luo, "On Transit Map, All Roads Lead to Politics," *The New York Times* (25 January 2004): 29-30. For more detailed information, see the web sites www.mta.nyc.us and www.accesstotheregionscore.com.

[42] For information on the status of the Second Avenue Subway as of the first quarter of 2004, see Greg Sargent, "Miracle on Second Avenue," *New York Magazine* (5 April 2004).

[43] For historical details of the el lines in Manhattan and the other boroughs, see Stan Fischler, *The Subway: A Trip Through Time on New York's Rapid Transit* (New York: H&M Productions II, 1997). Manhattan's East Side Corridor now has only one-third as many rapid transit lines as it had 63 years ago, despite more than half a century of extensive real estate development that has significantly increased its population of residents and jobs. At the beginning of the 1940s, the East Side Corridor was served by the Lexington Avenue Subway, the Third Avenue El, and the Second Avenue El (all running to Lower Manhattan), plus the commuter rail line under Park Avenue that ended at Grand Central Terminal. The Second Avenue El was closed and torn down during 1942 on the assumption that the Second Avenue Subway would soon be built (as happened when the Eight Avenue IND Subway replaced the Ninth Avenue El in 1932 and the Sixth Avenue IND Subway replaced the Sixth Avenue El in 1940). The Third Avenue El was closed and torn down during 1955 on the same assumption.

[44] Michael Luo, “Four Options Presented for J.F.K. Rail Link,” *The New York Times* (5 February 2004): B3

[45] From various private conversations during 2004 with New York City Transit Authority operating personnel.

[46] A leading source of information about Transportation Demand Management is the Federal Department of Transportation, which has been advocating greater use of TDM as part of its policy theme “We can’t build our way out of congestion.”