

Queens-Manhattan Transit Improvements

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Problems of peak-hour subway overcrowding continue to persist for Queens-Manhattan passengers in New York City. During the morning rush hour more than 110,000 passengers enter Manhattan via the 53rd Street, 60th Street, and 42nd Street tunnels. Ridership exceeds the capacity of each tunnel, resulting in serious passenger discomfort, especially on the Queens Boulevard E and F trains that use the 53rd Street tunnel. A fourth tunnel, the 63rd Street tunnel, is underused because it does not connect with the Queens subway and elevated lines. The long-range opportunities for improving subway service between Queens and Manhattan, including making better use of the 63rd Street tunnel, are evaluated using the physical feasibility, operating feasibility, ridership feasibility, capacities, costs, and institutional acceptability of more than 20 options. This analysis suggests a subway improvement strategy that involves completing the 63rd Street tunnel connection to the Queens Boulevard express and local tracks; connecting the 60th Street tunnel to the Flushing Line express track; using a rapid transit car capable of running on both tracks; possibly adding a fifth track through the Roosevelt Avenue station; and building a connection between the Queens Boulevard and Rockaway lines. Ultimately, the Long Island Rail Road main line should be connected with the lower level of the 63rd Street tunnel and an initial terminal provided on 3rd Avenue in Manhattan.

Queens, the largest of New York City's five boroughs in land area and the second-largest in population, has less subway service to Manhattan than the Bronx and Brooklyn. Rapid transit is limited to the 42nd (Steinway), 53rd, 60th, and 63rd Street tunnels. Four tracks (of which three are really effective) enter Manhattan from Queens, compared with six from the Bronx and nine from Brooklyn. The 1989 a.m. peak-hour riders entering Manhattan averaged 38,000 per track from Queens, compared with 25,000 crossing the 60th Street (Manhattan) cordon and 21,000 coming from Brooklyn.

The lack of subways across the East River and within Queens has caused serious overcrowding on the Queens Boulevard Line and the Flushing Line. Crowding on the Queens Boulevard E and F express trains is so severe that passengers are sometimes unable to board at the Roosevelt Avenue station. These problems of peak-hour subway overcrowding have persisted for many years.

Plans for alleviating this congestion have been proposed for several decades but relatively little action has been taken. The Metropolitan Transportation Authority (MTA) 1968 New Routes program called for Queens Boulevard express bypass tracks along the Long Island Rail Road (LIRR) between Forest Hills and Long Island City (the Queens Bypass); and a two-level, four-track 63rd Street tunnel with the upper level used by New York City Transit Authority (NYCTA) trains and the lower level by LIRR trains. The 63rd Street tunnel,

with connections to the 6th and 7th Avenue subway lines in Manhattan, was completed and subway service was initiated to 21st Avenue, Queens, in 1989. However, because of the costs involved, the extensions into Queens were extensively restudied. This restudy led to the Northern Boulevard express-local connection proposal, which is currently under consideration.

STUDY CONTEXT

UMTA (now the Federal Transit Administration), concerned with the costs and benefits of the proposed connection, authorized three universities in the New York metropolitan area to take a fresh and innovative look at the Queens-Manhattan public transportation improvement opportunities. One of these studies was conducted by the Transportation Training and Research Center of Polytechnic University, Brooklyn. The key findings of this study are presented.

TRAVEL DEMANDS

Approximately 115,000 subway passengers enter Manhattan from Queens during the morning rush hour of a typical weekday. Of these, about 48,000 ride the E and F trains through the 53rd Street tunnel, 35,000 ride the No. 7 (Flushing) trains through the 42nd Street tunnel, 30,000 ride the N and R trains through the 60th Street tunnel, and 2,000 ride the Q trains through the 63rd Street tunnel.

Projected employment growth in Manhattan and in Long Island City (Queens), coupled with population growth in outer Queens, is expected to result in a demand of 130,000 inbound peak-hour riders by 2000 [the corresponding value in the draft environmental impact statement (EIS) was 132,000 (7)]. By the year 2015, the number of a.m. peak-hour riders could approach 145,000. These ridership forecasts were used in developing and comparing 21 transit improvement options.

OPTION DEVELOPMENT

As stated previously, some 21 improvement options were analyzed. Seven options, Options 1-1 through 1-7, build upon the planned 63rd Street tunnel connection to the Queens Boulevard Line. Nine options, Options 2-1 through 2-9, include major extensions or adaptations of the Queens Boulevard Bypass, which was proposed in the past, and five options (Options 3-1 through 3-5) involve the LIRR.

The analysis assumed that the 63rd Street-Queens Boulevard local express connection (the Northern Boulevard Con-

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nection) would be built as planned. To defer this project, in search of an ideal solution would be counter-productive. The resulting delay (as in 1979) would set the project completion back another decade, during which period costs would escalate, and cost-effectiveness diminish. A brief description of each option follows.

Option 1-1: Queens Boulevard Local-Express Connection

This option, shown in Figure 1, is MTA's currently approved plan; funds for it are included in the Intermodal Surface Transportation Efficiency Act of 1991. The option provides a two-track connection between the east end of the 63rd Street Line and the existing local and express tracks of the Queens Boulevard Line. It also includes a four-track, two-level "bell-mouth" structure for possible future extensions of both the subway and LIRR (i.e. to a new subway yard or to a new route).

The Queens-Brooklyn crosstown G service is cut back at Court Square (at least during peak periods) to allow 14 additional inbound Queens Boulevard trains into Manhattan via the 63rd Street tunnel. The cost, exclusive of rail vehicles, would be approximately \$400 million to \$450 million in 1990 dollars.

Option 1-2: Reverse Signaling

This option, suggested by NYCTA, calls for reverse signaling on Queens Boulevard express tracks between Queens Plaza and 71st Avenue. Reverse signaling during peak periods would make it possible to operate three tracks in the heaviest direction of travel, and operate only one track in the opposite direction. A new service yard would also be built at Sunnyside Yards to provide the necessary train storage.

Option 1-3: 63rd Street Connection to Queens (Brooklyn Crosstown Line)

This option connects the 63rd Street subway with both the Queens Boulevard and Queens-Brooklyn crosstown lines. It is designed to provide direct service between Manhattan and North Brooklyn and to increase the use of the 63rd Street tunnel.

Option 1-4: 60th Street Tunnel Connection to Flushing Line

This option provides additional track connections between the Astoria Line tracks at Queensboro Plaza and the Flushing Line west of 33rd Street to allow 60th Street tunnel trains to reach the express track without interfering with normal Flushing service to 42nd Street. The suggested track rearrangement, shown in Figure 2, creates a four-track section between Queensboro Plaza and 33rd Street. The Independent Rapid Transit (IRT) Flushing cars are 8 ft. 9 in. wide, and the Brooklyn-Manhattan Transit-Independent Line (BMT-IND)

cars are 10 ft wide. Therefore, it would be necessary to use a car that can operate on both sets of tracks or possibly to provide gauntlet tracks. Additional storage would be provided east of the Main Street Flushing terminal.

Option 1-5: 60th Street Tunnel Connection to Relocated Flushing Line

This option connects the 60th Street-Astoria Line to a relocated Flushing Line across the Sunnyside Yards that eliminates the reverse curves through Long Island City. It includes a new Sunnyside station that is tied to the planned commercial development over the yards.

Option 1-6: Reversible Fifth Track at Roosevelt Avenue with Rockaway Branch Connection

This option constructs a fifth reversible track on the Queens Boulevard Line at Roosevelt Avenue to eliminate the bottleneck at this location. To realize the increase in capacity to the east, an express-local connection would be built at Rego Park to join the abandoned LIRR Rockaway Branch that would be reactivated for subway service. Some of the express service would use the fifth track to bypass Roosevelt Avenue.

Option 1-7: Revised Service Patterns at Roosevelt Avenue with Rockaway Branch Connection

This option provides an express-local connection to a reactivated LIRR Rockaway Line. However, instead of building a fifth track through Roosevelt Avenue, all peak-period, peak-direction express trains would skip this station, and thereby eliminate the expense of the fifth track.

Options 2-1, 2-2, and 2-3: Queens Bypass Options

The Queens Bypass options would connect the 63rd Street tunnel with the Queens Boulevard Line local tracks just east of the 71st and Continental Avenue station in Forest Hills. An intermediate station could be provided at Woodside. Option 2-1 proposes a single-track bypass for peak-period, peak-direction super-express service via 63rd Street with two tracks on each approach to the LIRR right-of-way. Option 2-2 provides a two-track bypass, for two-direction super-express service between 71st and Continental avenues and 21st Avenue. Option 2-3 is similar to Option 2-2, but it eliminates the station platform for the super-express service at 71st and Continental avenues.

Option 2-4: Queens Bypass Connection to Rockaway Line and JFK Airport

This option would connect the 63rd Street tunnel to the existing Rockaway Line via a double-track bypass along both sides (or the south side) of the LIRR and a reactivated LIRR Rockaway Branch. Super-express service would operate both

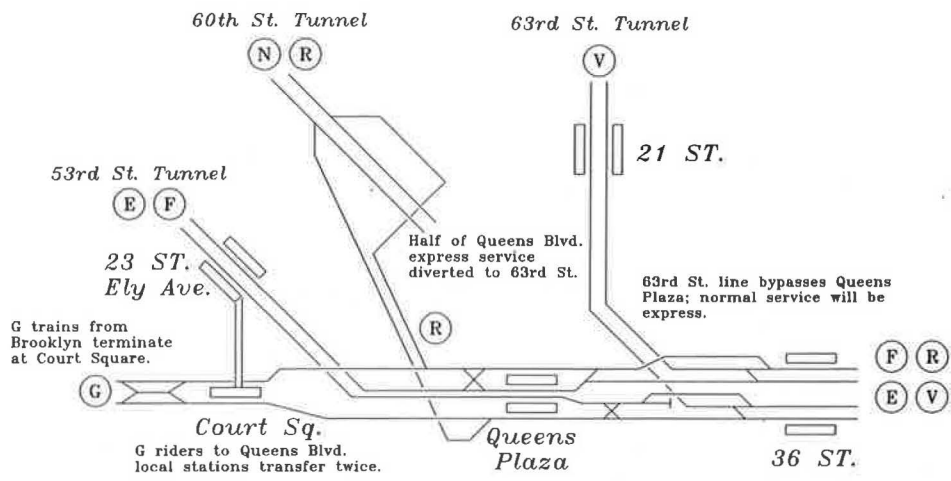


FIGURE 1 Planned local-express connection.

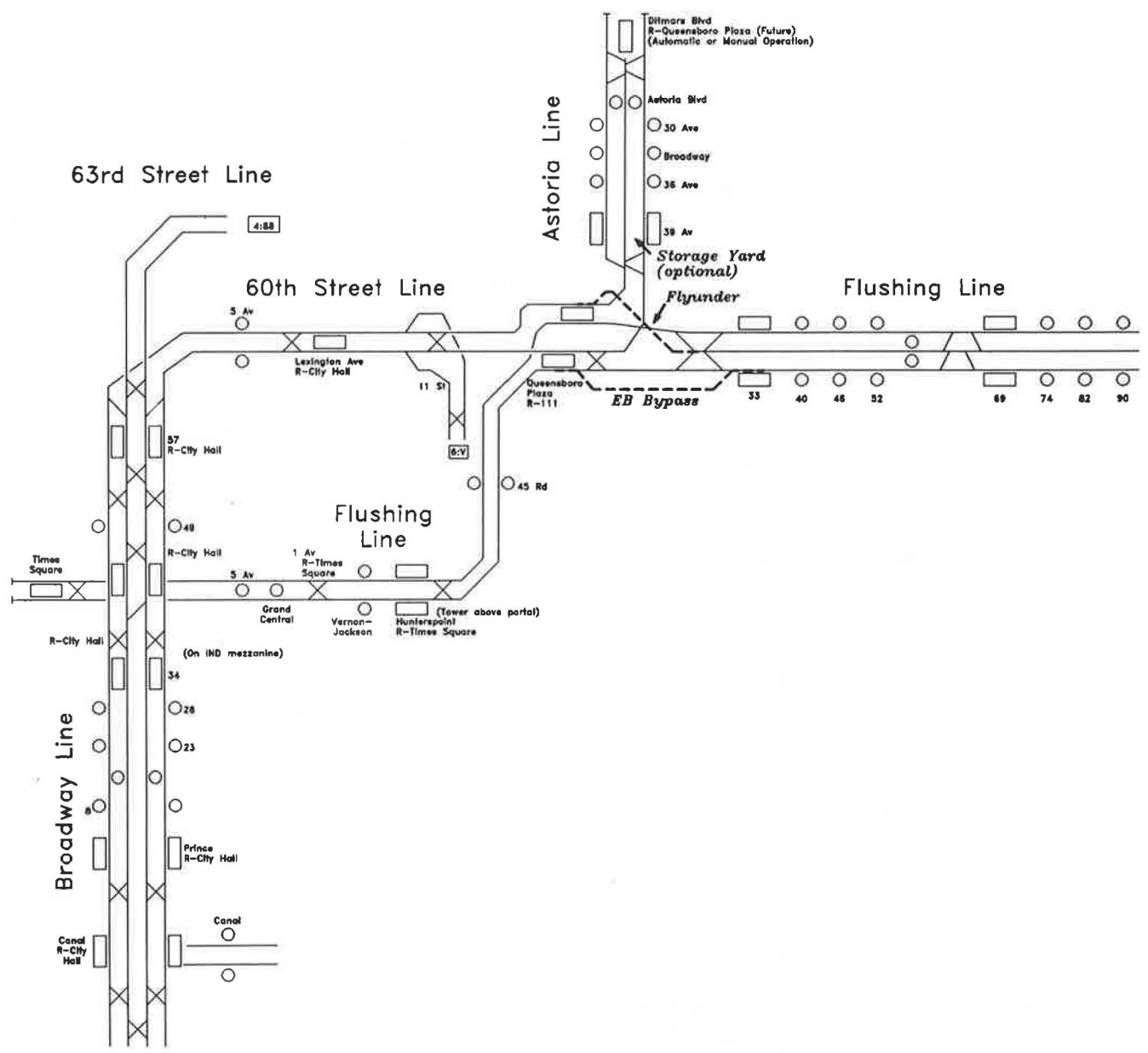


FIGURE 2 60th Street connection to Flushing express track.

ways during peak and base periods. A spur from the Aqueduct or Howard Beach area would connect with JFK International Airport. Alternatively, a people-mover could connect with the airport.

Option 2-5: Queens Bypass Connection with Southeast Queens Extension

This option develops the Queens Bypass from Long Island City to 71st and Continental avenues where it connects with the local tracks of the Queens Boulevard lines, extends the Archer Avenue (Queens Boulevard) Line via the LIRR Atlantic Branch to Laurelton, and reroutes the LIRR trains via the St. Albans Line. If the LIRR needs the Atlantic Branch's track capacity, the extension would require tracks parallel to the existing LIRR tracks.

Option 2-6: Queens Bypass Connection to East Central Queens Line

This option extends the 63rd Street Line to east Central Queens by way of a modified Queens Bypass along the north side of the LIRR tracks and a subway extension via the Long Island Expressway (LIE) to 164th Street.

Option 2-7: Bypass Truncated East of Grand Avenue

This option develops a two-track bypass along the north side of the LIRR that connects with the local tracks of the Queens Boulevard Line east of Grand Avenue. It provides faster service to the heavily used 67th Avenue, 63rd Drive, and Woodhaven Boulevard stations. Two variations of this option were also developed. One option provides a turnback for G trains east of Roosevelt Avenue to enable G trains to operate along part of Queens Boulevard; and a second option uses the existing tunnels of 63rd Drive to connect with a link to the Rockaways via the abandoned Rockaway Branch.

Option 2-8: LaGuardia Airport Extension via Northern Boulevard

This option extends the 63rd Street line along the north side of Sunnyside Yards (in subway) under Northern Boulevard, and then it is elevated via the Grand Central Parkway corridor to the Trump (New York–Washington–Boston) Shuttle and main terminals at LaGuardia Airport. It is designed to serve Northern Boulevard apartments in Jackson Heights, provide subway access to LaGuardia Field to Midtown, and relieve the Flushing Line.

Option 2-9: LaGuardia Airport Extension

This option provides a direct connection between the 63rd Street subway and LaGuardia Airport via an alignment that follows the north side of the Sunnyside Yards area (elevated), the National Railroad Passenger Corp. (Amtrak) Hell Gate-

Bridge route (elevated), a high crossing of the Consolidated Rail Corp. (Conrail) Elevated Line (elevated), the east side of the Brooklyn-Queens Expressway (elevated) and descends to the airport service road system (mainly subway) to pass under the flight path.

Option 3-1: Long Island City–LIRR Transfer

This option provides an across-the-platform transfer station between the 63rd Street NYCTA subway line and the LIRR in Sunnyside Yards. Special low-fare LIRR turnback services would operate from this terminal to Rosedale and Queens Village in eastern Queens.

Option 3-2: 63rd Street Connection to Montauk Branch

This option connects the 63rd Street subway to the Montauk Branch of the LIRR with a second connection to the Jamaica (elevated) in the Lefferts Boulevard–Richmond Hill area. The Montauk Branch would be electrified and a block signal system would be provided for NYCTA operation. NYCTA trains would operate from Jamaica Center via the Montauk Branch and 63rd Street tunnel to Manhattan. LIRR freight service would be limited to late at night and passenger trains would be rerouted over the main line.

Option 3-3: 63rd Street Connection to Port Washington Branch

This option connects the 63rd Street tunnel to the Port Washington Branch of the LIRR (in addition to Queens Boulevard). The branch is converted to NYCTA operations, with local trains terminating at Little Neck and express trains continuing on to Port Washington. Single-track sections on the eastern end of the line would be double-tracked.

Option 3-4: Conversion of LIRR Main Line Tracks to NYCTA Operations

This option (a) connects the 63rd Street subway to the two former LIRR tracks between Woodside and Rego Park; (b) reroutes LIRR diesel trains via the Montauk Branch; (c) operates all LIRR service on the two center LIRR tracks from Woodside to Jamaica and operates NYCTA subway service via the two outer tracks (alternatively, to create joint NYCTA-LIRR running); (d) builds a flyover for NYCTA tracks through the Jamaica area; (e) connects NYCTA to the Atlantic Avenue Branch, which would be converted to NYCTA operation to Springfield Gardens; and (f) possibly reactivates the Rockaway Branch for subway service.

Option 3-5: LIRR Connection to Midtown Manhattan

This option calls for providing LIRR operations to midtown via the lower level of the 63rd Street tunnel. Alternatives

include a connection to Grand Central Terminal, a terminal at Third Avenue and 49th Street, and a new cross-Manhattan line, which may extend to New Jersey and connect Amtrak's West Side line.

OPTION ASSESSMENT

Each option was assessed in terms of its physical feasibility, capital costs (excluding new rail cars), environmental effects, institutional implications, and cost effectiveness. Operating plans and ridership estimates were prepared for each option. The analysis procedure is shown in Figure 3.

Underlying Assumptions

The analysis reflects the following assumptions:

Ridership

The 130,000 a.m. peak-hour inbound subway riders anticipated by the year 2000 were allocated to the various Queens subway routes and the four Queens-Manhattan river crossings using the UMTA EIS (1) assignments as a base, making adjustments to reflect the number of trains operated on individual routes, the attractiveness of the service, and the characteristics of the areas served by the proposed extensions. Existing station boardings in proximate areas provided a further indication of ridership potentials of proposed new stations. The total inbound ridership was increased for several options to reflect the penetration of new market areas, and the expansion of subway capacity.

Capacity Requirements

The crush capacity (Level-of-Service F) represents the absolute maximum number of passengers that can be carried under conditions of extreme or intolerable overcrowding.

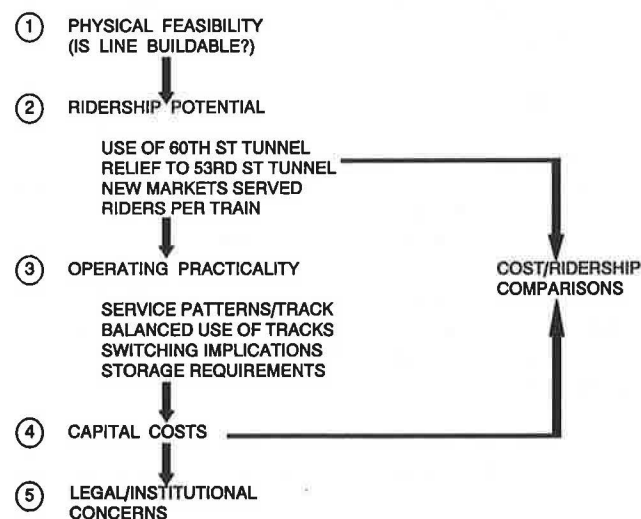


FIGURE 3 Analysis procedure.

However, for transport planning purposes consistent with past practices, schedule design capacities based on 3.0 ft²/standing passenger (Level-of-Service E) were used. Accordingly, schedule-design capacities of 1,400 persons per BMT-IND train and 1,210 persons per IRT train were applied to the number of trains operating under each option across the East River. On the basis of 28 trains per track per hour, the following capacities were produced

Tunnel	Passengers per hour
63rd Street	39,200
60th Street	39,200
53rd Street	39,200
42nd Street (IRT)	<u>33,880</u>
Total	151,480

Thus, the four tunnels, if fully used, could comfortably accommodate the anticipated a.m. inbound riders well beyond the year 2010. In many options, however, only 14 to 21 trains per hour would be able to use the 63rd Street tunnel, resulting in total capacities of 131,880 to 141,680 riders. These capacities would comfortably accommodate riders until approximately the year 2005.

Operating Guidelines

The following service guidelines were used in developing and assessing options:

- Operating plans were developed for the inbound service to Manhattan during the a.m. peak hour. These plans, derived for comparative purposes, were based on the existing subway service pattern and the provision of not more than two basic services per trunk-line route.
- Subway service would operate at a minimum 2-min headway during the peak of the peak hour. For planning purposes, this translates into a maximum practical capacity of 28 trains per track per hour when peaking is taken into account. The 42nd, 53rd, and 60th Street tunnels would operate at their practical capacity of 28 trains per hour, whereas the number of trains using the 63rd Street tunnel would vary from 14 to 28 depending on the specific option.
- The E and F Queens Boulevard express services would operate via the 53rd Street tunnel. These specific impacts were only assessed for the planned Queens Boulevard connection although it could apply to many options.
- The added service in Queens through the 63rd Street tunnel would be linked with the existing services that terminate at 21st Avenue. However, in some options an additional service might operate via 63rd Street. In all cases, the effects on existing Sixth and Broadway–Seventh Avenue services were considered and included possible turnback of trains in lower Manhattan.
- Because of track limitations, some changes in Queens-Brooklyn service linkages may be required.
- The crosstown Queens-Brooklyn G service is cut back at Court Square during peak hours in many of the options and in some cases, further refinements of operation plans might allow this service to continue to Queens Plaza or to 71st and Continental avenues. However, better use is made of the Queens Boulevard local tracks when the G service is cut back.

• Improvements at the Harold Interlocking and the new West Side storage yard should allow the number of peak-hour trains on the LIRR to be increased and Jamaica would become the new limitation.

Costs

Order-of-magnitude capital costs were derived from a variety of sources and adjusted to 1990 levels. The estimates for the bypass and bypass-related options were drawn from a July 1981 Queens transit alternatives study. The costs for the Northern Boulevard connection were based on those contained in the May 1990 draft EIS (1) and other costs were based on the following unit values and were subject to engineering judgment when complex construction would be required:

	<i>Cost per 2-track mile (millions of dollars)</i>
Subway	250-350
Elevated structure	75
New elevated embankment only	50
Existing embankment or grade	25

Rail car costs were not estimated because they depend in part on the amount of interlining possible and detailed schedule development.

Ridership Comparisons

Anticipated year 2000 a.m. peak-hour ridership forecasts for each option are presented in Tables 1 and 2. Table 1 compares ridership by option and river crossing and gives the estimated

total inbound peak-hour capacity. Table 2 gives the trains using the 63rd Street tunnel by option and identifies the number and sources of new riders, giving expected relief on each river crossing.

Findings presented in Tables 1 and 2 are outlined as follows:

1. Trains through the 63rd Street tunnel—The number of trains entering Manhattan through the 63rd Street tunnel in the a.m. peak hour ranges from 14 (Option 1-1: planned Queens Boulevard Connection) to 28 (Option 3-3: Port Washington Connection). Most options have 21 trains going through the tunnel.

2. Passenger Capacity—The total peak-hour inbound capacity across the East River ranges from about 132,000 (Option 1-1: Queens Boulevard Connection and Option 2-7: Queens Boulevard Connection east of Grand Avenue) to 151,000 (Option 3-3 b: 63rd Street-Port Washington Connection). The Queens Bypass (Option 2-2) currently has a capacity of 142,000, but this could easily be increased to 151,000. Most of the other options have a total capacity of 142,000. The year 2000 base demand is 130,000 and the year 2010 base demand is 145,000.

3. Total Riders—The anticipated number of inbound riders for the 2000 a.m. peak hour reflects the attractiveness of the subway service and its ability to serve new markets. Ridership ranges from 130,000 to 140,000 people. The largest number of riders (140,000) is expected on the Queens Bypass-Springfield Gardens Extension (Option 2-5) and on the Port Washington NYCTA operation (Option 2-6).

The Queens Bypass with an LIE extension (Option 2-6) has 137,000 riders, and the Queens Bypass-Rockaway-JFK Line (Option 2-5) and the Northern Boulevard-LaGuardia Line (Option 2-9) have 135,000 riders each.

TABLE 1 SUMMARY OF RIDERSHIP FORECASTS—EAST RIVER CROSSING (YEAR 2000: INBOUND A.M. PEAK HOUR)

OPTION	DESCRIPTION	Trains Using 63rd Street Tunnel	CAPACITY	TUNNEL					G SERVICE QUEENS TERMINAL
				63rd	60th	53rd	42nd	TOTAL	
0	No Build	14	131,880	3,000	36,000	53,000	38,000	130,000	71st
1-1 (a)	63rd St exp-local conn. (exp via 53rd)	14	131,880	16,000	34,000	44,000	36,000	130,000	Court Square
1-1 (b)	63rd St exp-local conn. (exp via 53rd, 63rd)	28	131,880	21,000	30,000	43,000	36,000	130,000	Court Square
1-2	63rd St conn. / reverse signaling	21	141,680	25,000	33,000	40,000	36,000	134,000	71st
1-3	63rd St conn. to Queens Blvd & crosstown line	21	141,680	21,000	34,000	42,000	35,000	132,000	Court Square
1-4	63rd St conn.; 60th conn. to Flushing line express track	21	141,680	24,000	35,000	42,000	31,000	132,000	Manhattan
1-5	63rd St conn.; 60th St conn. to Flushing line; Flushing line relocated across Sunnyside Yards	21	141,680	24,000	35,000	42,000	31,000	132,000	Court Square
1-6	63rd St conn., reversible 5th track at Roosevelt Ave; ext. to Rockaways	21	141,680	23,000	33,000	41,000	36,000	133,000	Court Square
1-7	63rd St conn.; revised service pattern at Roosevelt Ave.; ext. to Rockaways	21	141,680	22,000	35,000	40,000	36,000	133,000	Court Square
2 - 1,2,3	Queens Bypass	21	141,680	27,000	31,000	40,000	36,000	131,000	71st
2-4	Queens Bypass to Rockaway conn.	21	141,680	19,000	34,000	46,000	36,000	135,000	71st
2-5	Queens Bypass-Springfield Gardens ext.	21	141,680	28,000	34,000	42,000	36,000	140,000	71st
2-6	Queens Bypass to LIE ext.	21	141,680	27,000	33,000	42,000	34,000	136,000	71st
2-7 (1)	Queens Blvd conn. east of Grand Ave	14	131,880	19,000	33,000	42,000	36,000	130,000	Court Square
2-7 (2)	Queens Blvd conn. east of Grand Ave with ext. to Rockaway	14	131,880	19,000	34,000	44,000	36,000	133,000	Roosevelt Ave
2-8 (a)	LaGuardia ext. via Northern Blvd	21	131,880	20,000	34,000	46,000	35,000	135,000	71st
2-8 (b)	LaGuardia ext. via Northern Blvd	21	141,680	24,000	34,000	42,000	35,000	135,000	Court Square
2-9	LaGuardia ext. via BQE	21	141,680	19,000	34,000	44,000	36,000	133,000	Court Square
3-2 (a)	63rd St - Montauk Branch conn.	21	141,680	19,000	34,000	36,000	36,000	135,000	71st
3-2 (b)	63rd St - Montauk Branch conn.	21	141,680	24,000	33,000	42,000	36,000	135,000	Court Square
3-3 (a)	63rd St - Port Washington conn.	21	141,680	27,000	34,000	46,000	33,000	140,000	71st
3-3 (b)	63rd St - Port Washington conn.	28	151,480	33,000	34,000	40,000	33,000	140,000	Court Square

TABLE 2 COMPARATIVE ANALYSIS OF RIDERSHIP IMPACTS (YEAR 2000: INBOUND A.M. PEAK HOUR)

OPTION NUMBER	TRAINS USING 63rd ST TUNNEL	QUEENS TERMINAL FOR G SERVICE	ADDITIONAL SUBWAY RIDERS ACROSS EAST RIVER CORDON				RELIEF AFFORDED (Difference from No Build)		
			Total	From Bklyn subway lines	From LIRR	New	60th	63rd	42nd
1-1 (a)	14	Court Sq	---				2000	9,000	2000
1-1 (b)	14	Court Sq	---				6000	10,000	2000
1-2	21	71st	4000	4000 d	a	a	3000	13,000	2000
1-3	21	Manhattan	2000	1200	800		2000	11,000	3000
1-4	21	Court Sq	2000		800	1200	1000	11,000	7000
1-5	21	Court Sq	2000	a	a	a	1000	11,000	1000
1-6	21	Court Sq	3000	1500	700	800	3000	12,000	2000
1-7	21	Court Sq	3000	1500	700	800	1000	13,000	2000
2-1	21	71st	4000	a	a	a	5000	13000	2000
2-2	21	71st	4000	a	a	a	5000	13000	2000
2-3	21	71st	4000	a	a	a	5000	13000	2000
2-4	21	71st	5000	1500	700	2800	2000	7000	2000
2-5	21	71st	10000	4000 d	2000	4000	2000	11000	2000
2-6	21	71st	7000	---	---	7000	3000	11000	4000
2-7 (a)	14	Court Sq	---	---	---	---	3000	11000	2000
2-7 (b)		Roosevelt Ave	3000	1500	700	800	3000	9000	2000
2-8 (a)	14	71st	5000	---	---	5000	2000	7000	3000
2-8 (b)		Court Sq	5000	---	---	5000	2000	11000	3000
2-9	14	Court Sq	3000	---	---	3000	2000	9000	2000
3-1 b			---	---	---	---	2000	9000	2000
3-2 (a)	21	71st	5000	500	2000	2500	2000	7000	2000
3-2 (b)	21	Court Sq	5000	500	2000	2500	3000	7000	2000
3-3 (a)	21	71st	10000	---	8000	2000	2000	10000	5000
3-3 (b)	28	Court Sq	10000	---	8000	2000	2000	10000	3000

Notes: (a) Not specified.
 (b) Assumed, no ridership forecasts.
 (c) No ridership forecasts for options 3-4 or 3-5.
 (d) Time shift from existing services.

4. Use of 63rd Street Tunnel—The number of inbound peak-hour passengers through the 63rd Street tunnel ranges from 16,000 (Option 1) to 33,000 (Option 3-3b). The Queens Bypass with the Southeast Queens Connection (Option 2-5) results in 28,000 riders, and the Queens Bypass and Queens Bypass-LIE extensions (Options 2-2 and 2-6) result in 27,000 riders.

5. Relief Afforded—The relief afforded to the 53rd Street tunnel ranges from 9,000 to 13,000 riders. The greatest relief occurs when additional express services are operated to 179th Street (as in the case of the Queens Bypass options), or when 14 local trains, in conjunction with other service improvements, are operated from 179th Street via the 63rd Street tunnel. Options that relieve the tunnel by 13,000 trips include reverse running (Option 1-2) and the Queens Bypass (Option 2-2).

—The relief afforded to the 42nd Street tunnel ranges from 2,000 to 7,000 passengers. The greatest relief—5,000 and 7,000 passengers, respectively—results from the Port Washington Extension (Option 3-3) and the 60th Street connection to the Flushing express track (Options 1-4 and 1-5). Several options attract passengers from the LIRR, and thereby relieve the railroad. The greatest relief (8,000 passengers) results from the Port Washington Connection (Option 3-3).

—The Montauk-Archer NYCTA operation (Option 3-2) and the Bypass-Southeast Queens Extension (Option 2-5) each attract 2,000 LIRR peak-hour riders.

6. Queens-Brooklyn G Operation—Options that incorporate the Queens Boulevard Connection require the G ser-

vice to be turned back during peak hours at Court Square (The exception, perhaps, is the reverse running, which might allow inbound G service.) The Queens Bypass options enable the G service to begin at 71st Avenue. However, the extension to Rockaways (Option 2-4) provides more relief to the Queens Boulevard Line if the number of trains on Queens Boulevard is increased and the number of trains from the Rockaways is decreased. The Flushing corridor (Options 2-8, 2-9, and 3-2) and the Montauk (Option 3-2) also require the G Line to be cut back at Court Square to allow more trains on Queens Boulevard. The two options that provide service to the 60th Street tunnel from Flushing (Options 1-4 and 1-5) reduce the number of R trains entering Queens Plaza from 14 to 7. These R trains are shifted to the 63rd Street tunnel which makes it possible for the G trains to operate from the eastbound Queens Plaza track. Running more R trains via the 63rd Street tunnel in some of the other options might also allow this service modification. The point remains, however, that to maximize Manhattan-bound capacity, it is best to modify the G operation in many options.

Costs

Estimated construction costs in 1990 dollars for the various options are presented in Table 3, and the key findings are as follows:

1. The Northern Boulevard option (Option 1-1) would cost about \$450 million.

TABLE 3 COST SUMMARY OF QUEENS TRANSIT OPTIONS (IN MILLIONS OF 1990 DOLLARS)

NUMBER	OPTION	Est. Incremental Cost of Option	Est. Cost Northern Blvd Option	TOTAL
1-1	63rd St Local/Express Connection (Northern Boulevard Connection - NBC)		\$ 450	\$ 450
1-2	3:1 Reverse Signaling - reverse signaling - yard, including connections TOTAL	\$ 50 700 750	450	200
1-3	63rd Street GG Connection	250	450	700
1-4	60th St-IRT Joint Running - structural changes at Queensboro Plaza - storage (east of Main Street) - gap problem solution TOTAL	75 100 25 200	450	650
1-5	60th St-IRT Joint Running - structural changes at Queensboro Plaza - storage (east of Main Street) - gap problem solution - Flushing line relocation TOTAL	25 100 25 125 275	450	725
1-6	Reversible Fifth Track at Roosevelt Avenue with Rockaway Connection - fifth track (same level) - connection to Rockaway at 63rd Dr (local/express) - Rockaway extension to Liberty Avenue TOTAL	150 200 150 500	450	950
1-7	Revised service pattern at Roosevelt with Rockaway connection - connection to Rockaway Branch at 63rd Drive - Rockaway ext to Liberty Avenue TOTAL	200 150 350	450	800
2-1	Single-track bypass (\$660 in 1984 without cars)	\$ 850	\$ 450	\$ 1300
2-2	Double-track bypass	900	450	1350
2-3	Double-track bypass without 71st Avenue	850	450	1300
2-4	Bypass (west half) with connection to Rockaway Line and JFK spur - bypass (west half) - Rockaway branch to Liberty Avenue - JFK extension TOTAL	425 175 300 900	450	1350
2-5	Bypass plus Archer Avenue S.E. Queens extension - bypass - S.E. Queens extension on LIRR tracks TOTAL	900 200 1100	450	1550
2-6	Bypass (west half) with connection to East Central Queens Line via L.I.E. - bypass (west half) - L.I.E. subway extension including terminal facilities TOTAL	400 1100 1500	450	1950
2-7	Truncated Bypass - bypass to Grand Street - GG turnback east of Roosevelt Avenue Subtotal - Rockaway branch to Liberty Avenue TOTAL	\$ 600 100 700 200 900	\$ 0 0	\$ 700 900
2-8	LaGuardia Airport extension via Northern Boulevard - if from bellmouth - if from 54th Street (1.5 miles shorter)	1200 800	450 450	1650 1250
2-9	LaGuardia Airport extension (Brooklyn-Queens Expressway) - if from bellmouth - underground - if from bellmouth - part elevated	1300 750		
3-1	LIRR - Long Island City Transfer (Montauk transfer plan) (\$291 in 1984 without cars)	\$ 400	\$ 450	\$ 850
3-2	63rd Street connection to Montauk Branch (Montauk/Archer Avenue plan) (\$381 in 1984 without cars)	550	450	1000
3-3	63rd Street connection to Port Washington branch - 63rd Street connection to Port Washington tracks - conversion of Port Washington Line to NYCTA operation TOTAL	250 270 520	450	970
3-4	Conversion of LIRR Main Line tracks to NYCTA operation	OPTION DROPPED		
3-5	LIRR 63rd Street line to Grand Central Terminal - Queens connections (2 tracks* only) plus one of the following 1. Grand Central link, or 2. 3rd Avenue terminal** 3. crosstown (2 tracks) on 50th Street (to 10th Avenue) ***	600 750 600 1100	450	1050 750 600 1100

NOTES:

- * Queens Connection - Two track connection to LIRR instead of formerly proposed four track connection.
- ** 3rd Avenue Terminal, 4 track, single level, no tail tracks for storage.
- *** A future second crosstown tunnel for added capacity would add another \$500 million.

2. Options 1-2 through 1-7, which build on this option, would cost from \$200 million to \$500 million more.

3. The original Queens Bypass option (Option 2-2) would cost \$900 million. Thus, if it were built in lieu of the planned Northern Boulevard connection, it would cost about \$900 million today. However, building it in addition to the Queens-Northern Boulevard connection would cost \$1.3 billion overall. A truncated bypass (Option 2-7) with a connection to the Rockaway Branch would cost \$900 million. All other bypass-related options, taken with the Northern Boulevard connection, would exceed \$1 billion.

4. Conversion of the Port Washington Branch to NYCTA operation would cost about \$520 million about the costs for the Queens-Northern Boulevard connection.

5. Extension of the LIRR into Manhattan via the lower level of the 63rd Street connection would cost more than \$1 billion plus the \$450 million cost for the Northern Boulevard connection.

Cost Effectiveness

The cost effectiveness of each option was estimated by a simplified incremental cost analysis that compared the incremental benefits achieved over Option 1-1 with the incremental capital costs. The benefits assumed inbound a.m. peak-hour use of the 63rd Street tunnel and inbound a.m. trip reductions in the 53rd Street tunnel. The results of this analysis are presented in Table 4.

- The cost-effective options, in terms of using the 63rd Street tunnel, in order of effectiveness are Option 1-4 (60th Street trains using Flushing Express track); Option 3-3b (63rd Street tunnel connected to Port Washington Branch); Option 1-5 (60th Street trains using Flushing Express track with Flushing Line relocated); and Options 2-1 and 2-3 (Queens Bypass assuming that the Northern Boulevard connection is not built).

- The cost-effective options in terms of affording relief to the 53rd Street tunnel are Option 2-7a (63rd Street extension to Grand Avenue in lieu of the Northern Boulevard connection); Option 1-7 (Northern Boulevard connection with express trains skipping Roosevelt Avenue); 60th Street tunnel service via the Flushing express track; and Options 2-1 and 2-3 (the Queens Bypass without the Northern Boulevard connection).

It is evident that the Queens Bypass, if it is built in place of the Northern Boulevard connection, fares well in this analysis on both accounts. With the Northern Boulevard connection, the 60th Street link to the Flushing express track and the conversion of the Port Washington Line to NYCTA operation also appear to be cost-effective.

Table 5 presents a summary assessment of the various options. On the basis of this assessment, in conjunction with the cost-effectiveness analysis, the following options were screened from further consideration:

- Option 1-2 (high costs, adverse impact in off-peak direction),
- Option 1-3 (difficult construction, low ridership),

TABLE 4 COST EFFECTIVENESS OF OPTIONS OVER OPTION 1-1a (IN MILLIONS OF DOLLARS PER THOUSAND DAILY RIDERS FOR INBOUND A.M. PEAK HOUR)

OPTION	63rd Street Tunnel			Reduction in 53rd Street Tunnel		
	Base	Option	Rank	Base	Option	Rank
1-1						
1-2	83.3			187.5		9
1-3	50.0		8	125.0		5
1-4	25.0		1	100.0		3
1-5	34.4		3	136.0		7
1-6	71.4			166.7		8
1-7	58.3		10	87.5		2
2-1	77.3	(36.4)	4	212.5	(100)	3
2-2	81.8	(40.9)	6	225	(112.5)	
2-3	77.3	(36.4)	4	212.5	(100)	3
2-4	30.0			NEGATIVE		
2-5	91.7	(54.1)		550	(325)	
2-6	136			750		
2-7a	50		8	75		1
2-7abc	150			NEGATIVE		
2-8a	375	(300)		NEGATIVE		
2-8b		(100)		400		
2-9	250			NEGATIVE		
3-2a	183.3			275		10
3-2b	68.7			275		10
3-3a	47.3		7	NEGATIVE		
3-3b	30.6		2	130		6

NOTE: Values in parentheses assume Northern Boulevard connection is not built.

- Option 2-1 (difficult operations, limited flexibility),
- Option 2-4 (poor cost effectiveness),
- Option 2-6 (high costs because of difficult subway construction),
- Option 2-7 (not practical once the Northern Boulevard connection is built),
- Options 2-8 and 2-9 (high cost because of subway construction, little relief, poor cost effectiveness),
- Option 3-1 (high cost and little relief, nullified by 63rd Street-Queens Boulevard connection),
- Option 3-2 (community concerns, little additional relief over Queens Boulevard connection), and
- Option 3-4 (not operable in Jamaica).

Emergent Directions

The analyses reaffirm the desirability of building the Queens Bypass. The bypass provides effective relief to the Queens Boulevard corridor, achieves good use of the 63rd Street tunnel, enables the Queens-Brooklyn service to continue operating to and from 71st Avenue, and makes it possible to extend services to eastern and southeastern Queens as demand arises

TABLE 5 SUMMARY OF ASSESSMENT OF QUEENS-MANHATTAN TRANSIT OPERATIONS

OPTION	Capital Cost (Millions of 1990 dollars)	Queens Terminal for G Service	Trains Using 63rd St Tunnel	Passengers Using 63rd St Tunnel	Relief to 53rd St Tunnel	New Subway Trips Across East River	Coverage of New Areas	Engineering Implications	Development Impacts	Institutional Consideration	Remarks
1-1 (a)	450	Court Sq	14	16,000	9,000	-----					
1-1 (b)	450	Court Sq	14	21,000	10,000	-----					
1-2	1200	71st Ave	21	25,000	13,000	4,000					Adverse operation in off-peak direction
1-3	700	Manhattan	21	21,000	11,000	2,000	Direct service North Brooklyn - Manhattan	Very difficult construction	North Brooklyn		Not practical
1-4	650	Court Sq	21	24,000	11,000	2,000		Requires special cars	Sunnyside Yard		
1-5	725	Court Sq	21	24,000	11,000	2,000					Eliminates Queensboro Plaza transfer
1-6	950	Court Sq	21	23,000	12,000	3,000	Direct service - Rockaways	Disrupts service during construction			
1-7	800	Court Sq	21	22,000	13,000	3,000					
2-1	1300	71st Ave	21	27,000	13,000	4,000					Operationally not practical
2-2	1350 ¹	71st Ave	21	27,000	13,000	4,000					
2-3	1300	71st Ave	21	27,000	13,000	4,000					
2-4	1350	71st Ave	21	19,000	7,000	4,000	Direct service - JFK/Rockaways				
2-5	1550	71st Ave	21	28,000	11,000	10,000	Southeast Queens				
2-6	1950	71st Ave	21	27,000	11,000	7,000	Eastern Queens				
2-7 (a)	600 ²	Court Sq	14	19,000	11,000	-----					
2-7 (a,b,c)	900	Grand Ave	14	19,000	9,000	3,000	Direct service - Rockaways				
2-8 (a)	1650	71st Ave	14	20,000	7,000	4,000	Jackson Heights-LaGuardia				
2-8 (b)	1250	Court Sq	21	24,000	11,000	5,000					
2-9	1200	Court Sq	21	19,000	9,000	3,000	LaGuardia				
3-1	850	Court Sq	14	(4)	(4)	(4)				Yes	Poor passenger attraction
3-2 (a)	1000	71st Ave	21	19,000	7,000	5,000	Richmond Hill, Glendale, Maspeth			Community objects to plan	Impacts LIRR freight service
3-2 (b)	1000	Court Sq	21	24,000	11,000	5,000					
3-3 (a)	970	71st Ave	21	27,000	7,000	10,000	Bayside/Great Neck			Yes	Allows 7 more peak hour trains into Penn Station
3-3 (b)	970	Court Sq	28	33,000	13,000	10,000				Yes	
3-4	-----	Court Sq	14	(4)	(4)	(4)	Requires major construction in Jamaica			Possibly	Not practical - limits LIRR capacity at Jamaica
3-5	1650 ³	Court Sq	14	(4)	(4)	(4)	Very costly construction		Midtown	May allow benefit-assessment financing	Very long range

Notes:

¹ 900 without Northern Boulevard connection.

² Without Northern Boulevard connection.

³ To 3rd Avenue terminal, to Grand Central Terminal.

(4) Not estimated.

and resources permit. However, to build both the bypass and the Northern Boulevard connection would result in redundant investments. The complete bypass makes sense *only* if the planned Northern Boulevard connection is not built. Developing the bypass at this time would add delays, costs, and community acceptance problems. The Northern Boulevard express-local connection (Option 1-1) should be completed as soon as possible. Other viable options include connecting the 60th Street tunnel to the express tracks of the Flushing Line (Option 1-4), followed by possibly adding a fifth track through the Roosevelt Avenue station and building a connection between the Queens Boulevard and Rockaway lines (Option 1-6).

Two viable LIRR options emerge from this analysis: (a) the Port Washington Branch could be converted to NYCTA operation and routed through the existing 63rd Street tunnel (Option 3-3), representing an alternative to Options 1-4 and 1-7, and (b) ultimately, the LIRR should enter midtown through the lower level of the 63rd Street tunnel (Option 3-5).

TRANSIT IMPROVEMENT PROGRAM

The recommended transit improvement program builds on the comparative analysis. This program, shown in Figure 4, is keyed to the transport needs of the Queens-Manhattan

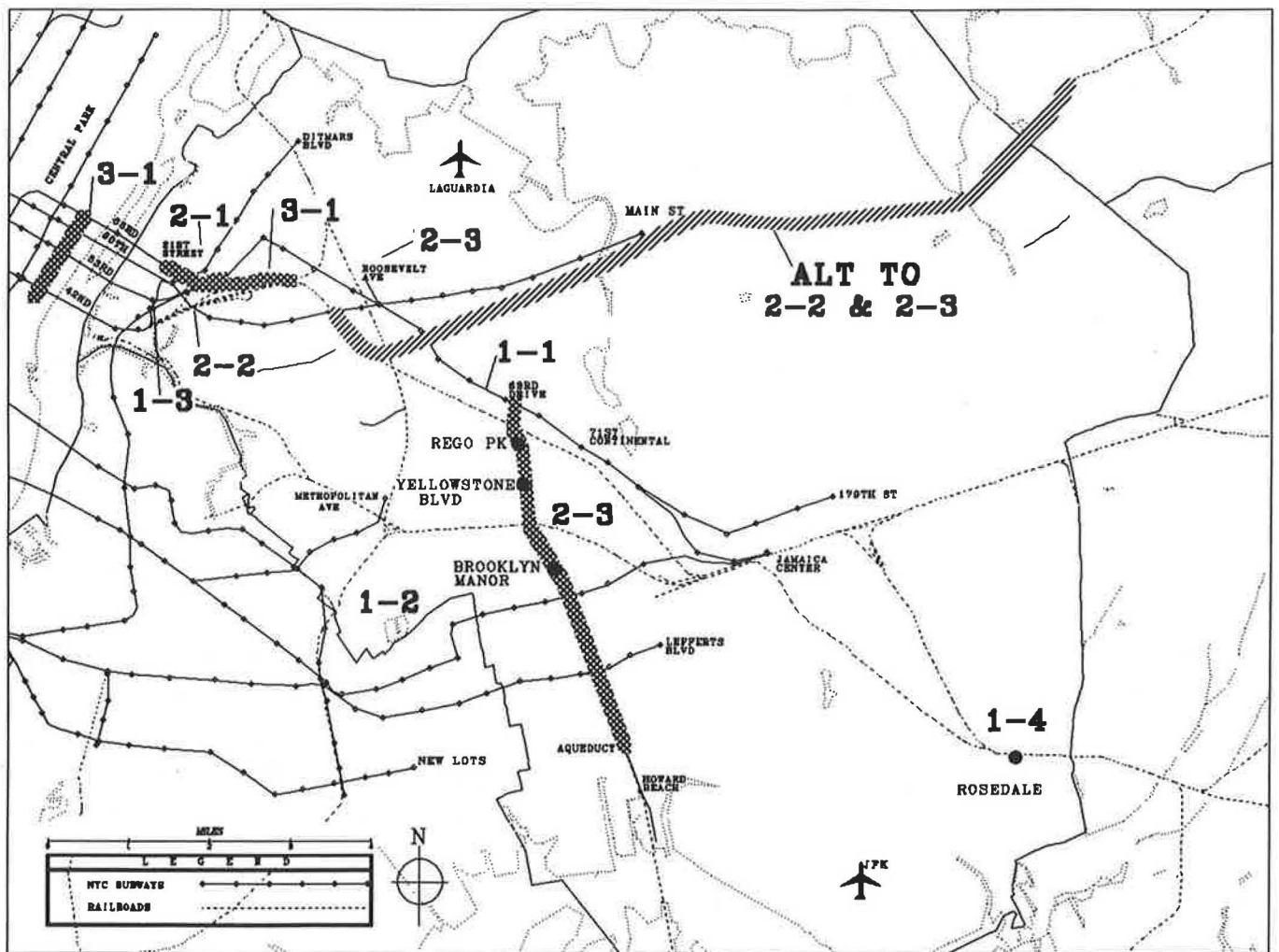


FIGURE 4 Queens-Manhattan Transit Development Program.

corridor over the next 25 years; it contains both short- and long-term proposals.

Short-Term Action (1990–1995)

The four low-cost short-term improvements should be implemented over the next few years in order to benefit travelers during Northern Boulevard construction.

1-1: 60-ft subway cars should be used on the E and F Queens Boulevard express trains instead of 75-ft cars to reduce dwell times at busy stations.

1-2: The J-Z service on the Broadway-Jamaica Line should be sped up by consolidating or closing lightly used, closely spaced stations.

1-3: Improved pedestrian connections should be provided in Long Island City between the IND Queens Plaza and the IRT-BMT Queensboro Plaza stations and between the IRT Court House Square stations.

1-4: A transit center should be developed at the Rosedale station of the LIRR in southeastern Queens.

Stage 2 Improvements (1995–2005)

The following improvements should be implemented by about the year 2005:

2-1: The express-local connection between the 63rd Street tunnel and Northern Boulevard should be built before the year 2000. This connection will allow the operation of 14 additional trains into Manhattan during the a.m. peak hour.

2-2: The 60th Street tunnel tracks serving Queensboro Plaza should be extended to connect with the Flushing Line express track by about the year 2000. This will allow the operation of an additional seven trains into Manhattan via 63rd Street and also increase the capacity of the Flushing Line express service by 50 percent. This extension will require the use of a car that can operate on both IRT and BMT tracks. This car should have extenders under each door that would operate on the 60th Street–Broadway Line. The stringent platform gap requirements of the Americans with Disabilities Act of 1991 may make this solution impractical; alternatively, gauntlet tracks could be provided at BMT stations in Manhattan.

2-3: A possible alternative by the year 2010 (if needed) would be to provide a fifth reversible track at Roosevelt Av-

enue and build a connection between the Queens Boulevard and a reactivated Rockaway Line. This would increase the number of Queens Boulevard express trains from 28 to 35. Under this concept, the E and F express trains would skip Roosevelt Avenue and the Rockaway express trains would use Roosevelt Avenue as a reservoir station, stopping and waiting for the next suitable interval between E and F trains.

The three projects represent an incremental approach to providing better subway service to Eastern Queens that permits full use of the 63rd Street tunnel; gives substantial relief to 53rd Street; provides additional capacity to northern, central, and eastern Queens; penetrates new markets; and provides faster service to the Rockaways.

Project improvements 2-2 and 2-3 contain some innovative operating concepts. If these concepts are unacceptable to NYCTA and MTA, an alternative concept should be implemented. This alternative concept involves converting the Port Washington Branch of the LIRR to NYCTA operation and connecting it to the upper level of the 63rd Street tunnel. Fourteen trains would operate to and from Manhattan via 63rd Street; seven express from Port Washington, and seven local from Little Neck. This option maximizes the use of the 63rd Street tunnel and provides better Manhattan distribution for Port Washington Branch passengers. It removes trains from the LIRR tunnel and creates track slots for the main line trains from Nassau and Suffolk counties.

Future Development (Post-2005)

A connection between the LIRR main line and the lower-level 63rd Street tunnel, along with extension of LIRR service to midtown Manhattan, has merit over the long run as part of regional transit improvements. This tunnel connection should

initially terminate on 3rd Avenue around 50th Street, and should also provide for the ultimate extension across Manhattan into New Jersey because this would permit integrated regional commuter rail operations similar to the Reseau Express Regional (RER) system in Paris.

CONCLUSIONS

The analyses of the Queens transit improvement options in terms of cost, ridership, relief to existing subway lines, cost effectiveness, and related implications is a straightforward process. Provided that realistic estimates can be obtained for ridership and costs, the approaches used in this study have important transferability to other major rail transit proposals.

It is also clear from this analysis that deferring desirable projects in search of low-cost alternatives can be both counterproductive and costly in the long run. Therefore, it is essential to move ahead as soon as possible with the planned Northern Boulevard Connection. The needed funding for additional improvements can be obtained over the next several decades.

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