

# **JFK One-Seat Ride Feasibility Study**

## **Final Report**

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*February 2001*

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# 1. Summary and Recommendation

New York Governor George E. Pataki's "Master Links" program includes achieving One-Seat Ride service (a direct rail service that does not require passengers to transfer) between Manhattan and both New York City airports, John F. Kennedy (JFK) and LaGuardia (LGA). Extension of rail service to LGA Airport to provide One-Seat Ride service from Manhattan is currently under study by New York City Transit (NYCT). At JFK Airport, the AirTrain service, currently under construction by the Port Authority of New York and New Jersey, will provide a two-seat ride for airport passengers and employees traveling to the airport. As a first step in achieving one-seat service to JFK Airport, the Metropolitan Transportation Authority (MTA) has conducted a feasibility study of the most likely alternatives for One-Seat Ride service between JFK Airport and the Manhattan central business district, in accordance with the July 1, 1998 Memorandum of Agreement among the State of New York, the City of New York, the Queens Borough President, and MTA.

The study examined 40 Long Island Rail Road (LIRR)-based and NYCT subway-based alternatives that would connect to the automated AirTrain light rail system (LRS) at JFK Airport. The study included:

- An analysis of the technical and operational feasibility of each alternative
- An analysis of the potential positive and negative impacts of such rail service on local communities in Queens County
- A cost estimate for each alternative
- A recommendation of the preferred option

## Recommended Alternative

As a result of this study, alternative L2 is the recommended alternative. L2 is an LIRR-based alternative that would provide One-Seat Ride service via Jamaica to Penn Station at an estimated conceptual capital cost of \$361 million, in 1999 dollars, and an estimated annual operating cost of \$18 million, in 1999 dollars. L2 would connect with the AirTrain LRS at Jamaica and use the LIRR's Main Line through Queens to access Manhattan via the East River tunnels and Penn Station.

## Requirements

The feasibility of alternative L2 hinges on the construction of a physical connection between LIRR trackage and the AirTrain system, which must be scheduled and coordinated with the construction of the AirTrain project at Jamaica and East Side Access at Harold Interlocking, and the completion of the following key requirements:

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- **Complete East Side Access.** The LIRR is currently progressing the East Side Access project that will allow the Railroad to provide direct rail access to Grand Central Terminal via the lower level of the 63rd Street Tunnel. East Side Access will also allow the relocation of up to five trains from Penn Station to Grand Central Terminal during the peak hour. Freeing capacity at Penn Station is needed to allow operation of four-train-per-hour One-Seat Ride service to and from Penn Station during peak hours. The final determination of the feasibility of operating four One-Seat Ride trains per hour to and from Penn Station in the constrained peak hours must await the finalization of LIRR and Metro-North service plans.
  - **Provide for Increased Main Line Capacity.** Main Line capacity constraints between Jamaica and Harold Interlocking must be addressed to deliver consistent One-Seat Ride service frequencies. Main Line capacity will be unavailable for One-Seat Ride service during certain peak periods, both in 2000 and after the scheduled completion of East Side Access in 2011. To address these capacity constraints, the installation of a communications-based train control (CBTC) signal system along the Main Line between Jamaica and Penn Station is recommended.
  - **Develop Vehicles for LIRR/LRS Operation.** Rail vehicles used for One-Seat Ride service would need to meet the operating and regulatory requirements of both the LIRR and the AirTrain LRS. Based on the physical requirements of both systems and the need to meet safety and crashworthiness requirements, One-Seat Ride vehicles would operate in four-car trains, 240 feet in length, with a seated capacity of 152 passengers and a maximum load of 236 per train. (One-Seat Ride vehicle design requirements and characteristics are described in detail in Section 4 of this report.)

## Evaluation of Alternatives

As part of the JFK One-Seat Ride Feasibility Study, MTA and its consultant team developed and evaluated 40 alignment alternatives that would use either an LIRR/LRS or an NYCT/LRS routing. A three-phase evaluation framework was employed to narrow the options under consideration to a core set of preferred alternatives. These evaluation phases were the fatal flow analysis, the preliminary feasibility analysis, and the final feasibility analysis.

### Fatal Flaw Analysis

Of the 40 possible alignment alternatives originally defined in the study, 12 were LIRR-based and 28 were NYCT subway-based. During the first phase of the study, the fatal flaw analysis, two of the 12 LIRR alternatives were eliminated, primarily because they were contingent upon construction of a new tunnel under the East River to Lower Manhattan, contrary to an initial "going in" assumption of the study that alignments should not require the construction of major new segments of right-of-way infrastructure.

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Seventeen of the 28 NYCT alternatives were also eliminated—13 for noncompetitive travel time (10 of these were also eliminated based on other criteria) and four for lack of bridge or tunnel capacity. (The findings of the fatal flaw analysis are summarized in Appendix C of this report.)

## **Preliminary Feasibility Analysis**

The remaining 10 LIRR-based alternatives and 11 subway-based alternatives were further examined in the second phase of the study, the preliminary feasibility analysis. As a result of this work, an additional four LIRR alternatives were eliminated because another alternative providing comparable service was less difficult to build. Nine more NYCT alternatives were also eliminated due to excessive travel time, lack of capacity (on the Broadway Line), or the need for costly or impractical construction. (The findings of the preliminary feasibility analysis are also summarized in Appendix C.)

## **Final Feasibility Analysis**

Six LIRR-based alternatives and two subway-based alternatives were carried through the last study phase, the final feasibility analysis. This more detailed effort resulted in eliminating both remaining subway-based alternatives and two LIRR alternatives. All four alternatives used the LIRR Montauk Branch right-of-way and were found infeasible due to civil construction difficulties of building a connection from the Montauk Branch to either the 63rd Street Tunnel or East River tunnels and high cost. The two NYCT-based alternatives also were eliminated because they would be constrained to single-track operation along much of the Montauk Branch right-of-way, which would significantly compromise their operational reliability and timeliness. (The findings of the final feasibility analysis are presented in Appendices A and B.)

## **Recommendation**

The four remaining alternatives are all judged physically feasible to construct. However, they have different service characteristics and costs. Alternative L1 would provide One-Seat Ride service via Jamaica to Grand Central Terminal, alternative L2 via Jamaica to Penn Station, alternative L8 via Howard Beach to Grand Central Terminal, and alternative L9 via Howard Beach to Penn Station.

Based on the results of the study's technical analyses, alternative L2 was determined to be the best option for providing One-Seat Ride service between JFK Airport and Manhattan. This alternative would connect with the AirTrain LRS at Jamaica, use the LIRR's Main Line through Queens, access Manhattan via the East River tunnels, and serve the Manhattan-JFK Airport air travel market with a terminus at Penn Station. Alternative L2 is the best option because:

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- One-Seat Ride service via an LIRR/LRS Jamaica connection is faster and less costly, and has fewer potential community impacts, than a Howard Beach connection.
  - Although capacity at Penn Station is constrained, it affords greater opportunity than Grand Central Terminal to provide a four-train-per-hour (once every 15 minutes) One-Seat Ride service during the critical morning and evening peak periods. Grand Central Terminal, with LIRR East Side Access, lacks capacity throughout both the morning and evening peak periods to allow One-Seat Ride service to operate every fifteen minutes.

## Implementation

As described above, L2's feasibility is contingent upon several physical improvements that would provide connections and capacity required to facilitate the operation of a One-Seat Ride service. As a result, the commencement of One-Seat Service is contingent upon the scheduled completion of these projects:

- **East Side Access and CBTC are needed to provide peak period station and track capacity.** Penn Station and the Main Line between Jamaica and Harold Interlocking are capacity constrained during the morning and evening 2-hour peak periods (7:00-9:00 a.m. and 4:30-6:30 p.m.). This constraint generally coincides with peak JFK Airport travel times. In the peak direction, the capacity limitation occurs at Penn Station, where the LIRR schedules 78 morning and 70 evening peak direction trains, or one train every 1.5-1.7 minutes. In the reverse peak, capacity constraints are focused on the Main Line, where the LIRR operates 45 morning and 48 evening trains—one train every 2.5-2.7 minutes. In addition, Penn Station capacity is severely limited in the reverse-peak direction. CBTC would increase Main Line track capacity; however, it does not address Penn Station's capacity constraints.

Because pressure on the Penn Station physical plant has been building due to increased demand at current service levels and the introduction of new services, the three railroads now using Penn Station, in a cooperative effort called the Tri-Venture Council, are currently undertaking a review and analysis of the capacity of Penn Station to meet the service requirements of each of the railroads into 2002. Results provided to date of the operations simulation for 2002 confirm that the Penn Station complex is challenged today to meet the railroads' levels of service. Construction of East Side Access will provide some relief by allowing for the diversion of some LIRR trains to Grand Central Terminal. However, LIRR's plans to continue service to Penn Station, including the provision of additional service to accommodate existing standees, growing ridership and seating capacity reductions required to meet ADA mandates, as well as plans for proposed Metro-North service into Penn Station, must be finalized before the feasibility of operating four One-Seat Ride trains per hour during the constrained hours can be determined.

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- **One-Seat Ride service could not be initiated until after the completion of East Side Access and AirTrain.** The LIRR Main Line is highly utilized and major construction projects need to be scheduled and coordinated to minimize the potential for serious service disruptions. Consequently, the LIRR system can accommodate only one major construction project at a time. Current AirTrain construction and platform modifications at Jamaica Station to provide a transfer between the JFK Airport rail system and the LIRR are scheduled for completion by mid-2005. Directly following this work, major construction for East Side Access will occur in the vicinity of Harold Interlocking between 2005 and 2010. Installation of CBTC is also assumed to occur on the Main Line during that time. To avoid unacceptable LIRR service disruptions and to maximize coordination with committed project construction schedules, One-Seat Ride construction must begin after the East Side Access work is completed.

If One-Seat Ride service at four trains per hour were implemented before freeing capacity at Penn Station by East Side Access, at least 19 peak and reverse-peak LIRR trains would be displaced. This would mean that an LIRR train with an average ridership of 1,000 passengers would be replaced by a One-Seat Ride train with a capacity of 152 passengers, adversely affecting approximately 19,000 existing daily LIRR riders during the peak period. In contrast, the One-Seat Ride would only serve an estimated 2,800 customers during these peak hours.

The remainder of this report describes the results of the final feasibility analysis of the JFK One-Seat Ride Feasibility Study, which provide a foundation for more detailed project development and evaluation. Included are descriptions of the features and key requirements of the four feasible alternatives and an outline of the strategic issues that need to be addressed to facilitate the feasible operation of the recommended alternative.

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## 2. Introduction

John F. Kennedy International Airport serves as the New York region's and the nation's primary gateway for international air travel. According to the Port Authority of New York and New Jersey, JFK Airport accommodates nearly 18 million overseas passengers each year. The airport serves a significant market base of domestic travelers of about 13 million passengers. Historically, JFK Airport has served more total air passengers than the Port Authority's two other airports, Newark and LaGuardia. Although Newark recently surpassed JFK Airport in total passenger activity, JFK Airport continues to serve more international passengers and handle more air cargo than Newark and LaGuardia.

A limited and congested transportation network connecting JFK Airport with Manhattan and the region adversely affects the airport's ability to accommodate additional passengers and cargo. Poor airport access not only affects JFK's ability to retain and increase its market share of passenger and freight air cargo, but also adversely affects the region's quality of life and economic competitiveness. Although New York City has a vast intermodal network of highways, rail lines, and bus routes, there is no fast, reliable transit service to JFK Airport. Virtually all airport access is via the congested roadway network. Consequently, ground access travel time to JFK Airport from midtown Manhattan is high, 54 minutes on average by taxi and auto. Travel time is also highly variable and unreliable due to frequent congestion and delays on the roadways.

The Port Authority renewed efforts to improve JFK Airport access in the 1990s and is progressing with the implementation of a transportation system that increases airport accessibility to, from, and within JFK Airport for both air passengers and airport employees. This is an 8.1-mile-long automated light rail system (LRS) called AirTrain. It consists of a 1.8-mile circulatory system within the JFK Airport Central Terminal Area, a 3.0-mile link along the Van Wyck Expressway to the Long Island Rail Road (LIRR) Jamaica Station, and another 3.3-mile link to the NYCT Howard Beach Station.

In 1997, recognizing the importance of modifying the transit system to meet future economic needs, New York State Governor Pataki introduced Master Links, a vision to better integrate and expand the existing rail network to enhance travel in the region. Master Links recognizes that travel to New York's airports must be faster and more reliable and identifies direct One-Seat Ride rail access to JFK Airport as a regional priority. Direct access would build on the Port Authority's LRS initiative and help to better achieve the region's goals for a seamless transportation network that improves economic competitiveness, quality of life, and environmental quality. As a result, the MTA, working in partnership with the State of New York, the City of New York, and the Queens Borough President, has undertaken this feasibility study to assess One-Seat Ride alternatives that would serve the Manhattan-JFK Airport travel market.



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As part of the JFK One-Seat Ride Feasibility Study, MTA and its consultant team have defined and evaluated 40 alternatives that would use either an LIRR/LRS alignment or an NYCT/LRS alignment. Vehicle technology strategies that would meet the dual requirements of either an LIRR/LRS or an NYCT/LRS operating environment were also examined. To evaluate the feasibility of alignment and vehicle technology alternatives, MTA and its consultant team undertook engineering, operations planning, market assessment and ridership forecasting, and community impact analyses that were used to define and assess the options under consideration. A three-phase evaluation framework, which included a fatal flaw analysis, preliminary feasibility analysis, and final feasibility analysis, was employed to narrow the options under consideration to one recommended alternative.

This report describes the results of the final feasibility analysis of the JFK One-Seat Ride Feasibility Study. The objective of the final feasibility analysis is to define a recommended alternative based on the results of engineering, operations, ridership forecasting, and community impact technical analyses. The results of this feasibility study provide a foundation for more detailed project development and evaluation.

Following this introduction, Section 3 describes the features and key requirements of the four feasible alternatives, including the recommended alternative L2, and Section 4 outlines strategic issues that need to be addressed to facilitate the feasible operation of the alternatives. The study conclusions are summarized in Section 5.

In addition to the main body of this report, there are three appendices. Appendix A describes the findings of the final feasibility analysis of the four feasible alternatives, while Appendix B describes the findings for the infeasible alternatives. Appendix C lists the 40 alternatives initially defined in the study and summarizes the results of the fatal flaw and preliminary feasibility analyses that resulted in the selection of the eight alternatives considered in the final feasibility analysis.

### 3. Feasible Alternatives: Key Features and Requirements

Alternative L2, which provides LIRR-based One-Seat Ride service via Jamaica to Penn Station, was selected as the recommended alternative for the study. Based on the results of the study's technical analyses, this alternative was found to be the best option because:

- One-Seat Ride service via an LIRR/LRS Jamaica connection, compared to a Howard Beach connection, is faster and less costly, and has fewer potential community impacts.
- Although Penn Station is capacity constrained, it affords greater opportunity than Grand Central Terminal to provide a four-train-per-hour One-Seat Ride service during the critical morning and evening peak periods. Grand Central Terminal does not have capacity for an every-15-minute (four-train-per-hour) One-Seat Ride service in any peak hour.

This section describes the features of the four feasible LIRR alternatives. It outlines the location of the alignments, their engineering and construction needs, and operating features. Although L2 is the recommended alternative, a detailed description of the features and requirements of all four feasible alternatives is included to:

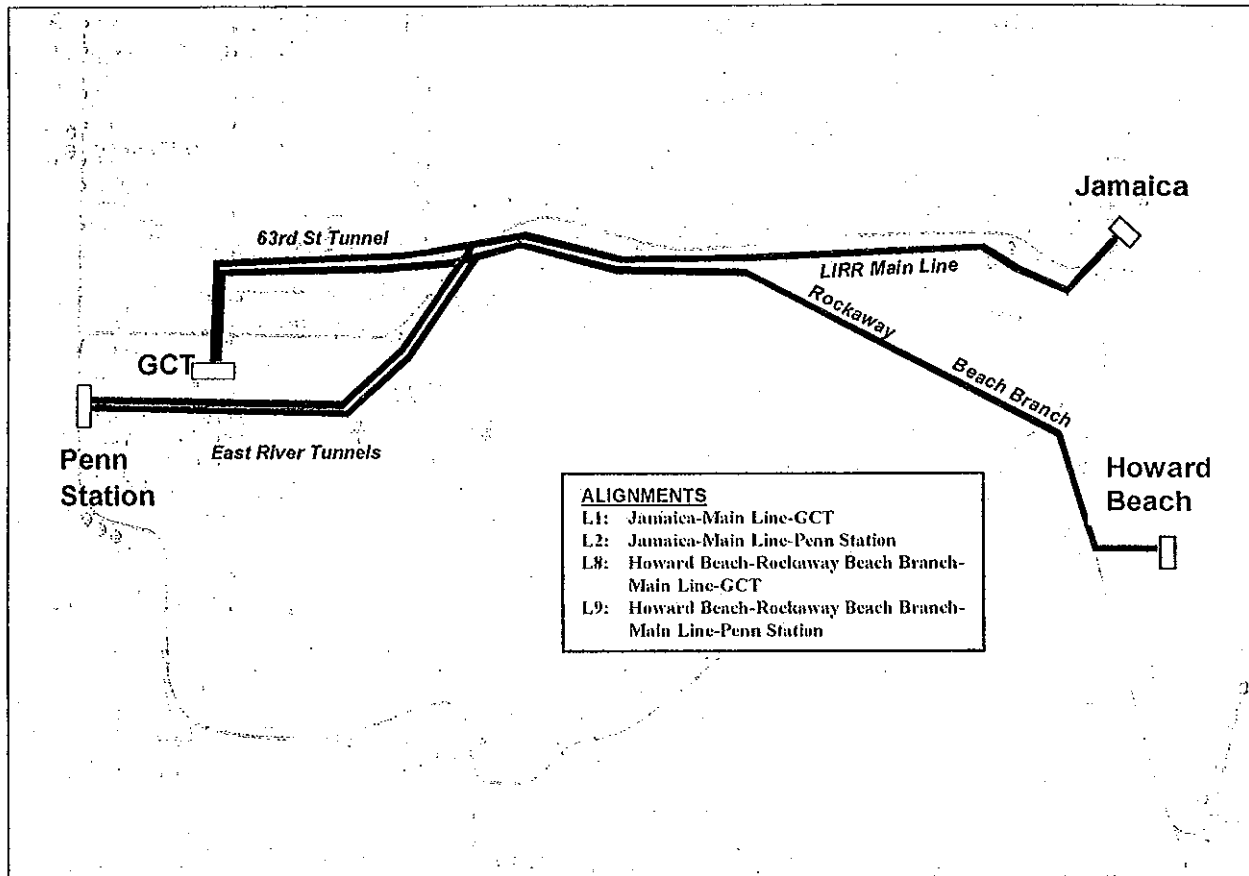
- Compare the common elements and differences among the alternatives
- Demonstrate how alternative L2 was identified as the recommended alternative based on an evaluation of the construction and operating requirements, community impacts, and costs and benefits of the feasible alternatives

The first part of this section summarizes common requirements for the alternatives. This is followed by a description of the civil, system, vehicle, operating, cost, and ridership features of the alternatives. Exhibits 1 and 2 summarize the feasible alternatives routing.

**Exhibit 1**  
Feasible Alternatives Routing

Alignment	Connection to the LRS	Route Through Queens	Route Into Manhattan	CBD Terminus
L1	Jamaica	Main Line	63rd St. Tunnel Lower Level	Grand Central Terminal
L2	Jamaica	Main Line	East River Tunnels	Penn Station
L8	Howard Beach	Rockaway Beach Branch—Main Line	63rd St. Tunnel Lower Level	Grand Central Terminal
L9	Howard Beach	Rockaway Beach Branch—Main Line	East River Tunnels	Penn Station

**Exhibit 2**  
Feasible Alternatives Alignment Map



## Common Requirements

The feasibility of the four alternatives depends on each alternative's ability to meet four key requirements. The following summarizes these requirements, while Section 4 provides a detailed description of their associated strategic issues.

- **Complete East Side Access.** The LIRR is currently progressing the East Side Access project, which will allow the Railroad to provide direct rail access to Grand Central Terminal via the lower level of the 63rd Street Tunnel. Implementation of the East Side Access project would also facilitate JFK Airport service from Grand Central. However, the LIRR's operating plan for East Side Access calls for up to 24 trains per hour during the peak, which is the practical capacity of the terminal. This would limit One-Seat Ride service to a frequency of less than four trains per

hour during certain periods. Providing four-train-per-hour service is one of the goals of the One-Seat Ride Study.

East Side Access will also facilitate One-Seat Ride service to Penn Station. Construction of East Side Access allows the LIRR to increase overall service to Manhattan, and will also allow the relocation of up to five trains from Penn Station to Grand Central Terminal during the peak hour. The relocation of these trains will help relieve capacity constraints to the operation of four-train-per-hour One-Seat Ride service to and from Penn Station during peak hours.

- **Provide for Increased Main Line Capacity.** For all of the alternatives, peak period Main Line capacity constraints between Jamaica and Harold Interlocking would need to be addressed to deliver consistent One-Seat Ride service frequencies. Based on the LIRR's East Side Access operating plan, Main Line capacity would be unavailable for One-Seat Ride service during certain reverse-peak periods, namely 8:00-9:00 a.m. for eastbound service and 5:30-6:30 p.m. for westbound service. These capacity constraints result from the need to dedicate sufficient Main Line track capacity in the predominant peak direction to accommodate the service demands of the LIRR's baseline operations.

To address these capacity constraints, the installation of a CBTC signal system is recommended along the Main Line between Jamaica and Penn Station, or Grand Central Terminal. CBTC is a leading-edge technology that uses vital microprocessors both on board trains and along the wayside to determine train position and to enforce safe train separation. Both the LIRR and NYCT are currently evaluating and testing CBTC as a strategy for enhancing systemwide operating capacity. Unlike the LIRR's current train control system, CBTC does not rely on traditional fixed-block track circuits and vital relays for safe train separation. CBTC provides moving block train control and offers the possibility of capacity improvements when compared with the train positional inaccuracies inherent in fixed-block systems. CBTC's capital costs for the One-Seat Ride alternatives are estimated to be up to \$101 million, in 1999 dollars. In addition, CBTC-compatible train control equipment would need to be installed on the LIRR's baseline fleet. The estimated cost for the retrofit of the existing fleet is up to \$245 million, in 1999 dollars. For purposes of this study, new cars purchased by the LIRR are assumed to be CBTC compatible. The costs for the systemwide retrofit of the existing LIRR fleet is not included in this report as part of the capital costs of the One-Seat Ride alternatives.

A second option to increase Main Line capacity was also examined. This option would entail the installation of two new Main Line tracks between Jamaica and Harold Interlocking. An engineering analysis found the capital cost for this strategy to be nearly \$1.0 billion, in 1999 dollars, and would cause significant negative transportation and community-related construction impacts in Woodside, Forest Hills, and Kew Gardens. As a result of this option's costs and impacts, it is not recommended to address the Main Line capacity needs of a One-Seat Ride service.

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- **Build Connections between the LIRR and the AirTrain LRS.** Each of the feasible alternatives would require construction of a connection between LIRR trackage and the AirTrain LRS. For either recommended alternative L2 or alternative L1, a new track structure between the Jamaica LRS station and the LIRR Main Line west of the Jamaica Station would be constructed at an estimated cost of \$133 million, in 1999 dollars. The Howard Beach connection for L8 and L9 would require a structure connecting the LRS to the Rockaway Beach Branch, rehabilitation and reactivation of that branch between Howard Beach, and its connection to the Main Line at White Pot Junction. Construction of these Howard Beach alignment connections is expected to cost \$250 million in 1999 dollars.
  - **Develop Vehicles for LIRR/LRS Operation.** Rail vehicles used for One-Seat Ride service would need to meet the operating and regulatory requirements of both the LIRR and the LRS. As part of the JFK One-Seat Ride Feasibility Study, consultant team members developed and evaluated a vehicle strategy that would meet the requirements of both systems, including the preparation of 20 percent design specifications. Based on the physical dimensions of the LRS' station platforms and weight limits of the system's elevated structures, and the need to meet the safety and crashworthiness requirements of the LIRR's Federal Railroad Administration (FRA)-regulated operation, One-Seat Ride vehicles would operate in 4-car trains, 240 feet in length, with a seated capacity of 152 passengers and a maximum load of 236 per train. Per vehicle costs are estimated to be approximately \$4.0 million, in 1999 dollars, with total fleet costs of up to \$146 million, in 1999 dollars, assuming a frequency of four trains per hour. Details of vehicle requirements can be found later in this report.

## Civil and System Construction Requirements

The following section discusses the details of the capital construction requirements of the four physically feasible alternatives. The two LRS/Jamaica alternatives, L1 and L2, have essentially the same construction requirements, as do the LRS/Howard Beach alternatives, L8 and L9. As the descriptions indicate, the construction requirements for alternatives L8 and L9 are more extensive and have more potential for community impacts. While construction of any of the four alternatives would require coordination with the LIRR and AirTrain operations, L8 and L9 would also require coordination with, and have potential impacts on, NYCT "A" Line service.

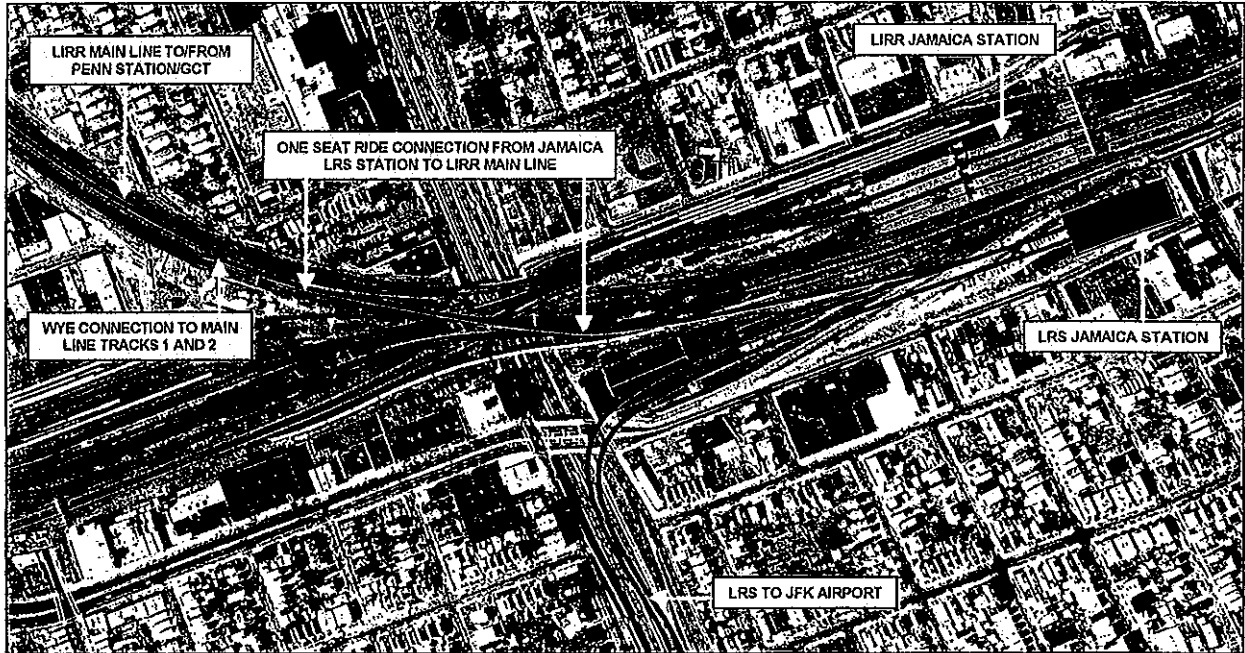
### **L1/L2: The LRS/Jamaica via Main Line and 63rd Street Tunnel to Grand Central Terminal or East River Tunnels to Penn Station**

Both L1 and L2 require a single-track connection between the AirTrain LRS now under construction and the LIRR Main Line west of Jamaica Station (see Exhibit 3). The two alignments differ only in the route they travel into Manhattan and the terminus in Manhattan. L1 uses the lower level of the 63rd Street

Tunnel to enter Manhattan and terminates at Grand Central Terminal, while L2 uses the East River tunnels to enter Manhattan and terminates at Penn Station.

### Exhibit 3 The LRS-Main Line Jamaica Connection

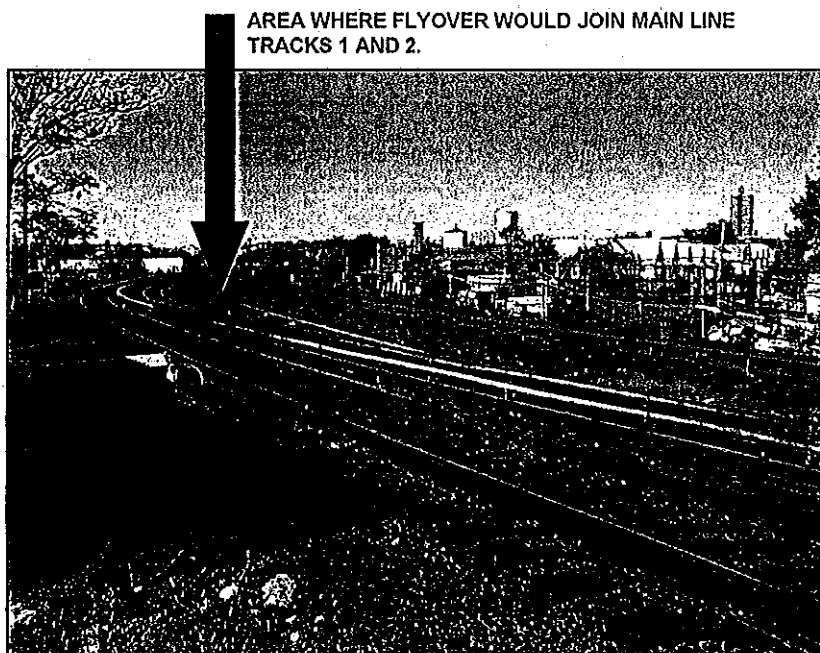
*The One-Seat Ride flyover from the AirTrain LRS Station to the Main Line west of Jamaica is shown in red. The approximate location of the LRS Jamaica Station and alignment towards JFK Airport via the Van Wyck Expressway median are shown in blue.*



### The LIRR/LRS Connection at Jamaica

The single-track aerial connection would begin at the north side of the LRS alignment, west of the Jamaica LRS Station, and would continue over the LIRR's Johnson Avenue Yard. It would then rise 22 feet above the raised LIRR right-of-way, cross over the Van Wyck Expressway, and pass over the LIRR Atlantic Branch lay-up track and eastbound Main Line. The structure would descend to an at-grade track connection to the Main Line's tracks 1 and 2. It would split to connect with both of the inside (express) eastbound and westbound Main Line tracks where these tracks attain the same elevation, east of Metropolitan Avenue, as shown in Exhibit 4.

**Exhibit 4**  
Main Line Tracks 1 and 2 Flyover Connection Detail



*West of Jamaica, the east and westbound tracks of the Main Line become parallel at matching elevation. The One-Seat Ride viaduct would descend between these two sets of tracks. The black arrow shows where the One-Seat Ride track would join the Main Line at a wye interlocking.*

An open deck structure for the aerial connection is proposed for the following reasons:

- Open deck structures contain less than half the dead weight of closed decks. The lighter weight allows the use of lighter girders, columns, and foundations. It also facilitates the construction of the substructure among LIRR tracks and interlockings and the Van Wyck Expressway, keeping disruptions to a minimum.
- The greater noise associated with the use of an open deck structure would not require mitigation because of its location within an existing high-traffic rail operation.
- An open deck would eliminate the need for a drainage system.

### Construction Requirements and Constructibility

L1 and L2's construction requirements and constructibility are mainly focused on the LRS connection to the LIRR Main Line. Although simple in concept, this single-track aerial connection would be a challenging structure to construct because of the density of the LIRR and LRS operations at Jamaica. The connection to the LRS structure and its northernmost track would require track outages and structural integration. As a result, the 4-minute headways on the LRS would be affected during the track and signal system connections.

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The design of the structure would need to identify footings and column locations that have minimal impact on the LIRR lay-up yard at Johnson Avenue. Construction would need to be undertaken when the yard is empty. This may require the LIRR to identify additional lay-up capacity elsewhere while the yard is out of service.

The contractor would need to place footings and columns between operating tracks at Jay Interlocking. This would require both adjacent tracks to be out of service during contractor operations. In addition, shoring would be required to support the track structure adjacent to the excavations. Extensive relocation of railroad cables, air pipes, signal cases, and gas lines may be required.

The single-track aerial structure would cross the Van Wyck Expressway, which would necessitate the construction of flyovers above the Atlantic and Montauk Branches at Jamaica, where the LIRR crosses the Van Wyck. Existing signal equipment and signal bridges would need to be relocated before construction of the structure begins. A pile foundation system would be used to support the flyover's steel straddle-bent structure, abutments, and piers. In vibration sensitive zones, bored-in or pre-augured piles may be required. Columns may be placed within the Van Wyck's center median, and lane closures on the Van Wyck may be required for footing and column placement. New tracks would need to be installed on the elevated structure. This construction should have minimal community impact since the proposed location, adjacent to an LIRR maintenance area, is in a primarily industrial neighborhood with few residential buildings.

The major constructibility issue for the L1 and L2 alignments would be the need to maintain, and in no way interfere with, the LIRR's peak period operations. The flyover construction would need to be done in off-peak hours within the LIRR right-of-way, and for contractor efficiency, the work would most likely need to be done at night between 8 p.m. and 5 a.m.

Since the work zone would be a small area, proper construction staging would be needed. Packaging of various components so that work activities could be done off site would enable staged activities to proceed with the least disruption. Coordination with the LIRR on track outages and force account work would be required. The staging would include relocation of utilities and signal systems, excavation, installation of the foundation, erection of the superstructure, and installation of new track.

Other construction issues for L1 and L2 would include the accessibility of utilities and coordination among local agencies, utility providers, and the LIRR. The construction zone should be surveyed to determine its adequacy as a site for construction activities and related field offices, materials, and equipment.

Additionally, the construction of the One-Seat Ride alignments would require comprehensive geotechnical investigation to determine subsurface conditions. The survey would identify areas of



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concern, including variations in the subsurface conditions or groundwater levels that may cause excessive settlement or undermine existing footings. The survey would also identify areas where contaminated soil removal is needed before the excavation can begin.

Finally, the L1 and L2 alignments assume the use of CBTC signaling to improve the Main Line's operational capacity for the addition of LRS service. The LIRR force account labor would install this system between Jamaica Station and Penn Station, or Grand Central Terminal.

### **Conceptual Implementation Timeframe**

Neither L1 nor L2 could begin service before the East Side Access project, scheduled to be completed in 2011, is finished. Recommended Alternative L2 needs the operating capacity created at Penn Station by the relocation of some LIRR trains to Grand Central Terminal. L1 would depend on East Side Access to access the lower level of the 63rd Street Tunnel and Grand Central Terminal. To avoid unacceptable LIRR service disruptions, all work on this project must be scheduled and coordinated with other projects being implemented by the LIRR, including East Side Access work at Harold Interlocking. Because the LIRR system between Jamaica and Penn Station is so heavily used, it can only absorb the service and scheduling impacts of one major construction project can at a time. Therefore, this East Side Access work must be completed before construction of the One-Seat Ride connection at Jamaica can begin.

Construction of the LRS connection at Jamaica would take place within the existing LIRR right-of-way. Because the construction is confined to the LIRR right-of-way, an environmental impact statement (EIS) is not anticipated to be required for this work. An EIS may be required, however, to assess other aspects of the One-Seat Ride service, such as impacts on existing service at Penn Station. If required, it is anticipated that such an EIS would take 18 to 24 months to complete. The design for the connection between the LRS and the LIRR could be completed in less than 1 year. The construction time, including long lead items for signal, switch material, and installation of CBTC, should be approximately 3 years. The procurement period for One-Seat Ride vehicles should be approximately 4 years from the notice-to-proceed for the production vehicles.

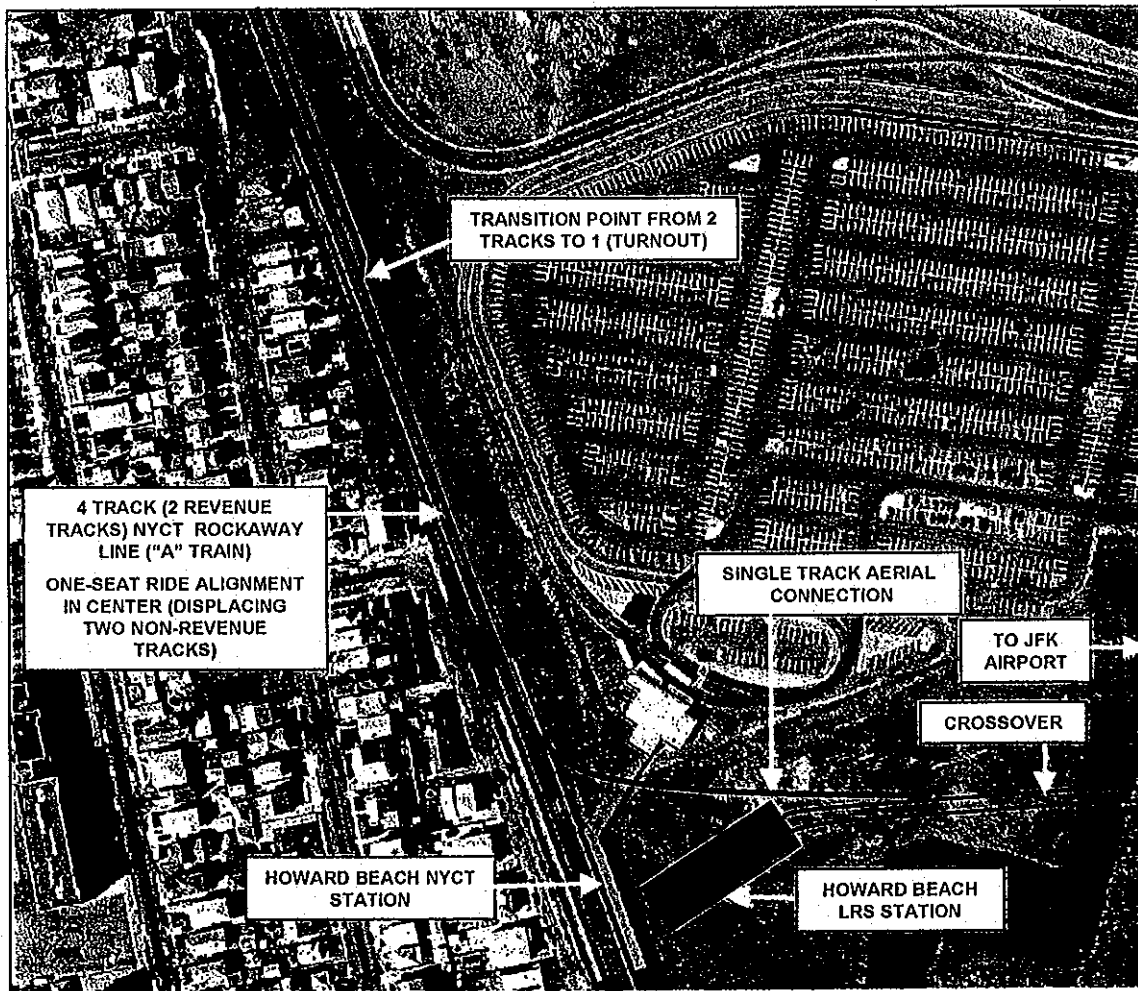
### **L8/L9: The LRS/Howard Beach via Rockaway Beach Branch, Main Line, and 63rd Street Tunnel to Grand Central Terminal or East River Tunnels to Penn Station**

L8 and L9 follow the same route from Howard Beach along the Rockaway Beach Branch, a rail line north of Howard Beach that has been abandoned since the 1950s, and the Main Line in Queens. However, these lines differ in their East River crossings and midtown Manhattan terminal locations. L8 enters Manhattan through the 63rd Street Tunnel and arrives at Grand Central Terminal, while L9 travels through the East River tunnels into Manhattan and uses Penn Station as its terminus.

## LIRR/LRS Connection at Howard Beach

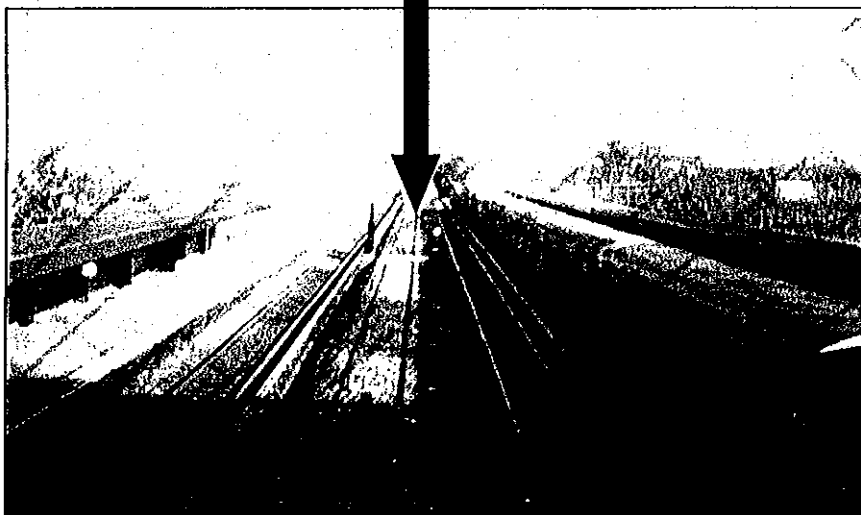
The single-track aerial connection from the LRS to the Rockaway Line would begin with a turnout from the outbound LRS track east of the LRS Howard Beach station. An additional crossover would be added east of this point on the LRS system to permit moves to the JFK Airport-bound track (see Exhibit 5). Once off the LRS tracks, the One-Seat Ride alignment would curve north and cross over the NYCT Rockaway Line ("A" service) northbound track. The structure would then ramp down on a retained fill in the center of the Rockaway Line embankment and diverge into two tracks, between the NYCT revenue tracks, on the existing embankment as seen in Exhibit 6.

**Exhibit 5**  
The LRS-Rockaway Beach Branch Connection



**Exhibit 6**  
NYCT Howard Beach Station Connection Detail

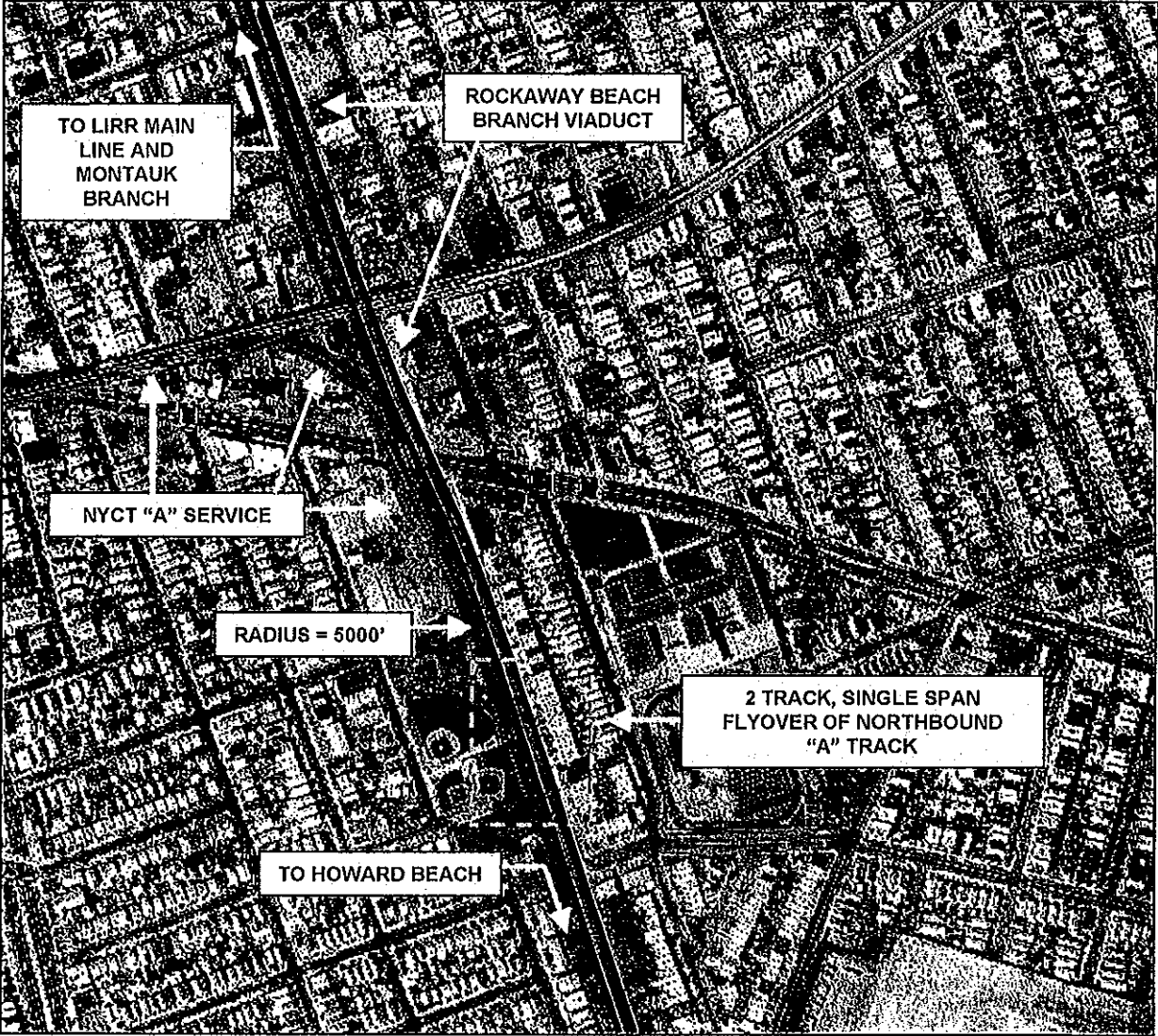
AREA WHERE LRS CONNECTION  
JOINS ROCKAWAY ALIGNMENT



*A view north from the pedestrian overpass at NYCT's Howard Beach station. The One-Seat-Ride alignment would use the two middle, non-revenue tracks, and join this right-of-way where noted.*

The alignment would stay between the two "A" revenue tracks so that NYCT service to Aqueduct Racetrack can be maintained. After traveling north between these two NYCT tracks beyond the racetrack, the alignment would rise by ramping up on retained fills and flying over the NYCT northbound track with a single span, double-track flyover, where the track converges with the southbound track as seen in Exhibit 7. The JFK One-Seat Ride service would continue north on the four-track former Rockaway Beach Branch viaduct north of Liberty Avenue as shown in Exhibit 8. The NYCT tracks curve to the west onto a steel viaduct south of Rockaway Boulevard.

**Exhibit 7**  
Rockaway Beach Branch Two-Track Flyover—North of Howard Beach



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**Exhibit 8**  
Rockaway Beach Branch Viaduct Detail

*Looking south from the Rockaway Beach Branch viaduct, now unused. The NYCT "A" service tracks join the alignment here to provide service to Howard Beach and the Rockaways.*



### **Construction Requirements and Constructibility**

In addition to the LRS connection to the Rockaway Line, L8 and L9 would require a flyover of the NYCT "A" northbound track, rehabilitation of the Rockaway Beach Branch, and connection of the Rockaway Beach Branch to the Main Line. The following sections discuss the construction requirements and constructibility issues for each segment independently.

#### ***The LRS Connection***

Construction of the LRS connection would occur within the operating environments of both the LRS and NYCT. As a result, construction staging plans, which would avert operating impacts, would need to be developed in coordination with the Port Authority and NYCT.

The LRS connection's construction at Howard Beach would affect Port Authority property and NYCT where the new connection shares the Rockaway Line embankment. Construction on Port Authority property could proceed without affecting the LRS, which should be in operation by the time construction begins. This heavy construction work could be accomplished during a normal workday by providing proper barricades to separate LRS operations from the construction. This would eliminate premium labor

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costs and other costs associated with off-peak work. However, maintenance of the LRS' 4-minute headways would be affected during the structural tie-ins and track and signal connections. Work on the NYCT property, specifically construction of the flyover structure and the new tracks between the two "A" service revenue tracks, would be done off peak, when fewer "A" trains are in operation. This activity would require track outages and protection personnel.

### ***Flyover of the NYCT "A" Northbound Track***

The twin-track, single-span flyover over the NYCT "A" northbound track on the Rockaway Beach Branch would require construction of a retained fill on top of the existing line's retained fill, and between the NYCT revenue tracks. Any utilities in the path of the flyover would need to be relocated. New electrification and signaling equipment would be incorporated into the design of the flyover.

Construction challenges for the flyover include locating an adjacent property for field offices and material access. The construction zone is located in a heavily traveled commercial and residential part of Ozone Park. Staging of the work would need to consider the effects on vehicular and pedestrian traffic and the frequency of the NYCT "A" service, which passes through the work zone. Much of the work could be staged from the four-track viaduct deck, but limited NYCT track outages, which would partially suspend service, may be necessary. The Maintenance and Protection of Traffic (MPT) plan would need to consider the effects on the heavily trafficked intersection of Rockaway Boulevard and Liberty Avenue, which forms part of the work zone, and allow for an area, away from the congestion, where material could be lifted up to the structure. A coordination and staging plan would be critical because peak construction activity would occur when "A" train operating frequency and vehicular traffic are greatest.

### ***Rehabilitation of the Rockaway Beach Branch***

The LIRR's Rockaway Beach Branch was removed from service in the early 1950s. Since that time, this exclusive right-of-way has become overgrown with trees and underbrush as shown in Exhibit 9. L8 and L9 would use an intact portion of the Rockaway Beach Branch right-of-way, although trees and shrubs would need to be cleared and new track, drainage, electrification, and CBTC signaling installed. (The structural assessments contained in this report were based solely on visual inspection of those elements accessible to the study team. Before the Rockaway Beach Branch could be reactivated for any purpose, in-depth inspection and testing of all structural elements would be required.)

**Exhibit 9**  
Rockaway Beach Branch Overgrown Right-of-Way

*Looking north along the Rockaway Beach Branch alignment between 91<sup>st</sup> and Jamaica Avenues. Trees and underbrush are prevalent.*



The five-block long Rockaway Beach Branch viaduct between 97th Avenue and Rockaway Boulevard would need minor structural repairs. This would include the removal of abandoned station platforms between 101st and 103rd Avenues, waterproofing, and the installation of two tracks within the four-track-wide structure. North of 97th Avenue, the Rockaway Beach Branch is elevated on an embankment. The stretch of the alignment directly north of 97th Avenue is used as a parking area by the Logan Bus Company. The reactivation of the line would terminate any claim to the right-of-way by the bus company.

The alignment continues north on an embankment, crossing Atlantic, 91st, and Jamaica Avenues, and Park Lane South on throughplate girder undergrade spans. A visual inspection of these structures found them to need minor steel work, waterproofing, and new trackwork. Removal of lead paint may also be necessary. A large pile of debris and abandoned platforms at Atlantic Avenue also would have to be removed.

In Forest Park, north of Park Lane South, the alignment enters a cut and passes under Forest Park's East Main Drive, Myrtle Avenue, and the Jackie Robinson Parkway. A portion of the alignment between the Jackie Robinson Parkway and Union Turnpike is used as a parking facility by a condominium and is shown in Exhibit 10. As in the case of the bus company, the parking facility would be displaced by the reactivation of service.

**Exhibit 10**  
Parking Lot Located Within Rockaway Beach Branch Right-of-Way

*The Rockaway Beach Branch alignment is occupied by a parking facility directly south of Union Turnpike.*



There are five additional undergrade crossings between the Jackie Robinson Parkway and the junction with the Main Line. Four of the undergrade crossings including Union Turnpike, Metropolitan Avenue, Yellowstone Boulevard, and Fleet Street would need to be rehabilitated with minor steelwork, re-waterproofing, and new trackwork. The fifth undergrade crossing, over the Montauk Branch, has been demolished and would need to be completely rebuilt.

The Rockaway Beach Branch connects to the Main Line at White Pot Junction. The southbound track of the Rockaway Beach Branch diverges to the right from the eastbound Main Line in a high-speed curve at grade. The Rockaway Beach Branch northbound track ramps down into a cut and passes under the Main Line through an existing tunnel. The tunnel that carries this track under the Main Line is currently filled in at its northern end. An inspection of the accessible portion of the tunnel found it in good condition. The speed limit on this stretch of track is expected to be 10 miles per hour due to the tight reverse curve where the track enters the Main Line embankment.

The tracks of the former Rockaway Beach Branch paralleled both sides of the Main Line, forming a six-track alignment, to a point just east of the convergence of the Main Line and the Port Washington Branch. The right-of-way for these two Rockaway Beach Branch tracks still exists and would be rebuilt for use by the One-Seat Ride service. All four undergrade crossings along this stretch, 63rd Drive, Woodhaven Boulevard, the Long Island Expressway and 57th Avenue, contain six-track structures and would be reused (see Exhibit 11).



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The connection of the Rockaway Beach Branch to the Main Line would require construction of a new interlocking. This interlocking would include two high-speed (60 mph) switches connecting the new service to the Main Line and two new high-speed crossovers between Main Line tracks 1 and 3.

**Exhibit 11**  
Rockaway Beach Branch and the LIRR Main Line—West of White Pot Junction



*A view looking west along the Rockaway Beach Branch alignment that parallels the LIRR Main Line on the northern side of the Main Line just west of White Pot Junction. The through-plate girder span in the foreground crosses over 63rd Drive.*

Encroachment by private entities currently using portions of the Rockaway Beach Branch would need to be addressed before construction. In addition, a comprehensive environmental investigation should be conducted along the alignment to identify any contaminants present from former railroad service or illegal dumping. Contaminated soil would need to be removed and replaced with clean fill.

The Rockaway Beach Branch should be evaluated to determine if any of the existing utilities or ductwork are salvageable. Contemporary electrical and signal requirements would require an upgrade in electrical service to this line. These efforts would require coordination between utility companies and any municipal agencies with jurisdiction over the alignment.

The Rockaway Beach Branch corridor has become substantially more developed since it was removed from service, which poses several construction challenges. The presence of many businesses and residential units adjacent to the line would restrict construction during nighttime hours. Although the alignment is in an exclusive right-of-way, an MPT plan would be required to protect pedestrian and vehicular traffic at places where they meet the line. This will be especially important while repair work or demolition is underway on the five-block Ozone Park viaduct.

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The Rockaway Beach Branch's overgrade crossing of the Montauk Branch would also need to be rebuilt. Since the bridge crosses an active railroad, coordination with the LIRR and the New York and Atlantic Railroad (NY&AR) would be required. An MPT plan, as well as track safety training and a safety program, would need to be established. New abutments and piers would need to be built during daylight hours, under the direction of railroad protective forces. A prefabricated bridge structure would then be dropped in by crane or launched from the adjacent embankment. Superstructure element placements would not be permitted over moving trains, so outages would need to be coordinated with the LIRR.

White Pot Junction, the area where the Rockaway Beach Branch meets the Main Line, is hilly and set away from nearby residential areas. Sufficient area would be available to establish a compound for contractors, material, and equipment. However, access may be from the eastbound Main Line local track or from local streets, which may have load limits or constraints due to proximity to residential areas.

New interlocking and CBTC would need to be installed along the Main Line between White Pot Junction and Harold Interlocking. This work would be done in off-peak hours with minimal impact to operations.

### **Conceptual Implementation Timeframe**

Neither L8 nor L9 could begin service without the completion of East Side Access. L8 depends on East Side Access to access the 63rd Street Tunnel and Grand Central Terminal. L9 relies on the operating capacity created at Penn Station by the relocation of some LIRR trains to Grand Central Terminal. In addition, an EIS would be required for the activation of the Rockaway Beach Branch. To avoid unacceptable LIRR service disruptions, all work on this project must be scheduled and coordinated with other projects being implemented by the LIRR, including East Side Access work at Harold Interlocking. Because the LIRR system between Jamaica and Penn Station is so heavily used, it can only absorb the service and scheduling impacts of one major construction project at a time. Therefore, this East Side Access work must be completed before the One-Seat Ride construction to reconnect the Rockaway Beach Branch to the Main Line at White Pot Junction can commence.

### **Vehicle Requirements**

The rail vehicles designed for One-Seat Ride service would need to meet the following criteria:

- Provide service quality appropriate to the airport operation
- Be operable on both the AirTrain LRS and the LIRR systems

Since the LIRR is under the jurisdiction of FRA, One-Seat Ride vehicles must achieve FRA vehicle safety and crashworthiness standards. In addition, the service will need to operate along the LIRR portion

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of the alignment in a manner compliant with FRA operating practices regarding train operations, maintenance, and safety testing. For the purposes of the feasibility study, the consultant team developed reasonably conservative assumptions to conclude that the design and operation of the One-Seat Ride service over the FRA-regulated LIRR and non-FRA regulated LRS systems is technically feasible using known technology, and accepted industry design standards and operating practices.

Based on the physical requirements of both systems and the need to meet the safety and crashworthiness requirements, One-Seat Ride vehicles would operate in 4-car trains, 240 feet in length, with a seated capacity of 152 passengers and a maximum load of 236 per train. One-Seat Ride vehicle design requirements and characteristics are described in Section 4 of this report.

## **Service Characteristics**

Because the distance traveled via Jamaica to Manhattan is less than that via Howard Beach, recommended alternative L2 and alternative L1 have shorter travel times than alternatives L8 and L9. This shorter travel time also means that L1 and L2 would require fewer trains to maintain four-train-per-hour service frequency than L8 and L9.

For the purposes of this feasibility study, it was assumed that One-Seat Ride service would be provided every 15 minutes to and from JFK Airport throughout the day. If the JFK Airport One-Seat Ride effort progresses through the project development process, it will be necessary to refine service level assumptions relative to the specific demands for travel to and from the airport at different times of the day and the requirements of other LIRR and AirTrain LRS services.

The alternatives' travel times were estimated based on a simulation of One-Seat Ride service on the LIRR and the LRS. The simulation considered LIRR- and LRS-specific alignment characteristics, station locations, and operating rules, as well as the likely performance of the One-Seat Ride train.

Trip times were calculated allowing 30-second platform dwells, with the exception of Jamaica Station and the Interface Track at Howard Beach. Two-minute dwells were used at Jamaica and the Interface Track to allow for switchover from automated train operation to manual operation and car height adjustment at both sites and to allow for passenger movement and train direction reversal at Jamaica.

So that the estimated travel times reflect actual operating conditions, a five percent makeup time was included in the analysis to allow for schedule recovery, and three minutes were added to the total run times for operating on the Main Line to account for potential interference from other trains in this high-density LIRR operating segment.

Exhibit 12 shows the average one-way and round-trip travel times for each alternative. The exhibit also presents daily and annual operating statistics based on the uniform 15-minute service frequency assumed in the analysis.

**Exhibit 12**  
Daily and Annual Operating Statistics

Alternative	Average One Way Travel Time (minutes)*	Round Trip Statistics				Annual Statistics			
		Train-Hours	Car-Hours	Train-Miles	Car-Miles	Train-Hours	Car-Hours	Train-Miles	Car-Miles
L1	34	1.42	5.68	32.44	129.75	49,757	199,027	1,136,617	4,546,467
L2	37	1.35	5.42	33.34	133.35	47,468	189,870	1,168,119	4,672,478
L8	41	1.65	6.60	40.55	162.20	57,845	231,381	1,420,872	5,683,488
L9	43	1.58	6.32	41.45	165.79	55,375	221,500	1,452,362	5,809,446

\*Travel times are average one-way to or from 42nd Street (the nearest major cross street to the centroid of Manhattan travel to and from JFK Airport). Travel times for L2 and L9 include five-minute access time between Penn Station and 42nd Street.

Note: Equivalent average travel times to 42nd Street for a two-seat ride (using the LIRR and AirTrain with a transfer at Jamaica) would be 40 minutes via Grand Central Terminal and 44 minutes via Penn Station.

One-Seat Ride vehicle fleet sizes were calculated based on service frequency and travel time. Exhibit 13 presents the base fleet requirement, number of spares, and total fleet. Given the alternatives' small base fleet requirement and their operation in fixed four-car units, a relatively high spare ratio was assumed—33 percent for L1 and L2 and 43 percent for L8 and L9. This spare ratio would ensure that at least one train unit would be available at either end of the line in case another train is taken out of service due to a breakdown. It should be noted that the Heathrow Express airport service, which operates a comparable small fleet in fixed units, has a 40 percent spare ratio.

**Exhibit 13**  
Fleet Requirements

Alternative	Base Fleet Vehicles	Spares	Total Fleet
L1/L2	24	8 (33%)	32
L8/L9	28	12 (43%)	40

## Forecasted Ridership

While the alternatives have a net ridership increase of roughly the same order of magnitude as the baseline AirTrain service, alternatives L1 and L2—with 2,200 and 2,110 new daily riders, respectively—would generate slightly larger increases than either L8 (1,780) or L9 (1,730).

Exhibit 14 presents forecasted average daily ridership for the One-Seat Ride alternatives based on a year 2020 design year. Ridership estimates were developed using a modified version of the Port Authority's airport access travel demand model. The forecasts also reflect the service characteristics of the One-Seat Ride alternatives, the baseline transit and highway network (including the Port Authority's AirTrain service), regional socioeconomic conditions, and baseline work and nonwork travel as defined by MTA.

**Exhibit 14**  
Average Daily Ridership in 2020

Alternative	Service	To/From Manhattan	To/From Other*	Total
AirTrain Baseline		11,240	3,930	15,170
L1	One-Seat Ride	10,590	480	11,070
	AirTrain	2,760	3,540	6,300
	<b>Total</b>	<b>13,350</b>	<b>4,020</b>	<b>17,370</b>
	<b>Change from Baseline</b>	<b>2,110</b>	<b>90</b>	<b>2,200</b>
L2	One-Seat Ride	10,860	600	11,460
	AirTrain	2,410	3,410	5,820
	<b>Total</b>	<b>13,270</b>	<b>4,010</b>	<b>17,280</b>
	<b>Change from Baseline</b>	<b>2,030</b>	<b>80</b>	<b>2,110</b>
L8	One-Seat Ride	10,140	360	10,500
	AirTrain	2,810	3,640	6,450
	<b>Total</b>	<b>12,950</b>	<b>4,000</b>	<b>16,950</b>
	<b>Change from Baseline</b>	<b>1,710</b>	<b>70</b>	<b>1,780</b>
L9	One-Seat Ride	10,410	470	10,880
	AirTrain	2,500	3,520	6,020
	<b>Total</b>	<b>12,910</b>	<b>3,990</b>	<b>16,900</b>
	<b>Change from Baseline</b>	<b>1,670</b>	<b>60</b>	<b>1,730</b>

\*Includes Queens, Bronx, and Brooklyn

As expected, almost all of the One-Seat Ride trips are to and from Manhattan. All of the alternatives capture about the same share of travel from Manhattan to JFK Airport, approximately 30 percent. It should be noted that a One-Seat Ride alternative would not capture all JFK Airport-bound rail customers.

Approximately 33 to 40 percent of rail customers to and from JFK Airport would use AirTrain service as part of a two-seat ride, even with a One-Seat Ride alternative. This is because most of these travelers would begin or end their trip in Queens, which would be more convenient to the Jamaica or Howard Beach AirTrain stations. In addition, some Manhattan travelers (about 20 percent across the alternatives) would continue to choose a two-seat trip using AirTrain because, for some Manhattan origins and destinations, a two-seat LIRR/LRS ride would be shorter than One-Seat Ride service.

## Capital and Operating Costs

Overall, alternatives L1 and L2 have lower conceptual capital and operating costs than alternatives L8 and L9. Exhibit 15 presents the conceptual capital and operating costs for the alternatives in base year 1999 dollars. Alternatives L1 and L2 have the lowest capital costs because the only civil construction feature of these alignments is the LRS-Main Line connection at Jamaica and the installation of CBTC. L8 and L9, by contrast, require an LRS connection at Howard Beach, reconstruction of the Rockaway Beach Branch to White Pot Junction, rehabilitation of the connection to the Main Line, and installation of CBTC on both the Rockaway Beach Branch and the Main Line. In addition, L1 and L2 have a lower capital cost because of their relatively smaller fleet needs compared to L8 and L9.

L1 and L2 also have a lower annual operating cost than L8 and L9 because the Jamaica-Main Line-based alternatives have a shorter trip time and less right-of-way length to be maintained, and travel a more direct route to Manhattan. This contributes to a faster trip time and fewer hours and miles that trains would need to be operated.

**Exhibit 15.**  
Capital and Operating Costs  
(in millions of 1999 dollars)

Alternative	Capital Cost				Annual Operating and Maintenance
	Construction (1)	CBTC (2)	Vehicles (3)	Total	
L1	\$133.0	\$65.0	\$127.0	\$325.0	\$18.0
L2	\$133.0	\$101.0	\$127.0	\$361.0	\$18.0
L8	\$250.0	\$47.0	\$146.0	\$443.0	\$26.0
L9	\$250.0	\$83.0	\$146.0	\$479.0	\$26.0

1. Construction costs do not include maintenance facilities, terminal modifications, or property acquisitions for right-of-way
2. Up to an additional \$245 million would be required to retrofit the existing LIRR fleet for CBTC operation
3. L1 and L2 require 32 cars to maintain 15-minute headway; L8 and L9 require 40 cars

All costs are based on conceptual estimates and expressed in base year 1999 dollars. Alignment-related construction costs were defined based on the specific line item activities required to construct the

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LIRR/LRS alignment connections, install CBTC, and rehabilitate the Rockaway Beach Branch. For example, line item construction activities associated with rehabilitating the Rockaway Beach Branch include track, electrification and substations, signal systems and CBTC, tree and shrub removal, lead paint abatement, bridge upgrade and repairs, and fencing and soundwalls.

It should be noted that the construction capital cost estimates do not include potential maintenance facility needs or terminal modifications at Penn Station or Grand Central Terminal. These costs elements are contingent upon an examination of whether the LIRR's existing Hillside facility, or the AirTrain maintenance facility would be most appropriate for servicing the One-Seat Ride vehicles and a determination of specific passenger and terminal provisions required at Penn Station or Grand Central to accommodate airport travelers.

The construction costs also do not include expenses associated with property acquisitions for additional right-of-way. These costs depend on real estate market conditions and would be defined in a subsequent phase of project development.

The construction cost estimates assumed that line items that need to be constructed during off-peak hours, due to impacts on existing services, had their base costs multiplied by a factor of 1.25 to account for the increased cost of labor and inefficiencies associated with off-peak work. Then, all construction activity items were assigned a 30 percent order-of-magnitude contingency factor to account for the unknowns associated with the limited engineering information available during the feasibility stage of analysis.

The construction cost estimates also reflect soft costs that include such work as EIS, design, construction phase services, project management, construction management, and transportation department support such as timetable changes, public outreach, and security at the work site. A soft-cost to hard-cost ratio of 40 to 60 percent is typical for rail transit projects similar in scope to the JFK One-Seat Ride Feasibility Study. Therefore, the construction costs are multiplied by a factor of 1.66 to identify the soft costs. The soft cost is then rounded off to the nearest million dollars, and the costs of each construction component for an alignment are then summed to arrive at the total alignment cost.

A per-unit vehicle cost estimate of \$3.96 million (in 1999 dollars) was used for L1 and L2, either of which would require 32 cars. An estimate of \$3.65 million (in 1999 dollars) per vehicle was used for the L8 and L9, either of which would require 40 cars. These vehicle cost estimates are based on an assessment of industry standards and unique features of the One-Seat Ride vehicle, the size of the fleet order, and the LIRR's recent fleet purchase experience. The costs also reflect the fact that the One-Seat Ride vehicles require a custom design to operate on both the LIRR and the LRS systems. The costs include activities associated with engineering, manufacturing, administration, and testing.

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Although the operating entity for a One-Seat Ride service has not been determined, LIRR cost factors were used to estimate potential operating and maintenance costs. The consultant team identified LIRR management centers that would likely incur increased costs associated with the service's operation, including management centers responsible for transportation, field operations, track, structures, power, signals and communications, running repair, vehicle cleaning, and vehicle maintenance. Cost drivers were identified for each management center based on its area of focus. For example, operating costs associated with the General Superintendent-Road Passenger management center are largely driven by the amount of service operated. As a result, the total number of hours of vehicle (or car) operation was chosen as the cost driver for this management center. Management center-based costs were divided by the appropriate cost driver to derive unit costs for each management center. These unit costs were then multiplied by the corresponding operating statistics and the incremental increase in track miles associated with the alternatives to estimate operating and maintenance costs.



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## 4. Strategic Issues

The feasible operation of the One-Seat Ride alternatives is contingent on resolving two strategic issues: operating capacity and vehicle design. This section describes these issues and presents strategies for addressing them.

### Operating Capacity

The LIRR operating capacity is measured in terms of track and terminal space, or slots available to accommodate trains. The number of trains that can be accommodated is based on the number of tracks available, train operating speeds and performance, train stopping patterns, and the minimum distance required between trains as defined by the signal system. The LIRR's operating capacity is most constrained during the peak periods of 7:00-9:00 a.m. and 4:30-6:30 p.m. During this time, the LIRR provides service levels that effectively match the system's practical operating capacity to meet the travel demands of the railroad's customers.

Because the LIRR's scheduled peak period service so closely matches available capacity, the continued availability of capacity in some nonpeak periods is also important to LIRR operations. The railroad can recover from even minor service disruptions only by using up available slots in the shoulder periods (that is, the 1 or 2 hours immediately following the peak period). Service disruptions are not uncommon and the use of these shoulder period slots by another service, such as One-Seat Ride, would eliminate the ability of the railroad to recover from delays and consequently have a detrimental effect on the LIRR's overall on-time performance.

These operating constraints challenge the feasible operation of up to four One-Seat Ride trains per hour in the LIRR's operating environment both before and after the implementation of East Side Access. Operating capacity pinch-points are focused on the LIRR's Main Line between Jamaica and Harold, Penn Station, and Grand Central Terminal.

### Terminal Capacity

Transportation functions at Penn Station involve the movement of trains through the tunnels and tracks leading into and out of the station, the platforming and dispatching of trains, the control systems that govern train movements, and the capacity of all of these transportation systems elements.

Penn Station's tunnel capacity, where trains operate for extended periods of time in the same direction and where no interlocking conflicts or station dwell time issues exist, can be quantified with relative precision as a single rate (that is, number of trains per hour). However, the overall operating capacity of

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the transportation infrastructure at Penn Station itself is more complex because a large number of station operations factors constrain station capacity. These operations factors include:

- Station platform availability and dwell times, including boarding and alighting constraints
- Platform access constraints and a general policy (or at least goal) of not having loading/unloading activity on two station tracks that share a common island platform
- Interlocking conflicts at the Penn Station throats ("A," "C," and "JO" Interlockings), as well as nonrevenue train conflicts at KN Interlocking
- Yarding capacities within the Penn Station area

The capacity constraints imposed by dwell times, interlocking conflicts, and yarding capacities are linked. When morning yard capacity is available, trains can discharge their passengers and continue in the same direction to a yard track. When yard space is no longer available, trains must change direction on the platform, thus lengthening dwell times (due to the need for crew changes/train-length walking or terminal departure brake tests) and increasing the probability of an interlocking conflict. Both of these factors reduce Penn Station capacity. ✖

Evening capacity at Penn Station is generally lower than in the morning peak period. One reason is that evening dwell times are longer because boarding trains takes more time than unloading. Another reason is the higher probability of interlocking conflicts, especially when the paths of departing eastbound LIRR trains and arriving westbound NJT and Amtrak trains from Sunnyside Yard conflict. In addition, when the LIRR trains stored in the West Side Yard have departed, all subsequent peak direction evening service requires the more time-consuming process of turning westbound trains on the platforms to provide eastbound service.

By contrast, there should be fewer operational conflicts at the new LIRR terminal at Grand Central Terminal because LIRR train operations at Grand Central Terminal will be completely separate from those of Metro-North. However, LIRR's East Side Access operating plan will use all or most of the new LIRR terminal's practical capacity of 24 trains per hour during peak hours.

### **Capacity Before East Side Access**

Exhibit 16 presents LIRR operating capacity in trains per hour on the Main Line between Jamaica and Harold and at Penn Station compared to peak service requirements after completion of the JO Interlocking Clearance Improvement project and the subsequent implementation of the planned High Density/Penn 42 operating plan. The red boxes in Exhibit 16 indicate those peak hours in which sufficient capacity is not available to provide a four-train-per-hour One-Seat Ride service. It should be kept in mind

that the capacities shown here as fixed numbers assume adherence to schedule, are subject to a very dynamic operating environment as described above (especially at Penn Station), and may vary with changes in operating conditions or policies.

In the eastbound direction to JFK Airport, insufficient capacity throughout the entire 2-hour morning peak period indicates little operational flexibility, including limited ability to recover from service disruptions, that might allow additional One-Seat Ride trains to be operated. The same constraints apply to the westbound direction from JFK Airport in the evening peak period. In addition, the lack of capacity to operate One-Seat Ride service in one direction during a particular time period will also limit the ability to operate in the opposite direction. This is because there is no current or projected capacity within Penn Station or the adjacent West Side Yards for the storage and staging of One-Seat Ride trains. Therefore, if a One-Seat Ride train does not arrive from JFK, there will be no One-Seat Ride train in reserve to operate to JFK.

**Exhibit 16**

**Estimated Capacity (Trains per Hour) Available for One-Seat Ride Service  
After JO Interlocking Clearance Improvement Project**

<b>Westbound from JFK Airport</b>						
<b>Peak Period</b>	<b>Main Line</b>			<b>Penn Station</b>		
	<b>Existing Track Capacity*</b>	<b>LIRR Service</b>	<b>Available Capacity</b>	<b>Terminal Capacity*</b>	<b>LIRR Service**</b>	<b>Available Capacity</b>
7:00-8:00 a.m.	54	31	23	42	37	5
8:00-9:00 a.m.	54	33	21	42	41	1
4:30-5:30 p.m.	18	18	0	24	24	0
5:30-6:30 p.m.	18	18	0	24	24	0
<b>Eastbound to JFK Airport</b>						
<b>Peak Period</b>	<b>Main Line</b>			<b>Penn Station</b>		
	<b>Existing Track Capacity*</b>	<b>LIRR Service</b>	<b>Available Capacity</b>	<b>Terminal Capacity*</b>	<b>LIRR Service**</b>	<b>Available Capacity</b>
7:00-8:00 a.m.	18	18	0	24	24	0
8:00-9:00 a.m.	18	16	2	24	21	3
4:30-5:30 p.m.	54	27	27	38	34	4
5:30-6:30 p.m.	54	28	26	38	36	2

\* Assumes adherence to schedule

\*\* Service to/from Penn Station includes both Main Line and Port Washington trains

Replacing LIRR baseline commuter trains with One-Seat Ride trains would not adequately address this issue. An LIRR train has a seating capacity of approximately 1,440 passengers, while the One-Seat Ride train will seat only 152. As a result, the replacement of an LIRR commuter train with a One-Seat Ride

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train would severely reduce the system's passenger carrying capacity. Further, the displacement of LIRR baseline trains by One-Seat Ride trains would reduce service frequencies for commuter rail customers between Manhattan and Queens, Nassau, and Suffolk.

### **Capacity After Completion of East Side Access**

As noted in Section 3 of this report, the best opportunity to implement One-Seat Ride service requires two future improvements:

- East Side Access to create more terminal capacity in Manhattan
- CBTC to provide additional Main Line track capacity

These infrastructure improvements would help enable a four-train-per-hour One-Seat Ride service to Penn Station, except during one morning and one evening peak hour. At Grand Central Terminal, however, operating capacity would be insufficient to accommodate four-train-per-hour One-Seat Ride service in either the morning or evening peak periods. Exhibit 17 indicates the peak hours in which four-train-per-hour One-Seat Ride service can be accommodated (green boxes) and those hours in which One-Seat Ride service would be constrained (red boxes). As in Exhibit 16, the capacities shown in Exhibit 17 as fixed numbers would be subject to a very dynamic operating environment and may vary with changes in operating conditions or policies.

CBTC, which enhances train flow on mainline tracks, would not address capacity constraints within terminals. Terminal capacity constraints are largely attributable to conflicting train movements at the terminal approaches as well as platform track occupancy, neither of which are affected by the installation of CBTC.

The capacity limitations of Penn Station and Grand Central Terminal to accommodate One-Seat Ride service after the completion of the East Side Access project are discussed in more detail in the following section.

**Exhibit 17**  
**Estimated Capacity (Trains per Hour) Available for One-Seat Ride Service**  
**With East Side Access Service, MNR Service to Penn Station and CBTC**

<b>Westbound to JFK Airport</b>											
Peak Period	Main Line				Penn Station				Grand Central Terminal		
	Track Capacity w/CBTC*	LIRR	MNR**	Capacity/Deficit	Terminal Capacity*	LIRR	MNR**	Capacity/Deficit	Terminal Capacity*	LIRR#	Capacity/Deficit
7:00-8:00 a.m.	89	42	5	42	42	19	5	18	24	21	3
8:00-9:00 a.m.	89	48	6	35	42	37	6	-1	24	24	0
4:30-5:30 p.m.	30	16	5	9	24	12	5	7	24	22	2
5:30-6:30 p.m.	30	19	6	5	24	16	6	2	24	22	2

<b>Eastbound to JFK Airport</b>											
Peak Period	Main Line				Penn Station				Grand Central Terminal		
	Track Capacity w/CBTC*	LIRR	MNR**	Capacity/Deficit	Terminal Capacity*	LIRR	MNR**	Capacity/Deficit	Terminal Capacity*	LIRR#	Capacity/Deficit
7:00-8:00 a.m.	27	17	5	5	24	9	5	10	24	18	6
8:00-9:00 a.m.	27	18	6	3	24	13	6	5	24	24	0
4:30-5:30 p.m.	80	34	5	41	38	21	5	12	24	20	4
5:30-6:30 p.m.	81	43	6	32	38	23	6	9	24	24	0

\* Assumes adherence to schedule

\*\* Preliminary estimate of Metro-North service via Hell Gate Line. Service levels could differ depending on findings of ongoing Metro-North Penn Station Access Study

# Based on fully committed service plan for East Side Access, as noted in MIS and DEIS.

### **Penn Station and Grand Central Terminal Capacity**

Today, to accommodate existing standees, growing ridership, and seating capacity reductions required to meet ADA mandates, the LIRR is in the process of increasing service to Penn Station so that it can operate up to 42 trains per hour during the peak period. This represents the practical capacity for LIRR service at Penn Station after completion of the JO Clearance Improvement Project, presently scheduled for late 2001. Therefore, for the near future, it does not appear that Penn Station will be able to accommodate additional service, such as One-Seat Ride, beyond these levels without adversely affecting existing railroad services.

In fact, in the context of service being provided by all three railroads now using Penn Station (Amtrak, New Jersey Transit, and LIRR), pressure on the Penn Station physical plant has been building because of increased demand at current service levels and the introduction of new services. In response, the three railroads, in a cooperative effort called the Tri-Venture Council, are reviewing and analyzing the capacity of Penn Station to meet the service requirements of each of the railroads into 2002. Results provided to

date of the operations simulation for 2002 confirm that the Penn Station complex will be challenged to meet these service requirements.

After East Side Access (post 2011), it is possible that up to five peak LIRR trains per hour could be relocated from Penn Station to Grand Central. This relocation could provide sufficient capacity at Penn Station to operate a four-train-per-hour One-Seat Ride service together with proposed Metro-North services during most of the peak periods. However, under currently available operating plans and assumptions, westbound One-Seat Ride service would be constrained at Penn Station during one hour in the morning peak (8:00 a.m.-9:00 a.m.) and one hour in the evening peak (5:30 p.m.-6:30 p.m.). (See red boxes in Exhibit 17.) Sufficient off-peak capacity would be available to maintain four-train-per-hour frequency throughout the rest of the day. The final determination of the feasibility of operating four One-Seat Ride trains per hour to and from Penn Station in the constrained peak hours must await the finalization of LIRR service plans, as well as plans for proposed Metro-North service into Penn Station.

At this time, it does not appear that capacity will be available at Grand Central Terminal for future One-Seat Ride service during peak periods. According to an analysis of the operating plan used in the East Side Access Draft EIS, LIRR service will use the entire practical capacity at Grand Central Terminal of 24 LIRR trains per hour during certain peak hours. Overall, there would be insufficient operating capacity to accommodate four-train-per-hour One-Seat Ride service at Grand Central Terminal during any hour of the morning and evening peak periods. (See Exhibit 18 and the red boxes in Exhibit 17.)

Like Penn Station, Grand Central Terminal would have no storage capacity for One-Seat Ride trains during peak periods, when Grand Central Terminal will be operating at or near capacity. Consequently, when operating capacity is insufficient in one direction, the number of One-Seat Ride trains available to provide service in the opposite direction will likewise be limited. As at Penn Station, substituting baseline LIRR trains with One-Seat Ride trains would not be a viable solution given the adverse impacts of reduced passenger capacity and service frequency on LIRR customers.

#### Exhibit 18

##### Grand Central Terminal One-Seat Ride Service Peak Period Capacity Constraints

Time Period	Service	Constraint
7:00-8:00 a.m.	Westbound	3 trains per hour
8:00-9:00 a.m.	Both directions	No capacity available
4:30-5:30 p.m.	Westbound	2 trains per hour
5:30-6:30 p.m.	Eastbound	No capacity available
5:30-6:30 p.m.	Westbound	2 trains per hour

In the following sections, strategies that were considered to address Main Line track operating constraints are discussed in more detail, followed by a description of One-Seat Ride vehicle requirements and characteristics.

## Main Line Capacity

To address Main Line capacity constraints, the consultant team examined two strategies: installation of a new signal system and construction of new tracks. The following summarizes the features of these strategies.

## CBTC Signal System

CBTC provides the potential for increased operating capacity within existing track constraints. It provides, in theory, infinitesimally short blocks by using vital technology to continually track the position of trains and determine safe speeds for following trains. CBTC train operation simulation models of the LIRR between Jamaica and Penn Station were constructed to determine the capacity benefits of this technology. The results of the analysis show that CBTC would provide significant capacity gains over the current wayside with cab signaling system and would allow for a One-Seat Ride frequency of up to four trains per hour together with planned baseline LIRR services.

Exhibit 19 presents CBTC capital costs, in 1999 dollars, which reflect the resources required to install the signal technology along the Main Line between Jamaica and Penn Station, or Grand Central as well as on the Rockaway Beach Branch. Costs associated with CBTC equipment on board the One-Seat Ride vehicles are included in the vehicle costs estimates. As noted earlier, the estimated cost of up to \$245 million to retrofit the existing LIRR fleet for CBTC operations is not included in the CBTC costs for the One-Seat Ride alternatives. These costs are not included as part of the One-Seat Ride alternatives because the LIRR is pursuing CBTC as part of systemwide strategy and, for purposes of this study, new cars purchased by the LIRR are assumed to be CBTC compatible.

**Exhibit 19**  
CBTC Alignment-Related Capital Costs  
(in millions of 1999 dollars)

Alignment	Cost
L1	\$65
L2	\$101
L8	\$47
L9	\$83

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CBTC was selected as the preferred capacity enhancement strategy over the construction of additional Main Line track (see description below) because of the following factors:

- Significantly lower capital costs (up to \$101 million for CBTC compared to \$962 million for the additional track capacity)
- No community or environmental impacts of construction within existing rail transportation right-of-way
- No need to reconstruct existing transportation facilities, or disrupt service during construction

### **Additional Main Line Tracks**

The second capacity strategy studied would entail constructing a fifth and sixth track between Jamaica and Harold Interlocking. Although feasible, this strategy presents several significant construction challenges and an estimated construction cost of \$962 million. This does not include the additional costs to acquire adjacent properties needed to provide the required right-of-way. This strategy is not recommended to achieve additional Main Line capacity.

The major construction issues associated with adding the fifth and sixth track are:

- **Property Takings.** The proposed alignment would require taking of all or part of 12 tax lots in the Woodside area, including numerous buildings that abut the south side of the LIRR alignment, resulting in negative community impacts.
- **Woodside Station Reconstruction and Bypass.** Within Woodside, the Main Line abuts numerous structures, leaving little space for additional tracks. The Woodside station is a difficult obstacle to bypass. One option would be to build two tracks on the south side of the LIRR Main Line, at matching grade, through the obstacles of Woodside and the station. However, this would require demolition and reconstruction of several parts of the Woodside station structure, including the stairways and escalators connecting the mezzanine with Roosevelt Avenue, and would result in service disruptions during the construction period (see Exhibit 20).



**Exhibit 20**  
**Woodside Station**

*Looking west at the Woodside Station complex from the LIRR's Platform C. The LIRR train on the left is on the eastbound local track to Jamaica; the train on the right is eastbound on the Port Washington Branch. The NYCT #7 service operates on the elevated, green structure above the railroad.*



- **NYCT Flushing Line Modifications.** Construction of the two at-grade tracks in Woodside would also conflict with columns supporting the overgrade NYCT #7 Flushing Line. To address this conflict, the Flushing Line would need to be underpinned, with the weight transferred onto new columns that would also hold up the new line. Subway service disruptions would occur during this construction.
- **Forest Hills and Kew Gardens Station Reconstruction.** The platforms on both the eastbound and westbound local tracks of the Forest Hills station have recently been rebuilt. The station structure on the eastbound side is connected to a complex of buildings, built in the same motif, that form a town square (see Exhibit 21). To accommodate an additional track on each side of the station, the platforms would have to be relocated to the north and south. This would negatively affect the community, especially on the eastbound side. As at Forest Hills, the Kew Gardens station platforms would have to be relocated to accommodate the additional tracks (see Exhibit 22). Shifting back station platforms would also result in the loss of station parking spaces.

**Exhibit 21**  
**Forest Hills Station**

*Looking east at  
the Forest Hills  
Station from the  
eastbound  
platform.*



**Exhibit 22**  
**Kew Gardens Station**

*A view looking west  
from the Kew  
Gardens station  
eastbound platform.  
One of the two  
apartment buildings  
above the right-of-  
way can be seen in  
the distance.*

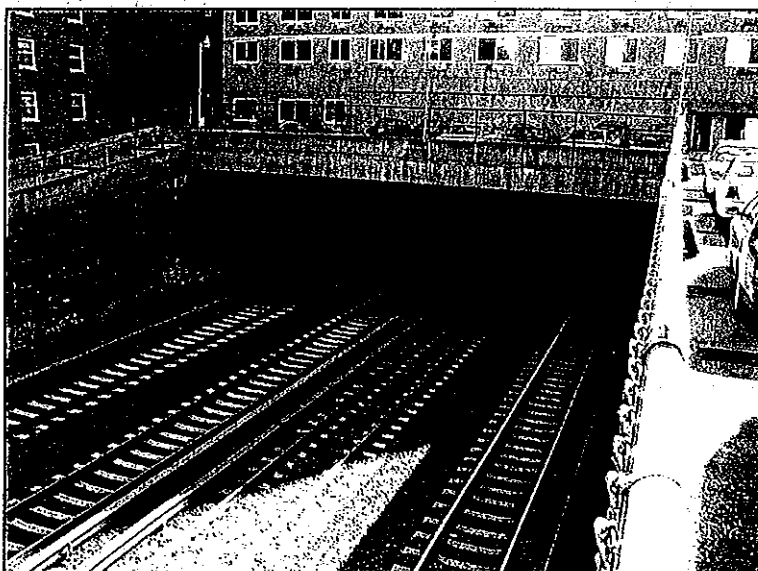


- **Apartment Buildings West of Kew Gardens.** Just west of the Kew Gardens station, the Main Line crosses Union Turnpike over grade. Matching apartment buildings have been built on either side of Union Turnpike above the railroad. The buildings' foundation walls limit the right-of-way

width to four tracks (see Exhibit 23). Extensive modifications to the foundations of the existing buildings would be required to accommodate an additional track on each side. Structural plans for the existing buildings would need to be acquired to determine the feasibility and extent of the required modifications and the impact these modifications would have on the use of the buildings' basements.

### Exhibit 23

#### Apartment Buildings Above the LIRR Main Line, West of Kew Gardens



*The four tracks of the Main Line passing under one of the matching two buildings on either side of Union Turnpike.*

- **Undergrade Crossings.** The viaducts carrying the LIRR right-of-way over Yellowstone Boulevard and Ascan, Metropolitan, and Hillside Avenues would have to be widened to accommodate the additional tracks. The viaducts over Yellowstone Boulevard, Metropolitan Avenue, and Hillside Avenue are through-plate girder structures spanning major arteries. These arteries would require additional MPT measures during construction.

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## Vehicle Design Requirements and Characteristics

The following section describes the design requirements and characteristics for a rail passenger vehicle that could be feasibly constructed and operated on both the LIRR and AirTrain LRS systems.

### General Arrangement

One-Seat Ride vehicles would be arranged in a 4-car fixed unit with a maximum length of 240 feet. This would ensure that One-Seat Ride trains do not exceed the length of LRS station platforms. A 4-car fixed unit is preferred because (1) the demand for service during most of the service day would require at least the 152-seat capacity of these units and (2) economies of scale associated with the maintenance of a fixed unit compared to individual cars. Each unit would include two types of cars, designated as "A" and "B." The cars at the outer ends of each unit would be "A" cars; an operator's cab would be provided at one end of each "A" car. Each cab end would be equipped with other features such as energy absorbing zones necessary to meet the LRS and LIRR crashworthiness requirements. The intermediate cars would be designated as "B" cars.

The spacing of the automated sliding doors along LRS station platforms would govern the door arrangement for the One-Seat Ride unit. As a result, there would be two doorways per side in each car, or eight on each side of each One-Seat Ride unit.

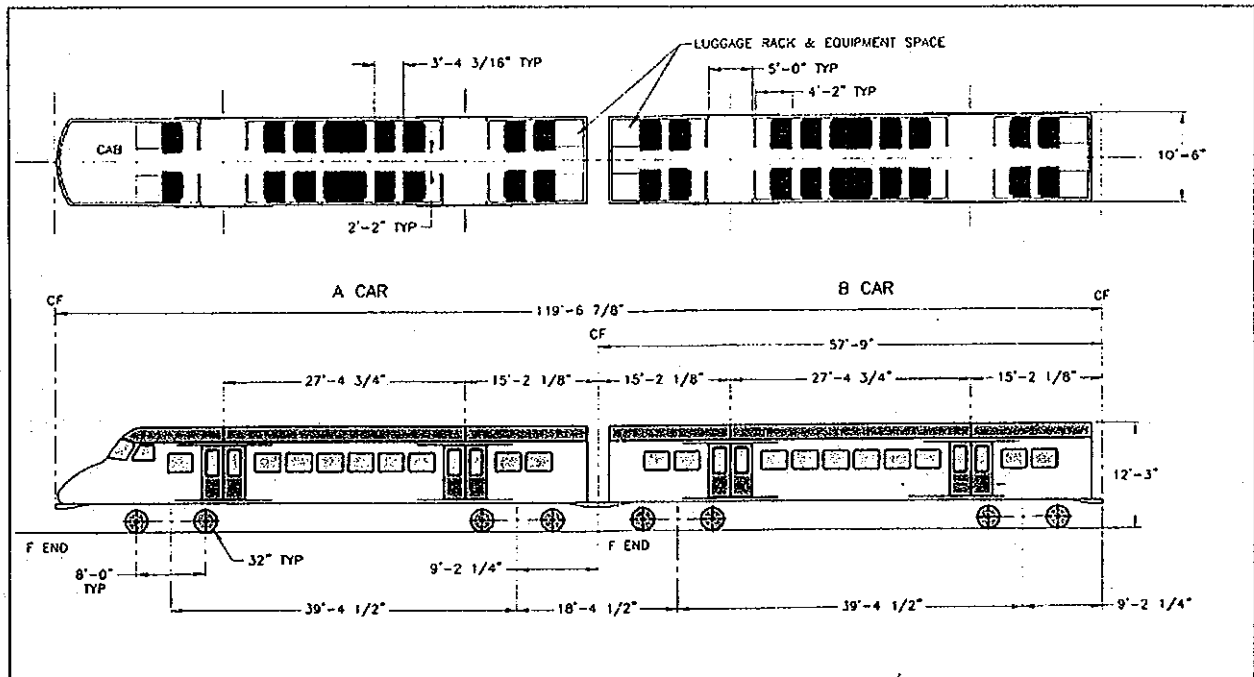
A full-width operator's cab would be provided at each end of the unit, to be used for the portion of the trip on the LIRR. To provide a seamless transition to and from the LIRR's operating environment, the cab and its controls would resemble that of the LIRR's M-7 cars as closely as possible in appearance and arrangement.

Exhibit 24 summarizes the overall dimensions for a One-Seat Ride unit composed of empty cars ready for revenue service, without crew or passengers. Exhibit 25 provides a schematic of a One-Seat Ride "A" and "B" car.

**Exhibit 24**  
**One-Seat Ride Vehicle General Dimensions**

Vehicle Element	Dimension
Unit length over coupler faces, maximum	240 feet, 0 inches
Width, overall maximum	10 feet, 6 inches
Height, nominal, top of rail to side door thresholds, LRS position	3 feet, 8 inches
Height, nominal, top of rail to side door thresholds, LIRR position	4 feet, 2 inches
Height, side door thresholds to top of roof	8 feet, 7 inches
Side door clear opening, minimum height	6 feet, 3 inches
Side door clear opening, minimum width	5 feet, 0 inches
End door clear opening, minimum height	6 feet, 3 inches
End door clear opening, minimum width	2 feet, 6 inches
Maximum truck wheelbase	7 feet, 0 inches
Wheel diameter, new, minimum	28 inches
Passenger capacity	152 seated/236 maximum

**Exhibit 25**  
**One-Seat Ride Vehicle Schematic**



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## Service Quality

The One-Seat Ride would be offered as a fast, frequent service targeted to airline passengers. As a result, the One-Seat Ride vehicle would need to incorporate the following features:

- **Industrial Design and Styling.** The One-Seat Ride vehicles would need to present a pleasing, ultra-modern appearance, inside and out. The vehicle specification would require the involvement of an approved industrial designer throughout vehicle design and construction, and the provision of renderings and mockups for review and approval.
- **Car Layout.** The One-Seat Ride vehicle should offer a high level of comfort. Therefore, the vehicle would be designed to provide seats for practically all passengers. Seats would have generous dimensions, with two-passenger seats on each side of the aisle. Because of the need for a quick turn-around in Manhattan, and to avoid labor costs for turning seats and maintenance problems, seats would be fixed, half facing in each direction.

Luggage rack areas would be provided in each car. Since the new FRA crashworthiness standards and the voluntary Passenger Rail Equipment Safety Standards developed by the American Public Transportation Association both require a crush zone at each end of each new passenger rail car, the luggage racks would be located in this area to avoid wasted space.

- **Ride Quality and Noise.** The One-Seat Ride vehicles would be designed to be free from objectionable vibration and shock. All equipment mounted in the passenger area would be free from resonance to avoid annoying audio and visual distraction. Additionally, noise levels under all conditions would be no greater than those generated by the LRS vehicles or by the LIRR M-7 cars under similar conditions.
- **Amenities.** The One-Seat Ride vehicles would feature passenger amenities designed for air travelers such as ample seating and luggage racks. Additional amenities could be incorporated into the design of the One-Seat Ride vehicles based on the policies and standards established for the service. The following describes two amenities that could be considered for the One-Seat Ride vehicles as well as their associated technical and institutional considerations:
  - **Toilets.** Toilet rooms are not provided in the One-Seat Ride vehicles because each would displace six to nine seats. Toilet rooms would also add significant weight, which would need to be evaluated relative to a One-Seat Ride train's fully loaded weight and the limits of the LRS' elevated structures. Toilets would also require servicing, which cannot be done on the loop at the airport, and would be difficult at the Manhattan terminal. Moving the unit to a point where such servicing can be done may ultimately require an additional unit to cover the service requirement, at considerable expense.

- **Real-Time Passenger Information.** A real-time video display of departing flights from the airport would be a convenience for JFK Airport-bound trips. With multiple terminals and dozens of airlines involved, assembling all arrival and departure information in real time may be an institutional challenge. If flight information can be gathered comprehensively and reliably, transmission to the train and on-board video displays would not be particularly difficult.

## AirTrain LRS and LIRR Requirements

The One-Seat Ride vehicle must meet the physical, operating, and regulatory requirements of both the LRS and the LIRR. The consultant team has identified strategies for addressing differences between the two systems. A compromise design could accommodate some of these differences, and resetting system parameters as the vehicle moves from one system to the other could accommodate some other differences. A few would require separate equipment for use on each system. The following describes how AirTrain LRS and LIRR requirements would be addressed within the design of the One-Seat Ride vehicle:

- **FRA Requirements and Weights.** FRA has recently issued new rules governing the construction of passenger cars for use on railroads under its jurisdiction, such as the LIRR. The rules for locomotives have also been revised recently. These new rules set requirements for structural strength and crashworthiness, which has the effect of increasing vehicle weights. The challenge for the One-Seat Ride vehicle is to achieve FRA's standards while not exceeding the weight limits of the LRS' structures. Achieving this goal will require careful design and avoidance of any unnecessary weight. Exhibit 26 shows the approximate weights for the LIRR, LRS, and One-Seat Ride vehicles and weight limits for the LRS.

**Exhibit 26**  
One-Seat Ride Vehicle Weight Parameters

System Element	Weight Status	Weight
LIRR M-7 cars, projected weight	Empty	60+ tons
Above, adjusted to 58-foot car	Empty	47+ tons
Permitted weight in 58-foot car on the LRS	Crush Load	46 tons
Passenger load in One-Seat Ride/LIRR vehicle	Crush Load	9 tons
Maximum weight for One-Seat Ride/LIRR vehicle	Empty	37 tons

While it is intended that the One-Seat Ride service would not normally carry the maximum load of 236 seated and standing passengers, the standing area of a train may be filled to a crush load during a possible service disruption. Deducting the weight of the crush load from the allowable

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gross weight leaves little weight for the vehicle itself. This is addressed in the conceptual vehicle design by providing enough seats that are positioned to minimize the standing area and thus the possible crush load.

- **Crashworthiness.** The LRS and LIRR signal systems are designed as the primary protection against collisions. Both systems' rail vehicles are also designed to meet certain crashworthiness standards to limit the risk to passengers in the unlikely event of a collision. The LRS system is being designed as a stand-alone system with crashworthiness requirements appropriate for the weight and strength of the LRS vehicles. The One-Seat Ride vehicle would have to meet FRA crashworthiness standards and be strong enough to protect its passengers in a collision with LIRR equipment. At the same time, the One-Seat Ride vehicle must not excessively damage an LRS vehicle if a collision should occur on the LRS system. To meet these requirements, the One-Seat Ride vehicles would have both energy absorbers and an outer crush zone at each end of the unit. These would lessen the shock of a collision.
- **Coupler and Platform Height.** On commuter railroad cars such as those operated on the LIRR, the coupler of one car is retained under the end sill of the other car to keep the heavy underframe structures of colliding vehicles in line. This maximizes resistance to the penetration of one vehicle by another. However, transit vehicles such as those on the LRS use an anticlimber, a horizontal member across the end of the car with ribs that engage those of the other car to resist vertical movement. To meet FRA requirements, the One-Seat Ride vehicle would have a coupler height in line with, not below, the anticlimber of the LRS vehicle. To address this issue, the One-Seat Ride vehicle would have both a transit anticlimber and a coupler meeting FRA strength requirements. The height of the One-Seat Ride vehicle body would adjust above the track as the vehicle shifts between the LRS and the LIRR. This would properly align the anticlimbers when the One-Seat Ride train operates on the LRS, and the couplers when operating on the LIRR. For the recommended alternative, L2, this adjustment would take place at the AirTrain station in Jamaica.

The adjustable car body also would address differences in platform height between the LIRR and the LRS. The mechanism would provide a vertical movement of about six to seven inches to meet the platform and coupler/anti-climber height requirements of both the LRS and the LIRR. A similar arrangement of a passenger vehicle capable of elevating to different heights is found in the mobile lounges used at several airports, including Montreal-Mirabel, Dulles International (Washington, D.C.) and at JFK Airport, for certain flights unable to use terminal jetways. One of the firms that built these mobile lounge vehicles was the Budd Company (since acquired by Bombardier), which also built the LIRR/Metro-North M-1 and M-3 fleet and NYCT's R-32 cars.

- **Mode Selection.** Because of the differences in train control, communications systems, and car body height required on the LRS and the LIRR, the One-Seat Ride unit would be equipped with a mode control to adapt it to LRS and LIRR requirements. When the LRS mode is selected, the



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affected systems used on the LRS would be activated, and the car body would be moved to the lower position. When the LIRR mode is selected, the systems used on the LIRR would be activated and the car body would be moved to the upper position.

- **Communications Systems.** The LRS and the LIRR use different communication systems for a variety of purposes, including train radio, public address, passenger information, intercom between cabs, and diagnostic data exchange with wayside installations. As a result, the One-Seat Ride vehicle would feature a complete communications system that would provide all required functions for operation on the LRS and the LIRR. Where the functions necessary for operation on one rail system are different from those required for operation on the other, separate functional units would be provided.
- **Cab Layout and Facilities.** To meet LIRR operating requirements, the One-Seat Ride vehicle cab would be outfitted with manual operation equipment that would allow the trains to be operated on LIRR tracks between Manhattan and the connection point to the LRS system. Equipment and control layout in the One-Seat Ride cab should be as similar as possible to that of the M-7 car. On the LRS, One-Seat Ride trains would be operated in an automated mode similar to that of the on-airport trains. As a result, the One-Seat Ride vehicle would need to include LRS-compatible automated train control equipment as well.
- **Maintenance Facilities.** The One-Seat Ride vehicle specification would require that the vehicles be as compatible as possible with both systems' maintenance facilities. Even when one system has been selected to perform normal maintenance, it would always be possible that, in case of a breakdown, the most expeditious course would be to take the unit to the nearest facility.

## Vehicle Costs

The per-unit vehicle cost for alternatives L1 and L2, either of which would require 32 cars (including spares) to maintain a 15-minute headway, is estimated at \$3.96 million, for a total cost of \$127 million in 1999 dollars. For alternatives L8 and L9, either of which would require 40 cars, the estimated per unit vehicle cost is \$3.65 million, for a total cost of \$146 million in 1999 dollars. These vehicle cost estimates are based on an assessment of industry standard and unique features of the One-Seat Ride vehicle, the size of the fleet order, and the LIRR's recent fleet purchase experience. The costs reflect the fact that to operate on both the LIRR and LRS systems, the One-Seat Ride vehicles require a custom design. The costs include activities associated with engineering, manufacturing, administration, and testing.

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## 5. Conclusion

As a result of final feasibility analysis, four LIRR-based alternatives were judged physically feasible to construct. Of these, alternative L2 was identified as the recommended alternative. This alternative would connect with the AirTrain LRS at Jamaica, use the LIRR's Main Line through Queens, access Manhattan via the East River tunnels, and serve the Manhattan-JFK Airport air travel market with a terminus at Penn Station. Alternative L2 is recommended because:

- One-Seat Ride service via an LIRR/LRS Jamaica connection, compared to a Howard Beach connection, is faster and less costly, and has fewer potential community impacts.
- Penn Station has more capacity to accommodate One-Seat Ride service during critical morning and evening peak periods than does Grand Central Terminal with East Side Access.

Finally, to advance alternative L2, certain key requirements must be met:

- **Complete East Side Access.** East Side Access will free up capacity at Penn Station, which is required for the operation of One-Seat Ride service during peak hours.
- **Provide for Increased Main Line Capacity with CBTC.** Capacity on the LIRR Main Line between Jamaica and Harold Interlocking must be increased to allow operation of One-Seat Ride service in the peak morning and evening periods. To achieve this, the installation of a CBTC signal system is recommended.
- **Develop Vehicles for LIRR/LRS Operation.** Rail vehicles used for One-Seat Ride service must meet the dual operating and regulatory requirements of both the LIRR and the AirTrain. The design and operation of the One-Seat Ride service over the FRA-regulated LIRR and non-FRA regulated LRS systems can be achieved in accordance with accepted industry design standards and operating practices.
- **Coordinate Construction with AirTrain and East Side Access.** To avoid unacceptable LIRR service disruptions and maximize coordination with committed project construction schedules, construction of a physical connection between LIRR trackage and the AirTrain system must be coordinated with the current construction of the AirTrain project at Jamaica and the planned East Side Access construction at Harold Interlocking, and must begin after the East Side Access work is completed.

# Appendices

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# Appendix A

## Final Feasibility Analysis Findings, Feasible Alternatives

### Introduction

This appendix supplements the final report by providing the detailed findings of the final feasibility analysis for the four feasible One-Seat Ride alternatives. Of the 40 alternatives analyzed in the JFK One-Seat Ride Feasibility Study, eight were carried through the last study phase. Based on the technical analyses and evaluation performed in the final feasibility analysis, four alternatives—L1, L2, L8, and L9—were found to be physically feasible. (Appendix B describes the other four alternatives that were found to be infeasible in the final feasibility analysis. Appendix C summarizes all 40 alternatives initially defined in the study.)

This appendix begins with an overview of the evaluation framework used to assess both the feasible and infeasible alternatives. The overview is followed by a summary of the evaluation results for the feasible alternatives.

### Evaluation Framework

As part of the JFK One-Seat Ride Feasibility Study, MTA and its consultant team developed and evaluated 40 alignment alternatives that would use either an LIRR/JFK Airport LRS, or an NYCT/LRS routing. Vehicle technology strategies that would meet the dual requirements of either an LIRR/LRS or an NYCT/LRS operating environment were also developed. To evaluate the feasibility of alignment and vehicle technology alternatives, MTA and its consultant team undertook engineering, operations planning, market assessment and ridership forecasting, and community impact analyses that were used to define and assess the options under consideration. A three-phase evaluation framework, which included a fatal flaw analysis, preliminary feasibility analysis, and final feasibility analysis, was employed to narrow the options under consideration to a core set of preferred alternatives. These evaluation phases were:

- **Fatal Flaw Analysis.** This was used to identify and screen out alternatives with technically or operationally infeasible or unacceptable features.
- **Preliminary Feasibility Analysis.** The analysis was based on an initial technical assessment of the alternatives. Alternatives were evaluated based on their operations, engineering and construction, market access and competitiveness, and community impacts. The results of this effort were used to define a shorter list of alternatives that were carried forward into the final feasibility analysis.

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- **Final Feasibility Analysis.** The final feasibility analysis was used to define a preferred set of alternatives from those selected in the preliminary feasibility analysis. The final feasibility analysis was based on the results of technical analyses that defined and assessed the alternatives using evaluation categories similar to those used in the preliminary feasibility analysis. In the final feasibility analysis phase, alternatives were rated based on their performance relative to specific evaluation criteria. Except for capital and operating costs and ridership, an “A” to “F” scale was used to rank the alternatives’ performance. Based on this scale, an “A” to “D” rating indicated increasing difficulty, complexity, and impacts, and decreasing effectiveness and service quality. An “F” rating denoted that the alternative did not meet the requirements for a particular criterion. Estimated cost data, expressed in 1999 dollars, were used for the capital and operating cost criteria, while forecasted year 2020 average daily travel demand was used for the ridership criteria.

The criteria used in the final feasibility analysis included:

#### **Operations Criteria**

- **Availability of Track and Operating Capacity.** This criterion examined how well the alternatives accommodated a desired travel time and minimum service frequency of four trains per hour within the track and operating capacity constraints of the LRS and NYCT, or LIRR.
- **Availability of Terminal Capacity.** This assessed whether the Manhattan terminals would have sufficient operating capacity to accommodate consistent four-train-per-hour One-Seat Ride service frequency.
- **Operations Complexity.** This examined how well the One-Seat Ride service could be integrated into baseline LIRR, NYCT, and LRS operations. The evaluation considered issues associated with the merging and diverging of One-Seat Ride trains with LIRR, NYCT, and LRS trains and the presence of single-track sections that would limit operating flexibility.

#### **Engineering and Construction**

- **Difficulty to Build the Alignment.** This criterion assessed the likelihood of encountering unanticipated or major construction issues such as significant need for tunnels and structures, major reconstruction of existing station areas and platforms, or integration of communication and signal systems. This criterion also assessed the complexity of the potential techniques used in the project’s construction.
- **Impact of Other Agencies’ Existing and Planned Services on the Alignment.** This criterion assessed how NYCT, LIRR, and LRS’ existing and committed services would likely affect the construction feasibility and implementation timeframe of the alignment alternatives.

- 
- **Available Right-of-Way/New Right-of-Way Required.** Ratings for this criterion were based on an order-of-magnitude assessment of the right-of-way requirements for the alignment alternatives relative to the amount of right-of-way available in existing transportation corridors and the possible need for new right-of-way. The need for a large amount of new right-of-way would be likely to adversely affect an alignment's implementation timeframe and construction complexity.
  - **Capital Cost in Millions of 1999 Dollars.** This was defined as the conceptual costs to construct the civil and system features of the alignments as well as to procure the fleet of One-Seat Ride vehicles associated with the alternatives.
  - **Operating Costs in Millions of 1999 Dollars.** This represented the conceptual annual costs to operate the alternatives. Annual operating costs were based on the operating plan and fleet requirements established for the alternatives.
  - **Implementation Timeframe.** This evaluation was based on the potential opening year for One-Seat Ride service. An alignment's opening year was determined by (1) the construction needs and construction schedule associated with the project's civil, system, and vehicle elements and (2) the completion of other capital projects, such as East Side Access and the LRS, which would provide the physical route and operating capacity required to provide service between Manhattan and JFK Airport.
  - **Implementation Risks and Uncertainties.** This criterion assessed whether specific construction complexities or community impacts associated with an alternative would affect the projected opening year.
  - **Vehicle Design and Operations Complexity.** This evaluation was based on the design features of the One-Seat Ride vehicle required to meet the dual operating requirements of either an LIRR/LRS or an NYCT/LRS service.

#### **Market Access and Competitiveness**

- **Travel Time.** This was defined as the average one-way travel time, expressed in minutes, between JFK Airport and 42nd Street, the major cross-Manhattan street closest to the concentration or centroid of Manhattan-based JFK Airport trip origins and destinations south of 72nd Street. (The centroid was calculated to be at 45th Street between 5th Avenue and 6th Avenue.) Travel times were based on an operations simulation analysis considering an alignment's route length, operating capacity, signal system characteristics, and operating speed restrictions, as well as the One-Seat Ride train's performance characteristics.
- **New Daily Riders in 2020.** This criterion was based on the number of additional daily riders that would use the One-Seat Ride service compared to the baseline assumed for the two-seat ride

AirTrain service. The results of the travel demand forecasting effort for this analysis estimate that 15,170 daily riders would use the two-seat AirTrain service.

### Environmental and Community Impacts

- **Extent of Private Property Takings.** This criterion was based on the potential amount, current use, and current density of private property that would need to be acquired to construct the alignment.
- **Extent of Adjacent Residential Land Use Impacts.** This was an order-of-magnitude analysis of residential properties that would be immediately adjacent to the alignment alternatives. As part of this evaluation rating, the analysis considered the extent of affected residential land uses along new rights-of-way as well as rights-of-way that are dedicated for transportation but are currently abandoned or underused.
- **Extent of Parkland Impacts.** This rating was based on an order-of-magnitude estimate of parkland that would be adjacent to the alignment, or would be needed to accommodate construction.
- **Extent of On-Airport and Off-Airport Access Road Impacts.** This considered the potential traffic impacts associated with the removal of existing lanes, or segments of the road network accessing JFK Airport, during and after construction of the alignment alternatives.

### Evaluation Results

As a result of the final feasibility analysis, four alternatives (L1, L2, L8, and L9) were found to be physically feasible and four alternatives (S7, S23, L5, and L11) were found to be not feasible. Exhibit A-1 outlines the alignments for the four feasible alternatives. (Appendix B describes the findings for the infeasible alternatives.)

**Exhibit A-1**  
Feasible Alternatives Routing Alignment

Alignment	Connection to LRS	Route Through Queens	Route into Manhattan	CBD Terminus
L1	Jamaica	Main Line	63rd St Tunnel Lower Level	Grand Central Terminal
L2	Jamaica	Main Line	East River Tunnels	Penn Station
L8	Howard Beach	Rockaway Beach Branch-Main Line	63rd St Tunnel Lower Level	Grand Central Terminal
L9	Howard Beach	Rockaway Beach Branch-Main Line	East River Tunnels	Penn Station

Exhibit A-2 summarizes the overall evaluation results for the feasible alternatives. The remaining sections of this appendix describe the analysis results in more detail for each evaluation criterion category.

**Exhibit A-2**  
Feasible Alternatives Overall Evaluation Ratings

Alignment	L1	L2	L8	L9
<b>Operations</b>				
Availability of track capacity	C	C	C	C
Availability of terminal capacity	D	C	D	C
Operations complexity	A	A	B	B
<b>Engineering and Construction</b>				
Difficulty to build	B	B	B	B
Impact of other agencies' services	B	B	B	B
Available right-of-way/new right-of-way required	A	A	A	A
Capital cost (in millions of 1999 dollars)*	\$325	\$361	\$443	\$479
Operating cost (in millions of 1999 dollars)	\$ 18	\$ 18	\$ 26	\$ 26
Implementation timeframe	B	B	B	B
Implementation risks and uncertainties	A	A	B	B
Vehicle design and operations complexity	C	C	C	C
<b>Market Access/Competitiveness</b>				
Travel time (average to/from 42nd St. in minutes)**	34	37	41	43
New daily riders in 2020 (increase over 15,170 AirTrain riders)	2,200	2,110	1,780	1,730
<b>Environmental and Community Impacts</b>				
Extent of private property takings	A	A	C	C
Extent of adjacent residential land use impact	A	A	D	D
Extent of parkland impact	A	A	D	D
Extent of on- and off-airport road impact	A	A	A	A

*General Rating Scale: A to D indicates increasing difficulty, complexity, impacts; decreasing effectiveness, service quality. F = Does not meet criterion.*

\* Includes vehicle cost assuming four-train-per-hour service. Does not include potential costs for vehicle maintenance facilities, property acquisitions, Grand Central Terminal/Penn Station modifications, or retrofitting baseline LIRR fleet.

\*\* Travel times for L2 and L9 include 5-minute access time between Penn Station and 42nd Street.

## Operations Criteria

Exhibit A-3 highlights the alternatives' evaluation ratings for the operations criteria. As described below, the alternatives would meet most operating criteria established for the One-Seat Ride service. However, as explained below, alternatives L1 and L8, which go to Grand Central Terminal, rate lower for the "availability of terminal capacity" criterion than do alternatives L2 and L9, which go to Penn Station.



**Exhibit A-3**  
**Feasible Alternatives**  
**Operations Criteria Evaluation Ratings**

<b>Alignment</b>	<b>L1</b>	<b>L2</b>	<b>L8</b>	<b>L9</b>
<b>Operations</b>				
Availability of track capacity	C	C	C	C
Availability of terminal capacity	D	C	D	C
Operations complexity	A	A	B	B

### Availability of Track Capacity

The feasibility of all four alternatives is contingent upon increased operating capacity on the Main Line between Jamaica and the Manhattan Terminals. As a result, the alignment options received an equal rating (“C”). As noted in the main body of the final report, CBTC would provide the capacity needed to operate both the LIRR’s baseline services, based on the East Side Access operating plan, and the One-Seat Ride.

### Availability of Terminal Capacity

CBTC, which enhances train flow on main line tracks, would not address capacity constraints in the slow speed environment of the terminals. Manhattan terminal capacity is projected to be more constrained at Grand Central Terminal than at Penn Station. As a result, the Grand Central Terminal-based alternatives were assigned a lower rating than the Penn-based alternatives.

- **L1 and L8 (“D”).** Grand Central Terminal would not have sufficient available capacity in the peak periods from 7:00-9:00 a.m. and 4:30-6:30 p.m. to allow four-train-per-hour One-Seat Ride service. During the morning peak, capacity would be available for only three westbound trains per hour between 7:00 and 8:00 a.m., while no One-Seat Ride service could be provided in either direction between 8:00 and 9:00 a.m. In the evening peak period, Grand Central Terminal would have capacity for only two westbound trains between 4:30 and 5:30 p.m, while between 5:30 and 6:30 p.m., no eastbound service could be provided and capacity would be available for only two westbound trains. Due to the lack of storage capacity at Grand Central Terminal, insufficient operating capacity in one direction would mean that the required number of trains would not be available to provide service in the opposite direction.
- **L2 and L9 (“C”).** With the implementation of East Side Access, LIRR plans to relocate up to five peak-hour trains from Penn Station to Grand Central Terminal. This relocation will help relieve capacity constraints on the operation of four-train-per-hour One-Seat Ride service to and from Penn Station during peak hours.

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## **Operations Complexity**

L8 and L9 ("B"), which connect the LRS to the Main Line via Howard Beach and a portion of the Rockaway Beach Branch, were found to be more operationally complex than L1 and L2 ("A"), which have a direct connection between the LRS and the Main Line at Jamaica. One-Seat Ride service via L1 and L2 would operate primarily over a multitrack alignment, which would allow for operating flexibility during a potential service disruption or delay. The only operating constraint for these alternatives would be the single-track connection between the LRS and the Main Line at Jamaica. L8 and L9 would also operate over the multitrack portions of the Main Line. However, L8 and L9's operating flexibility would be more constrained because One-Seat Ride trains would need to transition between the LRS and the Rockaway Beach Branch via a single-track connection at Howard Beach. In addition, service along these alignments would need to be integrated with the LIRR Main Line's high traffic operations via a connection at White Pot Junction, which is west of Jamaica.

## **Engineering and Construction**

### **Construction Challenges**

The primary construction challenge of the feasible alternatives is the connection between the LRS and LIRR. All four alternatives were ranked equally for this criterion ("B"; see Exhibit A-4). As noted in the main body of the report, L1 and L2 would require a single-track connection between LRS and the Main Line in Jamaica. Construction would occur within LIRR's dense operating environment west of the Jamaica Station complex. The structure's design would need to identify footings and column locations that have minimal impact on the LIRR lay-up yard at Johnson Avenue and Jay Interlocking. In addition, the structure would cross the Van Wyck Expressway, which would require the construction of flyover structures above the Montauk and Atlantic Branches at Jamaica.

The LIRR/LRS connection for L8 and L9 would also pose a challenge for these alignments, namely the construction of single-track connection in the operating environment of the LRS and the NYCT's Rockaways service. In addition, rehabilitation of the Rockaway Beach Branch would require contaminated soils treatment, reclamation of right-of-way leased to or encroached upon by adjacent properties, rehabilitation of four undergrade crossings, and the replacement of a fifth crossing over the Montauk Branch.

**Exhibit A-4**  
**Feasible Alternatives**  
**Engineering and Construction Criteria Evaluation Ratings**

<b>Alignment</b>	<b>L1</b>	<b>L2</b>	<b>L8</b>	<b>L9</b>
<b>Engineering and Construction</b>				
Difficulty to build	B	B	B	B
Impact of other agencies' services	B	B	B	B
Available right-of-way/new right-of-way required	A	A	A	A
Capital cost (in millions of 1999 dollars)	\$ 325	\$ 361	\$ 443	\$ 479
Operating costs (in millions of 1999 dollars)	\$ 18	\$ 18	\$ 26	\$ 26
Implementation timeframe	B	B	B	B
Implementation risks and uncertainties	A	A	B	B
Vehicle design and operations complexity	C	C	C	C

### Impact of Other Agencies' Services

All four alternatives were ranked equally for the Impact of Other Agencies' Services criterion ("B") because of the overall need to coordinate construction with the AirTrain LRS and the LIRR to mitigate potential effects on service reliability. Alternatives L8 and L9 also require coordination with NYCT.

Construction would be coordinated with the LIRR and the LRS at Jamaica Station for the implementation of the LRS track connection for L1 and L2. For L8 and L9, construction would need to be coordinated with the LRS and NYCT for implementation of the LRS connection at Howard Beach. Rehabilitation of the Rockaway Beach Branch would need to be coordinated with the LIRR to minimize service impacts associated with construction of the Rockaway Beach-Main Line connection at White Pot Junction and the reconstruction of the bridge over the Montauk Branch.

### Available Right-of-Way/New Right-of-Way Required

All alternatives received the highest possible rating for the Available Right-of-Way/New Right-of-Way Required criterion because construction would occur within existing active transportation rights-of-way. As a result, no property acquisitions would be required, although encroachments by adjacent properties onto the Rockaway Beach Branch right-of-way would need to be removed.

### Capital and Operating Cost

Exhibit A-5 summarizes the feasible alternatives' order-of-magnitude capital and annual operating costs in base year 1999 dollars. L1 has the lowest capital cost of all of the alternatives (\$325 million) and L2

has the second lowest (\$361 million). As noted in the main body of the report, the primary features of these alignments would be the construction of the Jamaica LIRR/LRS connection, installation of CBTC, and procurement of the One-Seat Ride vehicle fleet. In contrast, L8 and L9 would require a complete rehabilitation of the Rockaway Beach Branch between Howard Beach and White Pot Junction. In addition, L8 and L9 feature a larger fleet size than L1 and L2 because of their relatively longer route length. As a result, L8 and L9 have the highest capital cost among the alternatives (\$443 million and \$479 million, respectively, in 1999 dollars). L2 has a slightly higher capital cost than L1 because of \$36 million in additional expenses associated with installation of CBTC through Harold Interlocking and the East River Tunnels to Penn Station. (L1 would use the 63rd Street Tunnel to Grand Central Terminal and would not pass through Harold Interlocking or the East River Tunnels.)

L1 and L2 have the lowest annual operating costs (\$18 million for both in 1999 dollars). In contrast, L8 and L9 each have an annual operating cost of \$26 million in 1999 dollars. The higher operating cost for the Rockaway Beach Branch-based L8 and L9 alternatives is attributable to their longer operating times between JFK Airport and Manhattan and the greater amount of right-of-way requiring maintenance compared to L1 and L2.

**Exhibit A-5**  
**Feasible Alternatives**  
**Total Capital and Annual Operating Costs**  
 (in millions of 1999 dollars)

Alternative	Capital Cost				Annual Operating and Maintenance
	Construction (1)	CBTC (2)	Vehicles (3)	Total	
L1	\$133.0	\$65.0	\$127.0	\$325.0	\$18.0
L2	\$133.0	\$101.0	\$127.0	\$361.0	\$18.0
L8	\$250.0	\$47.0	\$146.0	\$443.0	\$26.0
L9	\$250.0	\$83.0	\$146.0	\$479.0	\$26.0

1. Construction costs do not include maintenance facilities, property acquisitions, or terminal modifications
2. Up to an additional \$245 million would be required to retrofit the existing LIRR fleet for CBTC operation
3. L1 and L2 require 32 cars to maintain 15 minute headway; L8 and L9 require 40 cars

### Implementation Timeframe

Initiation of One-Seat Ride service for all alternatives depends on the completion of East Side Access. As a result, all of the alternatives received the same "B" rating for the Implementation Timeframe criterion. For L1 and L8, East Side Access provides the physical route required to serve Grand Central Terminal. For L2 and L9, the completion of East Side Access will allow the relocation of up to five peak-hour trains, freeing up capacity to permit operation of One-Seat Service into Penn Station. East Side Access is expected to be completed by 2011.

## Implementation Risks and Uncertainties

L1 and L2, which were rated “A” for the Implementation Risks and Uncertainties criterion, do not appear to present significant challenges that would adversely affect the project’s implementation. As noted in the main body of the report, construction for these alternatives requires close coordination with LIRR and the New York State Department of Transportation (NYSDOT) to ensure the continuing smooth flow of trains through Jamaica and motor vehicles along the Van Wyck Expressway. In contrast, L8 and L9 were rated “B” because of potential community impacts associated with the reconstruction and operation of the Rockaway Beach Branch, such as removing right-of-way encroachments of adjacent property owners, short-term construction activity effects on nearby residences and businesses, potential short-term traffic effects associated with the reconstruction of four over-grade Rockaway Branch bridges crossing local streets, and longer-term impacts associated with reintroducing train service in adjacent communities and through Forest Park. These environmental and community effects are described later in this appendix.

## Vehicle Design, Operations, and Complexity

All of the alternatives, which were rated a “C” for the Vehicle Design, Operations, and Complexity criterion, would use the same LIRR/LRS-compatible vehicle technology described in the main body of the report. The One-Seat Ride vehicle would need to meet both LRS and LIRR’s physical, operating, and regulatory requirements. Based on conservative assumptions, the consultant team concluded that One-Seat Ride service over the FRA-regulated LIRR and non-FRA regulated LRS systems, although complex, can be achieved.

## Market Access and Competitiveness

Exhibit A-6 presents the market access and competitiveness evaluation criteria ratings for the feasible alternatives.

**Exhibit A-6**  
Feasible Alternatives  
Market Access and Competitiveness Criteria Evaluation Ratings

Alignment	L1	L2	L8	L9
<b>Market Access/Competitiveness</b>				
Travel time (average to/from 42nd St., in minutes)	34	37	41	43
New daily riders in 2020 (increase over 15,170 AirTrain riders)	2,200	2,110	1,780	1,730

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## **Travel Time to 42nd Street**

Travel times were calculated between JFK Airport and 42nd Street, the closest major cross street to the focal point, or centroid, of Manhattan trip origins and destinations south of 72nd Street. The centroid was calculated at 45th Street between 5th and 6th Avenues and corresponds to the concentration of Manhattan trips tourists and business travelers make.

L1 and L2, which provide service between Manhattan and JFK Airport via a Jamaica LIRR/LRS connection, have the fastest average travel times to 42nd Street—34 minutes via Grand Central Terminal for L1 and 37 minutes via Penn Station for L2. Travel via a Howard Beach to Rockaway Beach Branch LIRR/LRS connection would take up to nine minutes longer (L8 is 41 minutes via Grand Central Terminal; L9 is 43 minutes via Penn Station). The travel times via Howard Beach are almost the same as equivalent travel times to 42nd Street for a two-seat LIRR/AirTrain service with a transfer at Jamaica (estimated at 40 minutes via Grand Central Terminal and 44 minutes via Penn Station).

Travel times via Penn Station include five minutes of access time to 42nd Street. This access time reflects walk access to the Broadway/Seventh Avenue subway lines and travel between the 34th Street and 42nd Street stations.

## **New Daily Riders in 2020**

Estimates of average daily ridership for the One-Seat Ride alternatives based in 2020 were developed using a modified version of the Port Authority's airport access travel demand model. The forecasts also reflect the service characteristics of the One-Seat Ride alternatives, the baseline transit and highway network (including the Port Authority's AirTrain service), regional socioeconomic conditions, and baseline work and nonwork travel as MTA has defined them.

The four recommended alternatives would increase daily ridership by 11.4 to 14.5 percent compared to two-seat AirTrain service alone. Exhibit A-7 summarizes daily ridership by market component for each alternative and highlights the number of new daily riders compared to the baseline two-seat ride.

**Exhibit A-7**  
**Feasible Alternatives**  
**2020 Daily Ridership**

<b>Alignment</b>	<b>L1</b>	<b>L2</b>	<b>L8</b>	<b>L9</b>
One-Seat Riders	11,070	11,460	10,500	10,880
Two-Seat Riders	6,300	5,820	6,450	6,020
Total Ridership	17,370	17,280	16,950	16,900
AirTrain Base	15,170	15,170	15,170	15,170
New Riders	2,200	2,110	1,780	1,730
% New Riders	14.5%	13.9%	11.7%	11.4%

## Environmental and Community Impacts

L1 and L2 are expected to have the fewest community and environmental impacts because One-Seat Ride service would be constructed and operated within existing transportation rights-of-way. As a result, these alternatives received an “A” rating for each environmental and community evaluation criterion (see Exhibit A-8). In contrast, reconstruction and reactivation of the Rockaway Beach Branch for L8 and L9 are expected to have some impacts, including:

- **Private Property Takings (L8/L9: “C”).** Temporary construction easements may be required for work along activated portions of the Rockaway Beach Branch. Encroachments by adjacent properties onto the Rockaway Beach Branch right-of-way must also be removed.
- **Residential Land Use Impacts (L8/L9: “D”).** 3,900 residential lots are estimated to be within 200 feet of portions of the Rockaway Beach Branch that would be reactivated.
- **Parkland Impacts (L8/L9: “D”).** 3,200 feet of Rockaway Beach Branch right-of-way that would be re-activated is located in Forest Park. In addition, a portion of right-of-way through the park is adjacent to Little League properties.
- **On-/Off-Airport Road Impacts (All Alternatives: “A”).** Construction and operation of the alternatives would not significantly affect the highway network serving JFK Airport. As noted earlier, placement of footings and column locations would need to be coordinated with NYSDOT for the portion of the LIRR/LRS connection crossing over the Van Wyck Expressway.

**Exhibit A-8**  
**Feasible Alternatives**  
**Environmental and Community Impacts Criteria**  
**Evaluation Ratings**

<b>Alignment</b>	<b>L1</b>	<b>L2</b>	<b>L8</b>	<b>L9</b>
<b>Environmental and Community Impacts</b>				
Extent of private property takings	A	A	C	C
Extent of adjacent residential land use impact	A	A	D	D
Extent of parkland impact	A	A	D	D
Extent of on- and off-airport road impact	A	A	A	A



# Appendix B

## Final Feasibility Analysis Findings, Infeasible Alternatives

### Introduction

This appendix describes the final feasibility analysis findings for the four final alternatives that were found to be infeasible.

Of the 40 alternatives analyzed in the JFK One-Seat Ride Feasibility Study, eight were carried through the last study phase. Based on the technical analyses and evaluation performed in the final feasibility analysis, four alternatives—S7, S23, L5, and L11—were found to be infeasible, as summarized in exhibits B-1 and B-2. (See Appendix A for a description of the four feasible alternatives and Appendix C for a summary of all 40 alternatives initially defined in the study.)

**Exhibit B-1**  
Infeasible Alternatives  
Alignment Features

Alignment	Connection to LRS	Route Through Queens	Route Into Manhattan	CBD Terminus
S7	Howard Beach	Rockaway Beach Branch-Montauk Branch	Upper Level 63rd Street Tunnel / 6th Avenue Line	2nd Avenue with major stops at 42nd and 34th Streets
S23	Jamaica	Montauk Branch	Upper Level 63rd Street Tunnel / 6th Avenue Line	2nd Avenue with major stops at 42nd and 34th Streets
L5	Jamaica	Montauk Branch	East River Tunnels	Penn Station
L11	Howard Beach	Rockaway Beach Branch-Montauk Branch	East River Tunnels	Penn Station

All four alternatives were found to be infeasible due to significant construction difficulties and high capital costs. All four include the LIRR Montauk Branch (as opposed to the LIRR Main Line) for some part of their right-of-way. The complications of modifying the Montauk Branch and the resulting limitations of its use even after modification combine to create insurmountable difficulties to building and operating a reliable service.

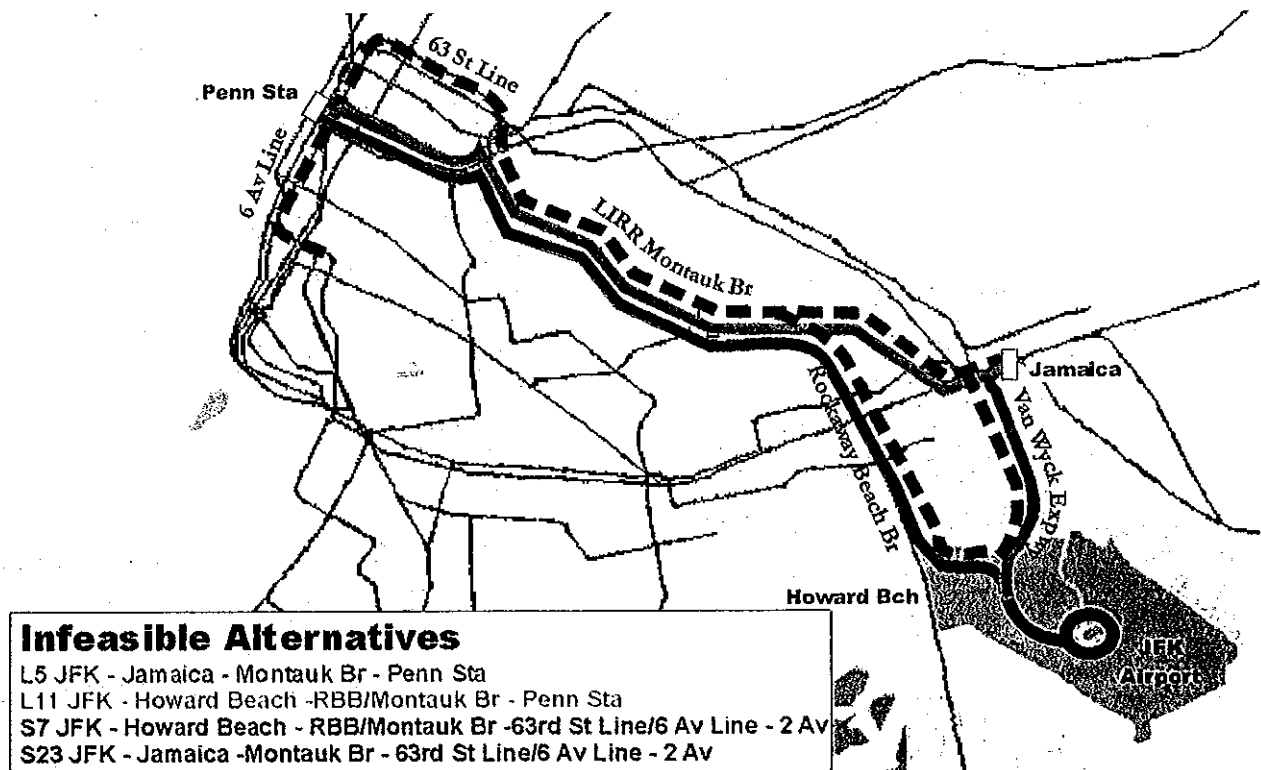
Connections between the Montauk Branch and the East River, or 63rd Street tunnels, would require the construction of two new 1.3-mile single-track tunnels that could adversely affect LIRR and NYCT operations through a critical choke point in their respective systems. The need for these tunnel

connections contributed to these alternatives' high estimated capital cost of about \$2.0 billion. Increased service along the Montauk Branch and service reactivation along the Rockaway Beach Branch would affect adjacent residential properties and parklands, particularly within Forest Park.

In addition, the need for single-track operations along portions along the Montauk Branch would severely affect the operating feasibility of subway-based alternatives S7 and S23 by limiting operating flexibility and affecting reliability. Intermixing 4-car One-Seat Ride trains with full length 8-10 car NYCT trains would further compromise the operational reliability of these two alternatives. Passengers would bunch up where both long and short trains stop, increase boarding time by waiting in the wrong location, and crowd onto the shorter trains. This would increase station dwell times.

The following section of this appendix describes in greater detail the factors that contributed to the infeasible finding for NYCT-based alternatives S7 and S23. This is followed by an analysis of the infeasible features of LIRR-based alternatives L5 and L11.

**Exhibit B-2**  
Infeasible Alignment Alternatives



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## NYCT Alternatives S7/S23

S7 and S23 would require significant modification to portions of the Montauk Branch to facilitate a side-by-side NYCT-based One-Seat Ride and freight/LIRR passenger rail service. These alignments also call for the construction of a new tunnel connection between the Montauk Branch and the upper level of the 63rd Street Tunnel. These construction features contributed to the infeasible finding for S7 and S23.

### Montauk Branch Single-Track Operating Constraints

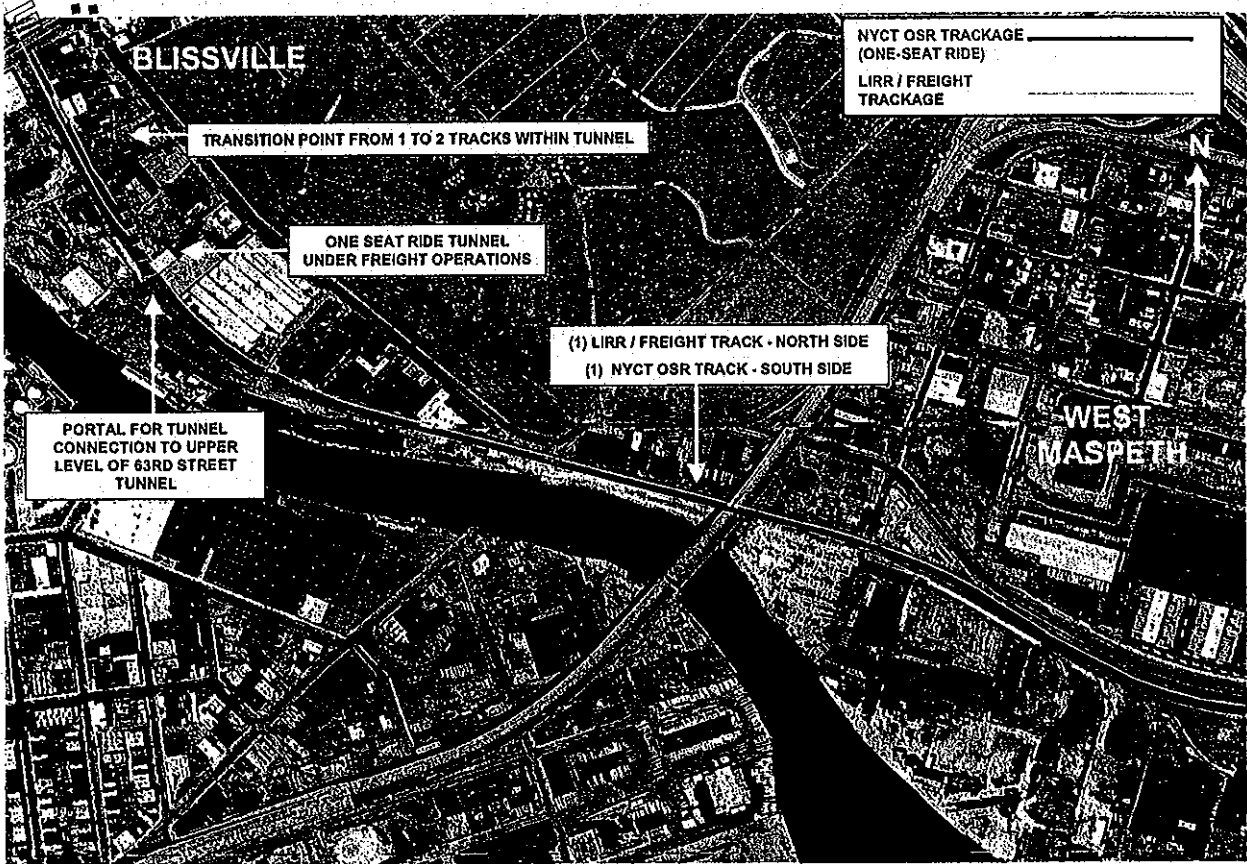
To accommodate an NYCT-based One-Seat Ride operation, the Montauk Branch would need to be separated into exclusive rights-of-way for the One-Seat Ride and any LIRR passenger or New York and Atlantic Railroad (NY&AR) freight operations. However, right-of-way constraints and the need to maintain NY&AR access to freight customers limits the ability to provide a consistent two-track operation for both the One-Seat Ride and the LIRR/NY&AR along the entire alignment. As a result, operations would be limited to a single track for a total of 4.3 miles at the following locations from east to west:

- From Jamaica through Richmond Hill (and over the Richmond Hill viaduct) to east of the point where the Montauk Branch enters Forest Park (1.4 miles)
- From the west end of Forest Park to Glendale (1.6 miles)
- From the west end of Maspeth to the east end of Maspeth Yard (0.5 miles)
- From the west end of Maspeth Yard to the tunnel portal for the Montauk Branch-63rd Street Tunnel (0.9 miles)

These single-track sections are highlighted in Exhibits B-3 through B-10.

The number and extent of single-track operations would severely limit operational flexibility and jeopardize service reliability. Single-track operations allow only one train to travel along the single track, while a train operating in the opposite direction needs to be scheduled so it does not enter the single track section until the first train clears it. If the first train is late, then the second train must wait at a passing siding until the first train leaves the single-track section. Single-track operations are common in low frequency, slow speed operating environments, but are atypical for a high frequency, express service like the One-Seat Ride. Given the number of single-track sections and the four-train-per-hour One-Seat Ride service frequency, one delayed train would have an adverse ripple effect on both eastbound and westbound operating reliability.

Exhibit B-3  
Blissville/West Maspeth



**Exhibit B-4  
Maspeth Yard**

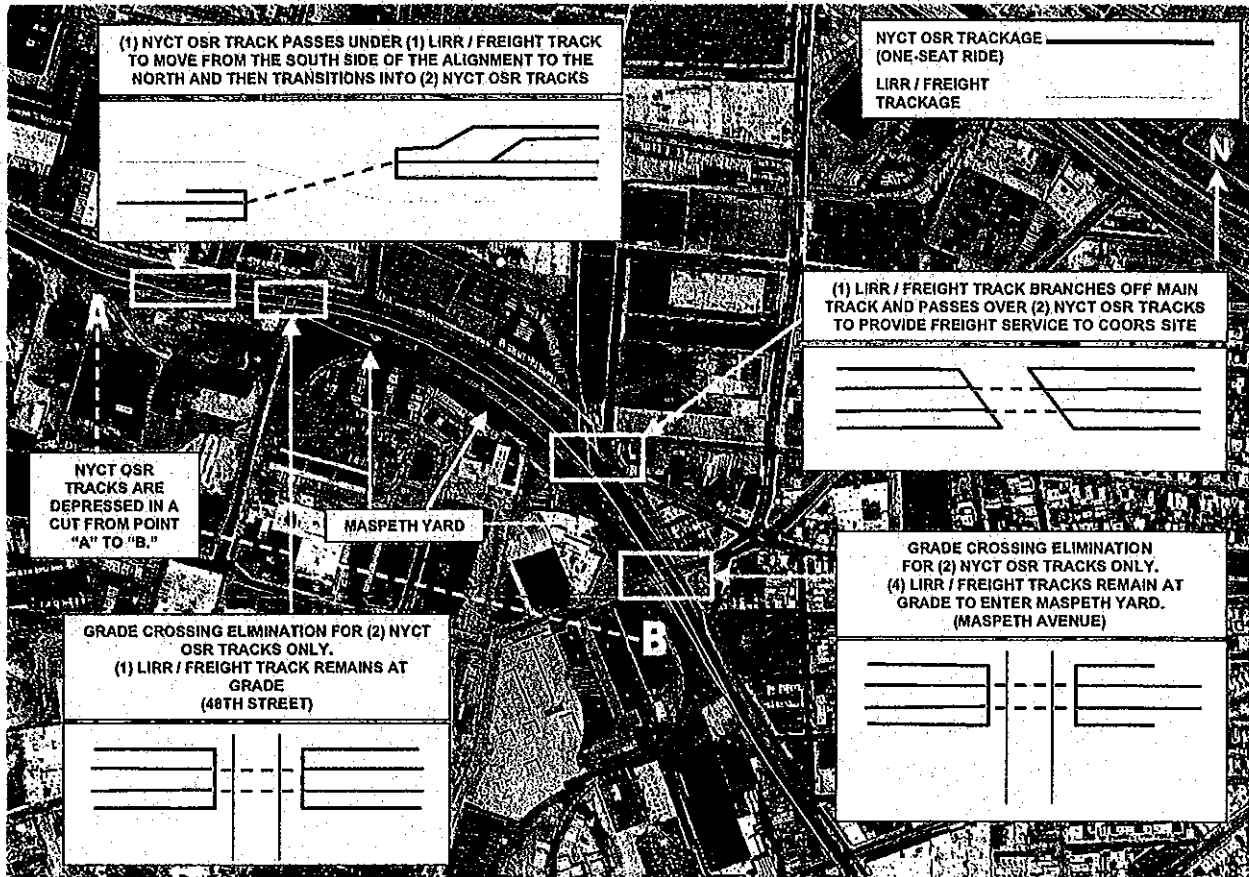


Exhibit B-5

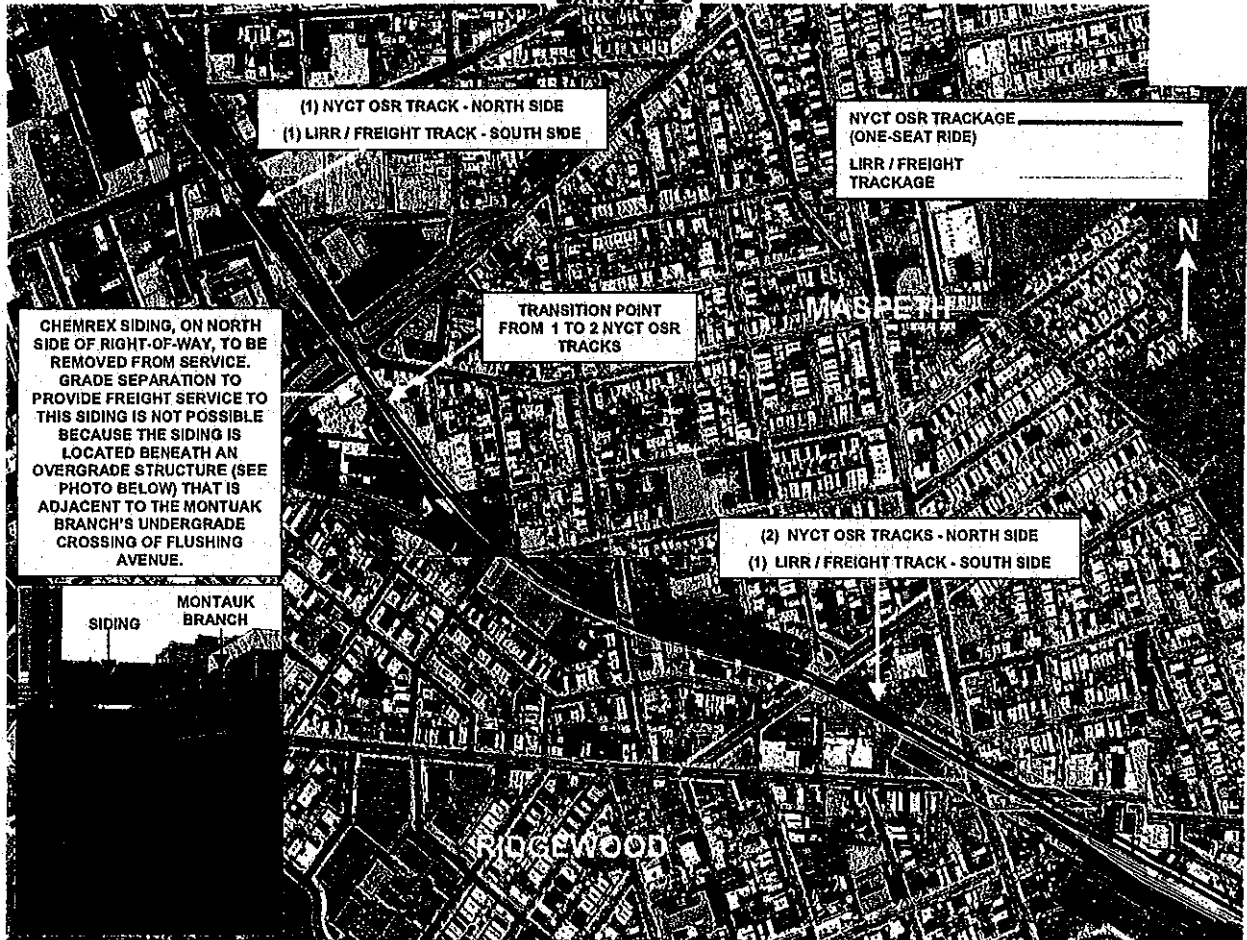


Exhibit B-6  
Fresh Pond

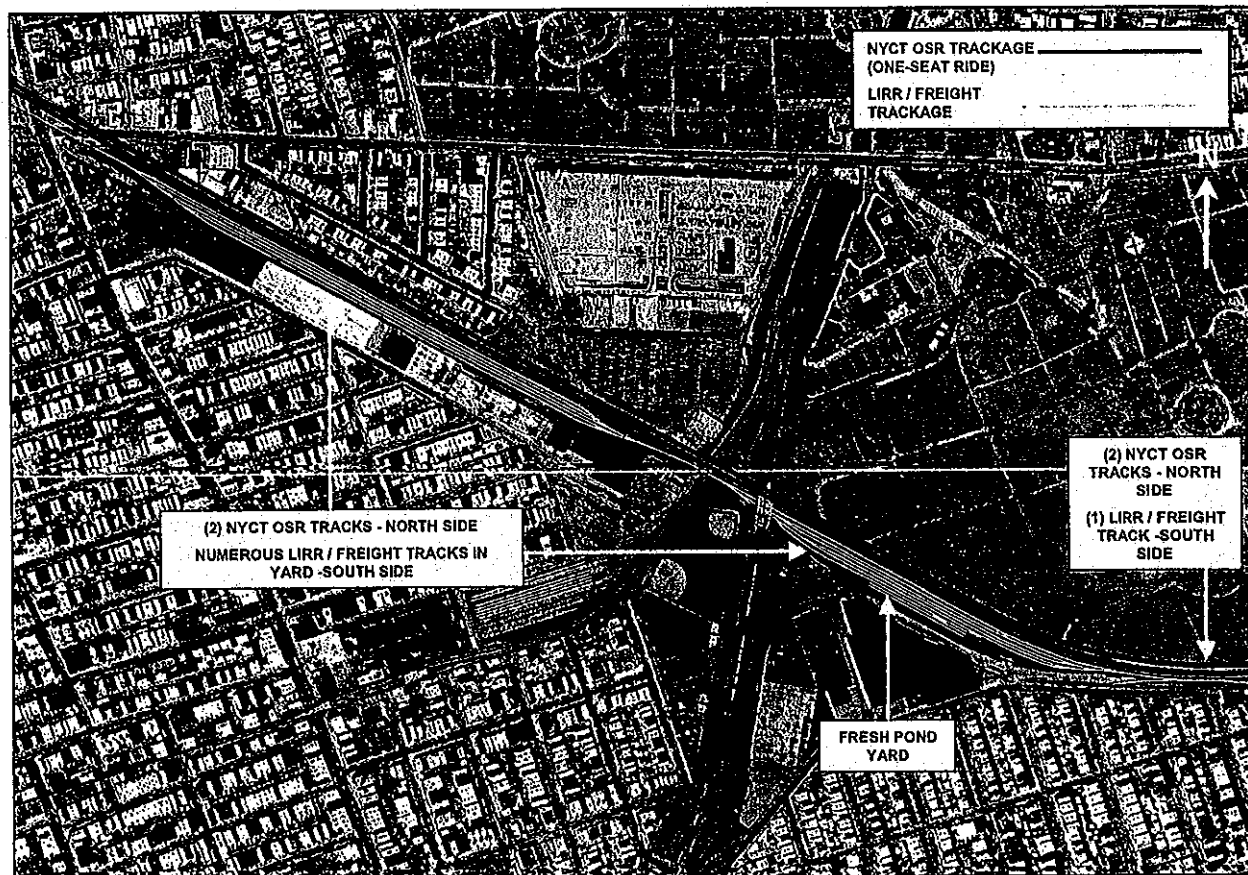


Exhibit B-7  
Glendale

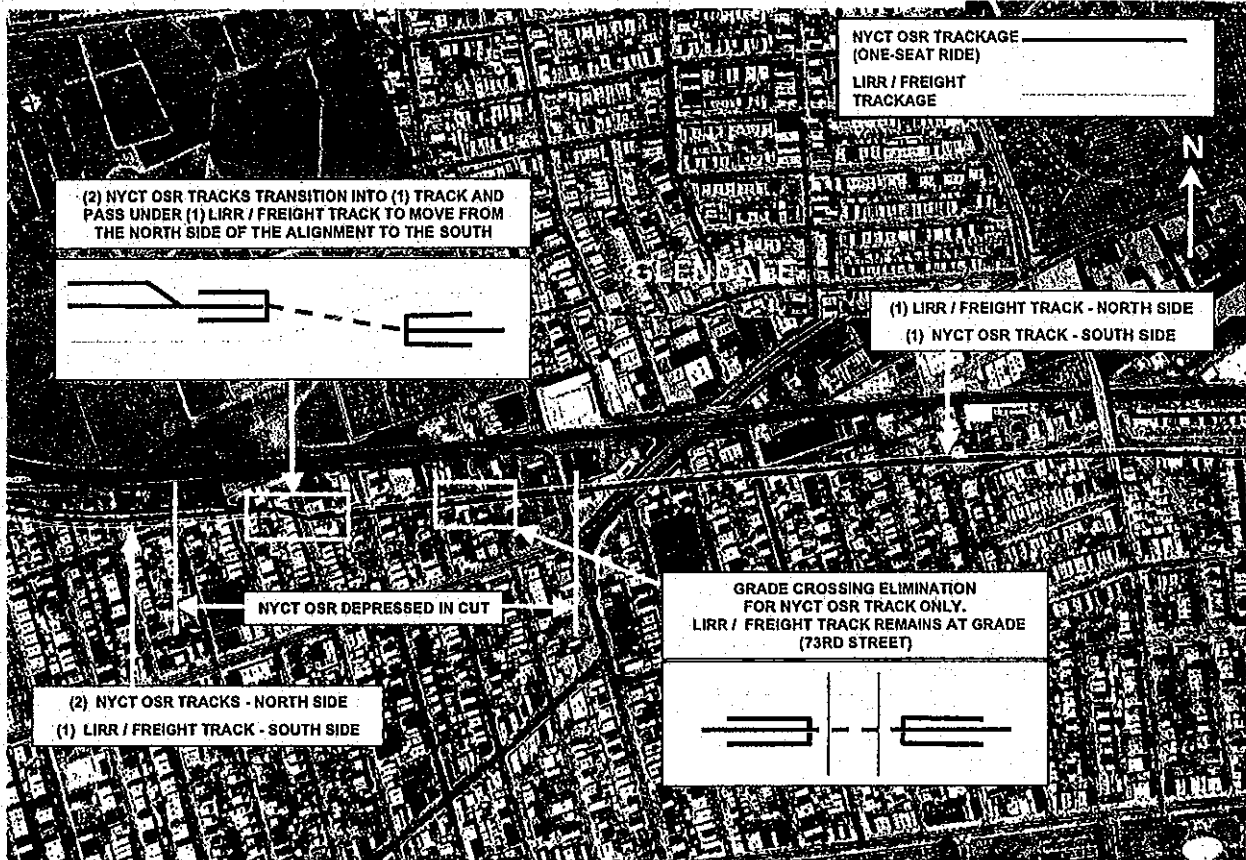




Exhibit B-8  
Glendale to Forest Park

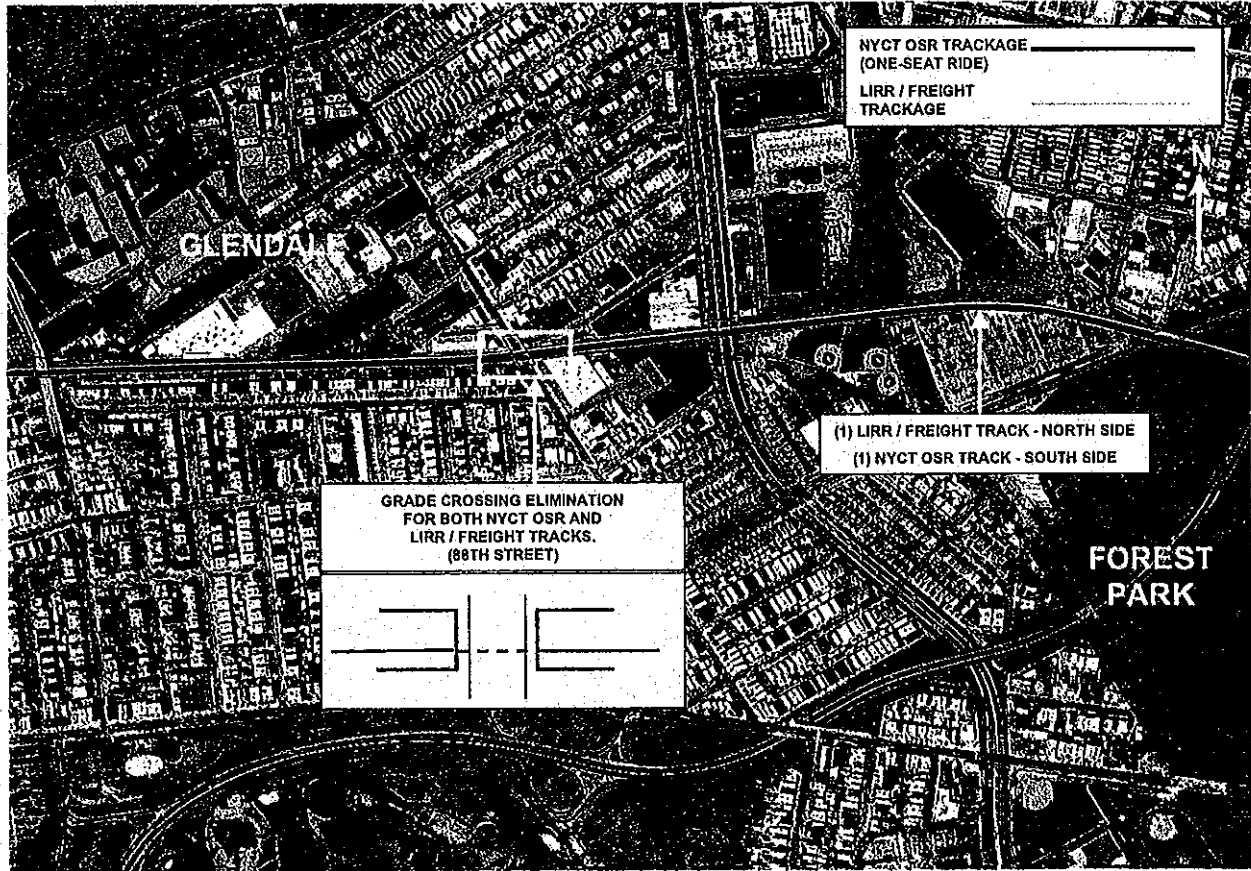
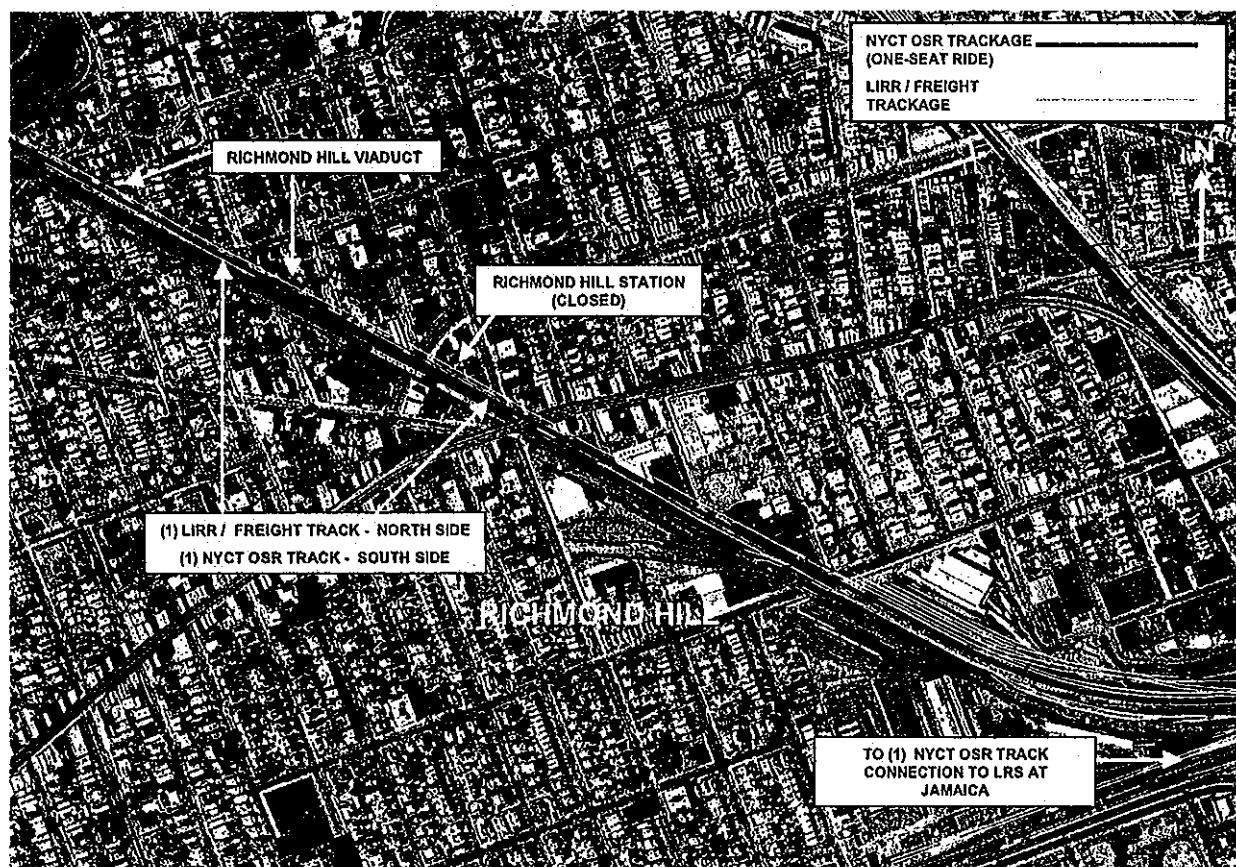


Exhibit B-9  
Forest Park



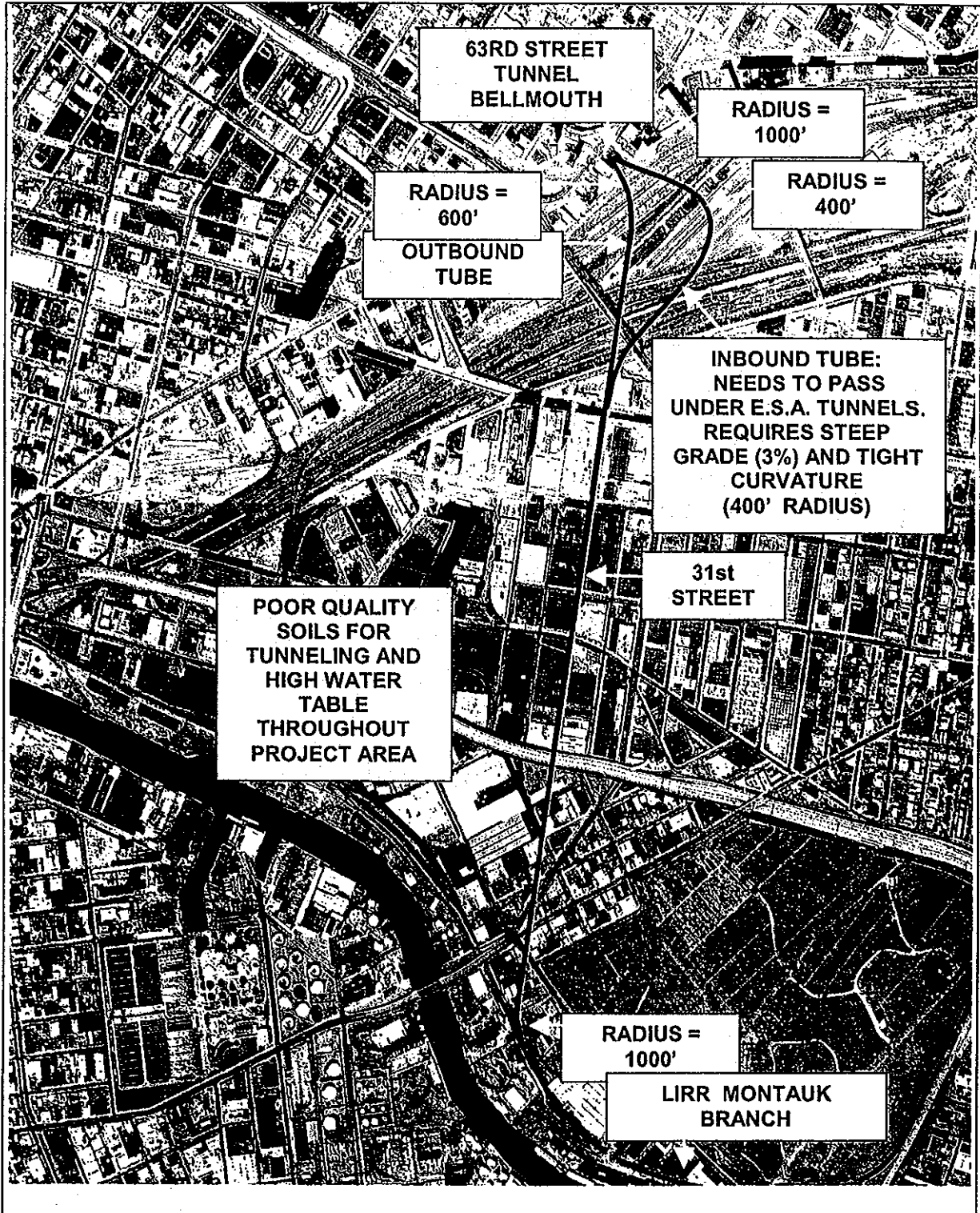
**Exhibit B-10**  
**Richmond Hill**



**Montauk Branch-63rd Street Tunnel Connection Civil Construction Difficulties**

A two-track, 1.3-mile tunnel would be required to connect the Montauk Branch in Long Island City with the upper level of the 63rd Street Tunnel. The two-track alignment must ramp down into a cut and enter bored tunnels just east of Greenpoint Avenue (see Exhibit B-11). The tunnels then must curve to the right and head north under 31st Street toward Sunnyside Yard to meet the upper level of the 63rd Street Tunnel.

Exhibit B-11  
S7/S23 Montauk Branch-63rd Street Tunnel Connection



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The complicated layout required for this tunnel connection would make it impractical to construct. The One-Seat Ride inbound track would be required to dive below the planned East Side Access tunnels at a steep grade and a very tight radius to reach the other side. The track would then rise to the same level as the NYCT structure, where it would merge. The alignment would need to be controlled by the lengths of tunnel needed to accommodate these significant elevation changes without exceeding maximum profile grades. In addition, most of the tunnel alignment is in very poor soft ground, beneath the water table (including beneath the Dutch Kills). Because the inbound connection tunnel must dive below the ESA tunnels before rising to the upper level of the 63rd Street Tunnel connector, this bore would also include a zone of mixed-face or rock tunneling.

## Other Impacts

In addition to the single-track operating constraints and Montauk Branch-63rd Street Tunnel connection civil construction difficulties, other factors contributed to the infeasible finding for S7 and S23, including:

- **Extensive Property Takings Along 31st Street.** Construction of the two-track, 1.3-mile Montauk Branch-63rd Street Tunnel connection would occur outside existing rail rights-of-way. The alignment would generally follow 31st Street in Long Island City. A number of residential and industrial properties would be affected or acquired to accommodate this new construction east of Greenpoint Avenue where the tunnel meets the Montauk Branch. The construction staging and material lay-down area would be located in this area. Additional property would likely need to be taken for a ventilation shaft near 31st Street and Hunterspoint Avenue.
- **Montauk Branch Flyovers to Maintain Access to Freight Sidings.** NYCT-based One-Seat Ride service would need to be completely separated from LIRR passenger and NY&AR freight services to maintain safe operation and meet FRA regulatory requirements. However, construction of a side-by-side operation would need to preserve rail access for the NY&AR's freight customers. Since these customers are on both the north and south sides of the Montauk Branch, the NYCT-based One-Seat Ride tracks would need to fly over the LIRR/NY&AR tracks at two locations. The first is at Maspeth Yard, where the One-Seat Ride tracks would transition from the south side to the north side of the Montauk Branch, and at Glendale, where the One-Seat Ride would transition back to the south side of the Montauk Branch.
- **Increased Use of the Rockaway Beach and Montauk Branches Through Forest Park.** Within Forest Park, the One-Seat Ride would require reactivating the Rockaway Beach Branch right-of-way (S7) and the addition of two tracks within the existing Montauk Branch right-of-way (S7 and S23). S7 and S23 would require the reactivation or increased use of an estimated 3,200 and 4,800 feet of existing rail right-of-way within the park, respectively. In addition, a four-train-per-hour service frequency would greatly increase the volume of trains operating through the park.

- **Montauk and Rockaway Beach Branch Residential Impacts.** Increased use of the Montauk Branch will affect an estimated 1,500 residential units within 200 feet of the right-of-way. Reactivation of the Rockaway Beach Branch for S7 would affect about 2,100 residential units with 200 feet of the right-of-way, in addition to the affected properties along the Montauk Branch.
- **Montauk Branch Grade Crossing Elimination.** Construction of NYCT-based One-Seat Ride service would also require eliminating four grade crossings along the Montauk Branch between the Rockaway Beach Branch and Greenpoint Avenue. The grade crossings would be eliminated by depressing the Montauk Branch using retained cuts, and putting in new overgrade crossings. The grade crossing at 43rd Street would also need to be replaced with a new track connection to a nearby industrial complex. This construction would affect traffic passing through the grade crossings and nearby residential properties.

## Costs and Benefits

Given their civil construction needs and difficulties, S7 and S23 have the highest capital costs of all of the alternatives, \$2.03 billion and \$2.02 billion in 1999 dollars, respectively (see Exhibit B-12). The estimated \$1.34 billion required to construct the Montauk Branch-63rd Street Tunnel connection accounts for most of these costs. S7 has a higher annual operating and maintenance cost than S23. This is because of the amount of right-of-way to be maintained and miles of operation are greater for S7 than for S23.

**Exhibit B-12**  
S7 and S23 Total Capital and Annual Operating and Maintenance Costs  
(in millions of 1999 dollars)

Alternative	Montauk Branch-63rd Street Tunnel Connection	Other Civil Requirements	Vehicles	Total Capital Cost	Annual Operating and Maintenance Costs
S7	\$1,340	\$529	\$161	\$2,030	\$23
S23	\$1,340	\$515	\$161	\$2,016	\$19

The average one-way travel time to or from 42nd Street for either S7 or S23 is 46 minutes, due primarily to slower speeds required on the single-track sections of the Montauk Branch and the lower top operating speed on the NYCT system. This travel time is slower than that of any of the six LIRR-based alternatives in the final feasibility analysis phase, where travel times range from 34 to 43 minutes. These alternatives are also slower than the baseline two-seat ride alternative (40 minutes via Grand Central Terminal and 44 minutes via Penn Station).

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NYCT-based alternatives S7 and S23 would attract 700-750 more daily riders than the LIRR-based recommended alternative L2, or about 2,800-2,860 more daily riders than a baseline two-seat ride AirTrain service. This is because the NYCT-based alternatives have multiple stops in Manhattan rather than a single terminus at Penn Station. However, the more than \$2 billion capital cost to construct either subway-based alternative to attract these additional 700-750 riders would be 5.6 times the \$361 million cost of alternative L2.

In summary, alternatives S7 and S23 were determined to be infeasible due to construction difficulties, operating feasibility issues, and the fact that their increased potential ridership is insufficient to offset their large additional capital costs.

## **LIRR Alternatives L5/L11**

L5 and L11 were determined to be infeasible due to the significant construction difficulties of a required connection between the Montauk Branch and East River tunnels. In addition, these alternatives would affect adjacent communities due to increased service levels on the Montauk Branch and, in the case of L11, the reintroduction of service on the Rockaway Beach Branch.

### **Montauk Branch-East River Tunnel Connection Civil Construction Difficulties**

As with S7 and S23, L5 and L11 would require a 1.3-mile tunnel connection between the Montauk Branch and the East River tunnels. From the Montauk Branch, the connection would ramp down into a cut and enter bored tunnels just east of Greenpoint Avenue. Twin tunnels would then curve to the right and head north under 30th Street toward Sunnyside Yard (see Exhibit B-13). As the tunnels approach the yard, they would curve west underneath the Dutch Kills Canal and diverge to connect with the inbound and outbound tubes of the East River tunnels to reach Penn Station. The One-Seat-Ride tunnels would meet the East River tunnels west of the East River tunnels' portals. This would entail reconstructing the portal areas to incorporate underground turnouts in new flared cut-and-cover box structures.

Significant construction challenges affecting the feasibility of these alternatives include:

- **Impact on LIRR, Amtrak, and NJ Transit Services.** Construction of the One-Seat Ride connections to the East River Tunnel approaches would require the periodic removal of existing tracks from service and slow speed restrictions. These service disruptions would occur at a critical choke point in the region's rail network. As a result, this construction would have adverse systemwide impacts on LIRR, Amtrak, and NJ Transit.
- **Poor Soil Conditions.** As with S7 and S23, the connection would be constructed in poor soil conditions. Although cut-and-cover construction would minimize geotechnical construction risks

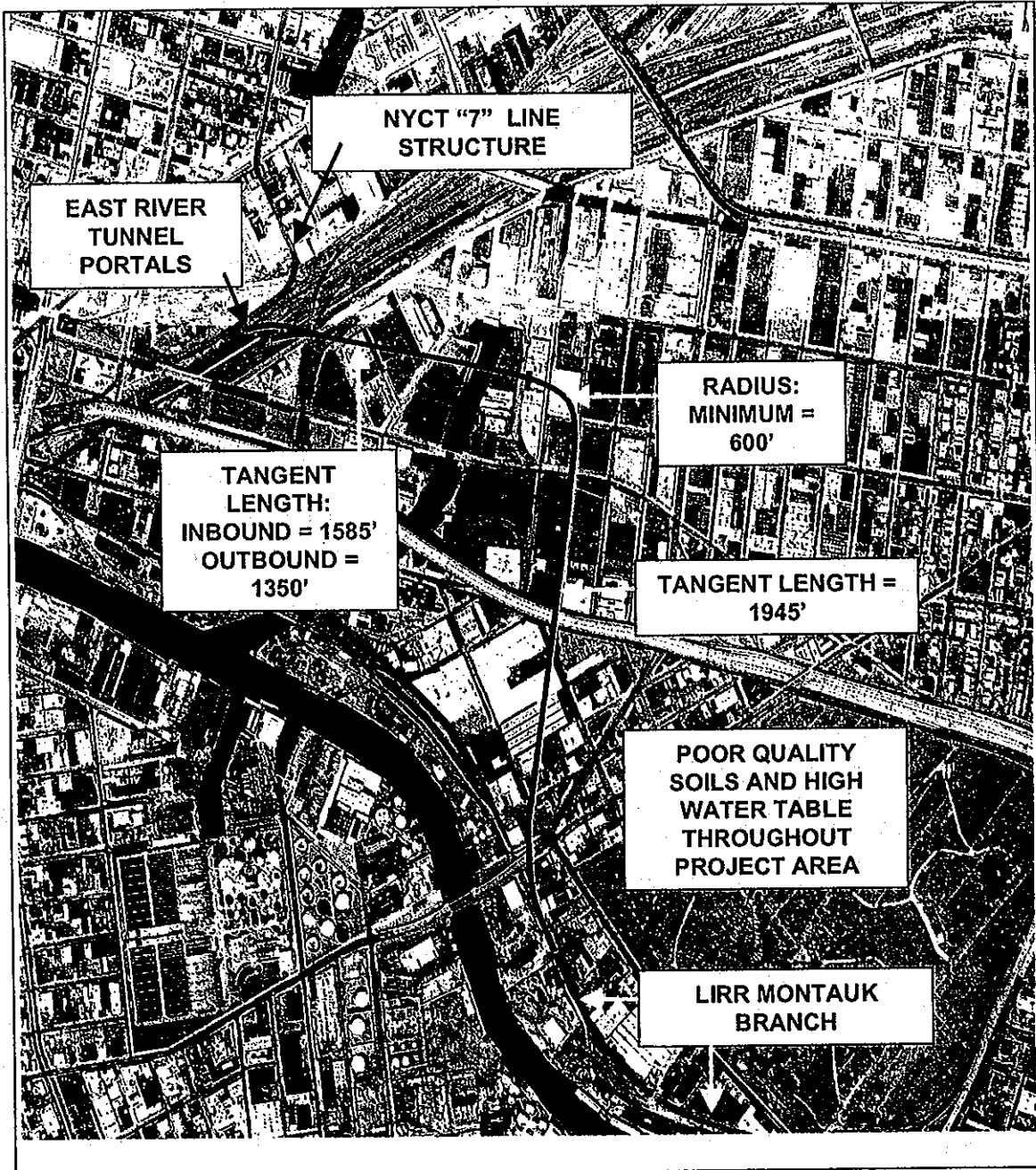
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in this area, it would necessitate costly acquisition of real estate, extensive surface and utility disruption, and major community impacts. Complex soil stabilization techniques such as injection grouting, use of deep wells to lower the groundwater level, or tunneling with compressed air may be required.

- **Potential NYCT Flushing Line Underpinning.** The northernmost leg of the tunnel connecting with the East River Tunnel Line 4 may require underpinning of the NYCT Flushing Line ("7") viaduct east of the Hunterspoint Station, which runs adjacent to the tunnel's portal. The underpinning of this structure would likely impact service on the Flushing Line.



Exhibit B-13  
L5/L11 Montauk Branch-East River Tunnel Connection



## Community Impacts

L5 and L11's construction and operation would have a number of community impacts. As with S7 and S23, increased use of the Montauk Branch and, in the case of L11, reactivation of the Rockaway Beach Branch would affect adjacent residential properties. Fifteen hundred residential units within 200 feet of the right-of-way would be affected on the Montauk Branch, 2,100 on the Rockaway Beach Branch. One-Seat Ride service via the Montauk and Rockaway Beach Branches would also call for the increased use of 3,200 to 4,800 feet of existing rail rights-of-way within Forest Park.

L5 and L11 would also require eliminating the same four grade crossings along the Montauk Branch called for in alternatives S7 and S23. Construction would affect nearby residential properties and traffic passing through the grade crossings.

## Costs and Benefits

L5 and L11 have the third- and fourth-highest capital costs, after S7 and S23 (see Exhibit B-14): \$1.98 billion and \$1.97 billion, respectively. This is primarily driven by the estimated \$1.3 billion cost to construct the 1.3 mile Montauk Branch-East River Tunnel Connection. Annual operating costs for both alternatives are estimated at \$23 million (in 1999 dollars).

**Exhibit B-14**  
L5 and L11 Total Capital and Annual Operating and Maintenance Costs  
(in millions of 1999 dollars)

Alternative	Montauk Branch-East River Tunnel Connection	Other Civil Requirements	Vehicles	Total Capital Cost	Annual Operating and Maintenance Costs
L5	\$1,340	\$515	\$127	\$1,982	\$23
L11	\$1,340	\$529	\$127	\$1,996	\$23

The estimated average one-way travel time between JFK Airport and 42nd Street for alternative L5 is 38 minutes, while for L11 it is 37 minutes. These travel times are comparable to the feasible alternatives L1, L2, L8, and L9. Additional daily ridership over a baseline two-seat ride AirTrain service is also comparable to the feasible alternatives, at about 2,020-2,120 more riders per day. However, the almost \$2 billion capital cost of these alternatives would be 5.5 times the \$361 million cost of recommended alternative L2.

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In summary, L5 and L11 were determined to be infeasible because these alternatives would have travel time and ridership benefits comparable to L1, L2, L8 and L9, but with significantly greater capital costs, construction difficulties, and community impacts.

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# Appendix C

## Fatal Flaw and Preliminary Feasibility Analyses Summary

### Introduction

This appendix lists the 40 alternatives initially defined in the study and summarizes the findings of the fatal flaw and preliminary feasibility analyses that resulted in the selection of the eight alternatives considered in the final feasibility analysis. (See appendices A and B for descriptions of the findings of the final feasibility analysis for the four feasible alternatives and the four infeasible alternatives, respectively.)

### One-Seat Ride Alternatives Considered and Initial Evaluation Results

#### Alternatives Defined

Based on discussions with MTA in consultation with the study's signatories, 40 alignment alternatives were developed and evaluated as part of the JFK One-Seat Ride Feasibility Study. These alignments' routings included the LRS serving JFK Airport; a connection between the LRS and the LIRR, or NYCT at either Jamaica or Howard Beach; and either an LIRR or NYCT route into Manhattan. Twelve of these alignments are LIRR-based, while 28 are NYCT-based. Specifically, the alternatives include:

- **Direct LIRR/LRS Connection at Jamaica.** This connection would allow LIRR trains from Penn Station, Grand Central Terminal, or Lower Manhattan (via a new link from the Atlantic Avenue Terminal in Brooklyn) to connect to the LRS system and continue on to JFK Airport. The alignments include:
  - L1: LRS/Jamaica-Main Line-63rd Street Tunnel-Grand Central Terminal
  - L2: LRS/Jamaica-Main Line-East River Tunnels-Penn Station
  - L3: LRS/Jamaica-Atlantic Branch-New Tunnel-Lower Manhattan
  - L4: LRS/Jamaica-Montauk Branch-63rd Street Tunnel-Grand Central Terminal
  - L5: LRS/Jamaica-Montauk Branch-East River Tunnels-Penn Station
  - L6: LRS/Jamaica-Montauk Branch-Rockaway Beach Branch-Main Line-63rd Street Tunnel-Grand Central Terminal
  - L7: LRS/Jamaica-Montauk Branch-Rockaway Beach Branch-Main Line-East River Tunnels-Penn Station

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- **New Rockaway Beach Branch Service via Howard Beach.** Restoration of service on the former LIRR Rockaway Beach Branch would allow either LIRR or NYCT airport service from several east-west routes to connect to the LRS at Howard Beach. The alignments include:

**LIRR-Based Alternatives:**

- L8: LRS/Howard Beach-Rockaway Beach Branch-Main Line-63rd Street Tunnel-Grand Central Terminal
- L9: LRS/Howard Beach-Rockaway Beach Branch-Main Line-East River Tunnels-Penn Station
- L10: LRS/Howard Beach-Rockaway Beach Branch-Montauk Branch-63rd Street Tunnel-Grand Central Terminal
- L11: LRS/Howard Beach-Rockaway Beach Branch-Montauk Branch-East River Tunnels-Penn Station
- L12: LRS/Howard Beach-Rockaway Beach Branch-Atlantic Branch-New Tunnel-Lower Manhattan

**NYCT-Based Alternatives:**

- S1: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Queens Boulevard Line-53rd Street Tunnel-6th Avenue Line
- S2: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Queens Boulevard Line-53rd Street Tunnel- 8th Avenue Line
- S3: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Queens Boulevard Line-60th Street Tunnel-Broadway Line
- S4: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Queens Boulevard Line-63rd Street Tunnel-Broadway Line
- S5: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Queens Boulevard Line-63rd Street Tunnel-6th Avenue Line
- S6: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Montauk Branch-63rd Street Tunnel-Broadway Line
- S7: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Montauk Branch-63rd Street Tunnel-6th Avenue Line
- S8: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-New Line along LIRR Main Line right-of-way-63rd Street Tunnel-Broadway Line

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- S9: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-New Line along LIRR Main Line right-of-way-63rd Street Tunnel-6th Avenue Line
  - S10: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-New Line along LIRR Main Line right-of-way-60th Street Tunnel-Broadway Line
  - S11: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Atlantic Branch-Montague Street Tunnel-Broadway Line
  - S12: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Atlantic Branch-Manhattan Bridge-6th Avenue Line
  - **Extension of LaGuardia Airport Subway Line.** A concept under separate study by NYCT is the extension of the Astoria subway line (the "N" route) to LaGuardia Airport. This alignment would extend LaGuardia Airport trains east and south to the Jamaica LRS station.
    - S13: LRS/Jamaica-LaGuardia Airport-19th Avenue-60th Street Tunnel-Broadway Line
  - **Direct NYCT/LRS Connection at Howard Beach.** This connection would allow NYCT service along the Fulton Street Line (the "A" route) to connect to the LRS and continue to JFK Airport. The alignment alternatives include:
    - S14: LRS/Howard Beach-Rockaway "A" Line-Fulton Street "A" Line-Rutgers Street Tunnel-6th Avenue Line
    - S15: LRS/Howard Beach-Rockaway "A" Line-Fulton Street "A" Line-Rutgers Street Tunnel-8th Avenue Line
    - S16: LRS/Howard Beach-Rockaway "A" Line-Fulton Street "A" Line-Cranberry Street Tunnel-6th Avenue Line
    - S17: LRS/Howard Beach-Rockaway "A" Line-Fulton Street "A" Line-Cranberry Street Tunnel-8th Avenue Line
  - **Additional Alternatives.** The JFK One-Seat Ride Feasibility Study also considered the following other NYCT alternatives:
    - S18: LRS/Howard Beach-New Conduit Avenue Link-Fulton Street "A" Line-Cranberry Street Tunnel-8th Avenue Line
    - S19: LRS/Howard Beach-Fulton Street "A" Line-Canarsie Line-14th Street
    - S20: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Jamaica Avenue Line-6th Avenue Line
    - S21: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Jamaica Avenue Line-8th Avenue Line

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- S22: LRS/Jamaica-Montauk Branch-63rd Street Tunnel-Broadway Line
  - S23: LRS/Jamaica-Montauk Branch-63rd Street Tunnel-6th Avenue Line
  - S24: LRS/Jamaica-Queens Boulevard Line-53rd Street Tunnel-8th Avenue Line
  - S25: LRS-New Liberty Avenue right-of-way-Fulton Street "A" Line-Cranberry Street Tunnel-8th Avenue Line
  - S26: LRS/Jamaica-Jamaica Avenue Line-Williamsburg Bridge-6th Avenue Line
  - S27: LRS/Jamaica-Jamaica Avenue Line-Williamsburg Bridge-8th Avenue Line
  - S28: LRS/Howard Beach-New Conduit Avenue right-of-way-New Lots Avenue Line-Clark Street Tunnel-7th Avenue Line

## Fatal Flaw and Preliminary Feasibility Analysis Evaluation Summary

To evaluate the feasibility of alignment and vehicle technology alternatives, MTA and its consultant team undertook engineering, operations planning, market assessment and ridership forecasting, and community impact analyses that were used to define and assess the options under consideration. A three-phase evaluation framework, which included a fatal flaw analysis, preliminary feasibility analysis, and final feasibility analysis, narrowed down the options under consideration to a preferred alternative. Specifically, these evaluation phases were:

- **Fatal Flaw Analysis.** This was used to identify and screen out alternatives with features that are technically or operationally infeasible or unacceptable.
- **Preliminary Feasibility Analysis.** The analysis was based on an initial technical assessment of the alternatives. Specifically, alternatives were evaluated based on their operations, engineering and construction, market access and competitiveness, and community impacts. The results of this effort were used to define a smaller list of alternatives that were carried forward into the final feasibility analysis.
- **Final Feasibility Analysis.** The final feasibility analysis was used to identify a recommended alternative from those advanced from the preliminary feasibility analysis. This analysis was based on the results of more detailed technical analyses that defined and assessed the alternatives based on evaluation categories similar to those used for the preliminary feasibility analysis. Alternatives were assigned a rating based on their performance relative to specific evaluation criteria. The recommended alternative was selected based on the results of this evaluation phase.

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The remainder of this section summarizes the results of the fatal flaw and preliminary analysis phases that led to the selection of the eight alternatives considered in the final feasibility analysis. The results of the final feasibility analysis phase are described in sections 3 and 4 and in appendices B and C of this report.

### **Fatal Flaw Analysis Results**

All 40 alternatives were evaluated against criteria that assessed their travel time relative to competitive modes; ability to accommodate four-train-per-hour (every fifteen minute) service frequency; operating compatibility with LIRR/LRS or NYCT/LRS; access to major JFK Airport trip origins and destinations; construction challenges; vehicle compatibility; and community impacts. For each criterion, alternatives were assigned an "F" when fatally flawed, a "U" when uncertain, or an "N" when not fatally flawed based on features and performance. An "F" rating for any criterion eliminated it from further consideration. Based on the results of this analysis, two of the 12 LIRR alternatives were eliminated, primarily because they were contingent on construction of a new tunnel under the East River to Lower Manhattan. Seventeen of the 28 NYCT alternatives were also eliminated—13 for noncompetitive travel time (10 of these were also eliminated based on other criteria, including lack of bridge and tunnel capacity, incompatible operations, and incompatible vehicle dimensions) and four for lack of bridge or tunnel capacity.

Of special note are those "A" Line alternatives that would directly connect the AirTrain LRS to the NYCT "A" Line at Howard Beach (that is, alternatives S14, S15, S16, and S17). While this connection may seem to be logical and is physically feasible, those alternatives were eliminated in the fatal flaw analysis, primarily due to noncompetitive travel time (the average travel time to 42nd Street via the "A" Line would be 66 minutes, as compared to 37 minutes for Alternative L2). In addition, the "A" Line does not directly serve Midtown where most JFK-Manhattan trips begin and end.

More important, further examination of these alternatives has revealed that capacity constraints would prevent the operation of One-Seat Ride service along the "A" Line. Three separate branches (Lefferts, Far Rockaway, and Rockaway Park) already vie for express track capacity in peak periods. Consequently, there is no excess track capacity, especially between Hoyt/Schermerhorn and WTC, including the Cranberry Street Tunnel. The "A" Line is also at capacity during shoulder periods and continued ridership growth on the line precludes replacing full-length NYCT trains with very short One-Seat Ride trains.

### **LIRR-Based Alternatives**

Two of the 12 LIRR-based alternatives were eliminated in the fatal flaw phase for the following reasons:

- **Construction Challenges (Need for New Atlantic Branch-Lower Manhattan Connection).** Alternatives L3 and L12, which would use the Atlantic Branch to provide service to Manhattan,



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were fatally flawed (rated "F") based on the construction challenges and access to major trip origins and destinations criteria. These Atlantic Branch alternatives are contingent on a new East River tunnel to provide direct access to lower Manhattan, where less than four percent of daily JFK Airport-Manhattan trips begin or end.

Construction of a new tunnel is contrary to an initial study assumption that alignments should not require the construction of major new segments of right-of-way infrastructure. It was also determined that the major capital investments involved in building the tunnel for the JFK Airport One-Seat Ride service alone would not be justified given the ridership levels expected.

Subsequent investigation of extending the Atlantic Branch from Atlantic Terminal into Manhattan for the Lower Manhattan Access Study confirmed that a new rail tunnel for conventional commuter service would be extraordinarily costly. The Lower Manhattan Study also examined the possibility of converting the Atlantic Branch to subway service, but determined that there was not a feasible way to connect into the existing subway system in Downtown Brooklyn to reach Manhattan.

### ***NYCT-Based Alternatives***

- **Noncompetitive Travel Time.** In the fatal flaw phase, alternatives with an estimated travel time of more than 63 minutes between JFK Airport and Manhattan were considered noncompetitive with the taxi, which, based on Port Authority survey data, has a 54 minute average travel time. Alternatives eliminated based on this criterion included:
  - Rockaway Beach Branch NYCT alternatives S3, S4, and S11
  - Direct NYCT/LRS Howard Beach Connection alternatives S14, S15, S16, and S17
  - Other NYCT alternatives S19, S20, S21, S26, S27, and S28
- **Bridge and Tunnel Capacity Constraints.** The following alternatives were eliminated because capacity would be unavailable at the 53rd Street and Montague Street tunnels and the Manhattan Bridge to support a consistent four-train-per-hour service frequency: S1, S2, S11, S12, and S24.
- **Incompatible Operations.** Three NYCT-based alternatives were eliminated from further consideration because they would require diverging and merging movements at key interlockings with insufficient operating capacity. These were S14, S15, and S20.
- **Inadequate Market Access, Construction Challenges, and Vehicle Compatibility.**
  - S19 was eliminated from further consideration because its route, via the 14th Street/Canarsie Line, does not serve Midtown and Lower Manhattan, the focal points for most JFK Airport trips.

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- S26 and S27 were eliminated because of the infeasibility associated with a required connection between the elevated Jamaica LRS station and the Archer Avenue subway.
  - S28, which would use the New Lots and 7th Avenue lines, was eliminated because of incompatibility between the LRS and NYCT Division "A" vehicle width requirements. A vehicle compatible with the LRS specifications would be too wide to operate on the "A" Division. All other NYCT-based alternatives would use a "B" Division route compatible with LRS' width requirements.

### **Preliminary Feasibility Analysis**

As part of the study's preliminary feasibility phase, MTA and its consultant team undertook more detailed analyses to develop and evaluate the alternatives that passed through the first-level fatal flaw analysis screening. Alignment options were evaluated in terms of operations feasibility, engineering and construction requirements, market access and competitiveness, and environmental and community impacts. For each preliminary feasibility criterion, alternatives were assigned a performance-based rating between "A" and "F." In general, an "A" to "D" rating indicated increasing difficulty, complexity, and effects, and decreasing effectiveness and service quality. An "F" rating meant that an alternative did not meet the criterion's requirements. Based on the results of this analysis phase, four of the remaining 10 LIRR alternatives were eliminated from further consideration because an alternative with fewer civil construction requirements could provide comparable service. Nine of the 11 remaining NYCT alternatives were determined not to be feasible because of civil construction difficulties, noncompetitive travel time, noncompetitive market access, or Broadway Line capacity constraints. Specifically, alternatives were eliminated because of the following:

- **Comparable Service Provided by Alternatives With Fewer Civil Construction Requirements.** Four LIRR-based alternatives requiring an extensive upgrade to the Montauk Branch, a new connection between the Montauk Branch and the 63rd Street Tunnel or Penn Station, or reactivation of the Rockaway Beach Branch, were eliminated from further consideration because other alignments could provide comparable One-Seat Ride service with less difficult construction:
  - L4 (Jamaica-Montauk Branch-63rd Street Tunnel-Grand Central Terminal) and L6 (Jamaica-Montauk-Rockaway Beach Branch-Main Line-63rd Street Tunnel-Grand Central Terminal) were superseded by alternative L1 (Jamaica-Main Line-63rd Street Tunnel-Grand Central Terminal), which would provide comparable Jamaica-to-Grand Central Terminal service, but would use the Main Line only and would not require Montauk or Rockaway Beach Branch construction.

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- L7 (Jamaica-Montauk-Rockaway Beach Branch-Main Line-Penn Station) was superseded by alternative L2 (Jamaica-Main Line-Penn Station), which would provide comparable Jamaica-to-Penn Station service, but would use the Main Line only and would not require Montauk or Rockaway Beach construction.
  - L10 (Howard Beach-Rockaway Beach Branch-Montauk-63rd Street Tunnel-Grand Central Terminal) was superseded by alternative L8 (Howard Beach-Rockaway Beach Branch-Main Line-63rd Street Tunnel-Grand Central Terminal), which would provide the same Howard Beach-to-Grand Central Terminal service, but would not require a Montauk Branch upgrade.
  - **Broadway Line Capacity Constraints.** Four NYCT-based alternatives (S6, S8, S10, and S22) were eliminated because current and future service demand (that is, Second Avenue Subway and LaGuardia Airport Access) would leave no excess Broadway Line capacity for One-Seat Ride service.
  - **Noncompetitive Travel Time.** Five NYCT-based alternatives (S5, S7, S13, S18, and S25) were eliminated for noncompetitive travel times relative to two-seat ride LRS. Travel time to 42nd Street via the LRS with a transfer to the LIRR is estimated at 40 minutes via Grand Central Terminal and 44 minutes via Penn Station. The five NYCT-based alternatives recommended for elimination exceed the two-seat ride travel time by 10 to 23 minutes.
  - **Civil Construction Difficulties and Need for Significant New Structures.** Four NYCT-based alternatives (S8, S9, S10, and S13) were recommended for elimination because they would require significant new structures conflicting with the study's initial assumption that the alignments should use existing subway and rail rights-of-way. Specifically, S8 and S9 would require a 3.8-mile two-track tunnel connecting the Main Line to the lower level of the 63rd Street Tunnel, while S10 would need a 4.1-mile tunnel to connect the Main Line with the 60th Street Tunnel. S13 would have significant construction requirements, including an elevated structure along the Van Wyck Expressway with a structure through, or under, the Kew Gardens interchange; a flyover structure at Willets Point on the Flushing Line; and a connection to the LaGuardia Access "N" Line extension alternative.
  - **Noncompetitive Market Access.** S18 and S25, which would use the 8th Avenue Line in Manhattan, were eliminated because they do not provide competitive access to the Manhattan-based JFK Airport trip market. Only 30 percent of JFK Airport trips would be within 20 minutes of the first Manhattan station on the route, Broadway-Nassau. In contrast, LIRR-based alternatives serving Grand Central Terminal and Penn Station would provide access to 73 percent and 62 percent of trips within 20 minutes of the two stations, respectively. NYCT alternatives using the 6th Avenue Line would serve 73 percent of trips within 20 minutes of the first Manhattan station, 63rd Street/L exington Avenue.

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## Alternatives Advanced to Final Feasibility Analysis

As a result of the fatal flaw and preliminary feasibility analyses, eight of the original 40 alternatives were carried into the last study phase, the final feasibility analysis. Six alternatives are LIRR-based and two are NYCT subway-based.

### *LIRR Alternatives*

- L1: LRS/Jamaica via Main Line and 63rd Street Tunnel to Grand Central Terminal
- L2: LRS/Jamaica via Main Line and East River Tunnels to Penn Station
- L5: LRS-Jamaica/ via Montauk Branch and East River Tunnels to Penn Station
- L8: LRS/Howard Beach via Rockaway Beach Branch, Main Line, and 63rd Street Tunnel to Grand Central Terminal
- L9: LRS/Howard Beach via Rockaway Beach Branch, Main Line, East River Tunnels to Penn Station
- L11: LRS-Howard Beach via Rockaway Beach Branch, Montauk Branch, and East River Tunnels to Penn Station

### *NYCT Alternatives*

- S7: LRS/Howard Beach to Manhattan via Rockaway Beach Branch, Montauk Branch, 63rd Street Tunnel, and 6th Avenue Line
- S23: LRS/Jamaica to Manhattan via Montauk Branch, 63rd Street Tunnel, and 6th Avenue Line

The findings of the final feasibility analysis are presented in appendices A and B.

## Disposition of JFK Airport One-Seat Ride Alternatives

The following is a list of the LIRR-based and NYCT subway-based alternatives examined in the JFK One-Seat Ride Study, indicating the level of analysis each was carried through. For those alternatives eliminated during the fatal flaw analysis and preliminary feasibility analysis phases, the analysis phase in which each alternative was eliminated from consideration is noted, followed by the reasons for elimination. Of the eight alternatives, carried into the final feasibility analysis phase, the main body of the report and Appendix A discuss the recommended alternative and the three other physically feasible alternatives. Appendix B discusses the remaining four alternatives found to be infeasible.

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(Note: The phrase “Also eliminated...” indicates a supplementary reason for elimination that was not applied in the original analysis but would have applied had the alternative gone through the next level of analysis.)

## LIRR-Based Alternatives

- L1: LRS/Jamaica-Main Line-63rd Street Tunnel-Grand Central Terminal  
Carried through final feasibility analysis (See main body of report and Appendix A for discussion)
- L2: LRS/Jamaica-Main Line-East River Tunnels-Penn Station  
Recommended alternative (see main body of report and Appendix A for discussion)
- L3: LRS/Jamaica-Atlantic Branch-New Tunnel-Lower  
Eliminated in fatal flaw analysis:
  - Fatally flawed based on the construction challenges criterion. Alternative L3 requires a new East River tunnel to provide direct access to Lower Manhattan, contrary to an initial study assumption that alignments should not require the construction of major new segments of right-of-way infrastructure
  - Fatally flawed based on access to major trip origins and destinations criterion. Alternative L3 provides direct access only to Lower Manhattan, where fewer than four percent of daily JFK Airport-Manhattan trips begin or end
- L4: LRS/Jamaica-Montauk Branch-63rd Street Tunnel-Grand Central Terminal  
Eliminated in preliminary feasibility analysis:
  - Superseded by alternative L1 (Jamaica-Main Line-63rd Street Tunnel-Grand Central Terminal), which would provide comparable Jamaica-to-Grand Central Terminal service, but would use only the Main Line and would not require Montauk or Rockaway Beach Branch construction
- L5: LRS/Jamaica-Montauk Branch-East River Tunnels-Penn Station  
Eliminated in final feasibility analysis (see Appendix B for discussion)
- L6: LRS/Jamaica-Montauk Branch-Rockaway Beach Branch-Main Line-63rd Street Tunnel-Grand Central Terminal  
Eliminated in preliminary feasibility analysis:
  - Superseded by alternative L1 (Jamaica-Main Line-63rd Street Tunnel-Grand Central Terminal), which would provide comparable Jamaica-to-Grand Central Terminal service, but

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would use only the Main Line and would not require Montauk or Rockaway Beach Branch construction

- L7: LRS/Jamaica-Montauk Branch-Rockaway Beach Branch-Main Line-East River Tunnels-Penn Station

Eliminated in preliminary feasibility analysis:

- Superseded by alternative L2 (Jamaica-Main Line-Penn Station), which would provide comparable Jamaica-to-Penn Station service, but would use only the Main Line and would not require Montauk or Rockaway Beach or Montauk construction

- L8: LRS/Howard Beach-Rockaway Beach Branch-Main Line-63rd Street Tunnel-Grand Central Terminal

Carried through final feasibility analysis (see main body of report and Appendix A for discussion)

- L9: LRS/Howard Beach-Rockaway Beach Branch-Main Line-East River Tunnels-Penn Station

Carried through final feasibility analysis (see main body of report and appendix A for discussion)

- L10: LRS/Howard Beach-Rockaway Beach Branch-Montauk Branch-63rd Street Tunnel-Grand Central Terminal

Eliminated in preliminary feasibility analysis:

- Superseded by alternative L8 (Howard Beach-Rockaway Beach Branch-Main Line-63rd Street Tunnel-Grand Central Terminal), which would provide the same Howard Beach-to-Grand Central Terminal service, but would not require a Montauk Branch upgrade

- L11: LRS/Howard Beach-Rockaway Beach Branch-Montauk Branch-East River Tunnels-Penn Station Line

Eliminated in final feasibility analysis (see Appendix B for discussion)

- L12: LRS/Howard Beach-Rockaway Beach Branch-Atlantic Branch-New Tunnel-Lower Manhattan

Eliminated in fatal flaw analysis:

- Fatally flawed based on access to major trip origins and destinations criterion. Alternative L12 provides direct access only to Lower Manhattan, where fewer than four percent of daily JFK Airport-Manhattan trips begin or end
- Also eliminated based on the construction challenges criterion. Alternative L12 requires a new East River tunnel to provide direct access to Lower Manhattan, contrary to an initial study assumption that alignments should not require the construction of major new segments of right-of-way infrastructure

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## NYCT Subway-Based Alternatives

- S1: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Queens Boulevard Line-53rd Street Tunnel-6th Avenue Line

Eliminated in fatal flaw analysis:

- Fatally flawed because of the 53rd Street Tunnel capacity constraints. The volume-to-capacity ratios for current operations using the 53rd Street Tunnel are so high that even with the benefits of new resignaling technology, such as CBTC, the minimal four operating slots per hour required for JFK Airport service would not be available
- Also eliminated due to 61-minute travel time
- Also eliminated due to lack of capacity on the Queens Boulevard line for additional express service

- S2: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Queens Boulevard Line-53rd Street Tunnel-8th Avenue Line

Eliminated in fatal flaw analysis:

- Fatally flawed because of the 53rd Street Tunnel capacity constraints. Volume-to-capacity ratios for current operations using the 53rd Street Tunnel are so high that even with the benefits of new resignaling technology, such as CBTC, the minimal four operating slots per hour required for JFK Airport service would not be available
- Also eliminated due to 63-minute travel time
- Also eliminated due to lack of capacity on the Queens Boulevard Line for additional express service

- S3: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Queens Boulevard Line-60th Street Tunnel-Broadway Line

Eliminated in fatal flaw analysis:

- Fatally flawed due to Broadway Line capacity constraints. Current and future demand (for example, LaGuardia Airport access) leaves no excess Broadway Line capacity for JFK Airport service
- Fatally flawed due to 64-minute travel time
- Also eliminated due to lack of capacity on the Queens Boulevard line for additional express service

- S4: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Queens Boulevard Line-63rd Street Tunnel-Broadway Line

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Eliminated in fatal flaw analysis:

- Fatally flawed due to 64-minute travel time
  - Also eliminated due to Broadway Line capacity constraints. Current and future demand (for example, LaGuardia Airport access) leaves no excess Broadway Line capacity for JFK Airport service
  - Also eliminated due to lack of capacity on the Queens Boulevard line for additional express service
- S5: LRS-Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Queens Boulevard Local Line-63rd Street Tunnel-6th Avenue Line

Eliminated in preliminary feasibility analysis:

- Eliminated due to 63-minute travel time
  - Also eliminated due to lack of capacity on the Queens Boulevard line for additional local service
- S6: LRS-Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Montauk Branch-63rd Street Tunnel-Broadway Line

Eliminated in preliminary feasibility analysis:

- Eliminated due to Broadway Line capacity constraints. Current and future demand (for example, LaGuardia Airport access) leaves no excess Broadway Line capacity for JFK Airport service
  - Also eliminated due to single-track operating constraints on the Montauk Branch. Four miles of the right-of-way are wide enough for only two tracks, one NYCT, and one LIRR. NYCT and LIRR cannot operate on the same tracks. Single-track operation will also cause operational unreliability and delays to passengers
  - Also eliminated due to civil construction difficulties of the Montauk Branch-63rd Street Tunnel connection: complicated layout, poor soil conditions and high groundwater level, extensive property takings along 31st Street, flyovers to maintain access to freight sidings, increased use of Rockaway Beach Branch right-of-way in Forest Park, and Montauk Branch grade crossing elimination
- S7: LRS-Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Montauk Branch-63rd Street Tunnel-6th Avenue Line

Eliminated in final feasibility analysis (see Appendix B for discussion)

- S8: LRS-Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-New Line along Main Line right-of-way-63rd Street Tunnel-Broadway Line



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Eliminated in preliminary feasibility analysis:

- Eliminated due to Broadway Line capacity constraints. Current and future demand (for example, LaGuardia Airport access) leaves no excess Broadway Line capacity for JFK Airport service
- Eliminated due to civil construction difficulties. Alternative S8 requires significant new structures (a 3.8-mile 2-track tunnel under Queens Boulevard and the elevated Flushing Line from the Main Line to the 63rd Street Tunnel). This conflicts with the initial study assumption that the alignments should use existing subway and rail rights-of-way
- S9: LRS-Howard Beach-Rockaway “A” Line-Rockaway Beach Branch-New Line along Main Line right-of-way-63rd Street Tunnel-6th Avenue Line

Eliminated in preliminary feasibility analysis:

- Eliminated due to civil construction difficulties. Alternative S9 requires significant new structures (a 3.8-mile 2-track tunnel under Queens Boulevard and the elevated Flushing Line from the Main Line to the 63rd Street Tunnel). This conflicts with the initial study assumption that the alignments should use existing subway and rail rights-of-way
- S10: LRS-Howard Beach-Rockaway “A” Line-Rockaway Beach Branch-New Line along Main Line right-of-way-60th Street Tunnel-Broadway Line

Eliminated in preliminary feasibility analysis:

- Eliminated due to Broadway Line capacity constraints. Current and future demand (for example, LaGuardia Airport access) leaves no excess Broadway Line capacity for JFK Airport service
- Eliminated due to civil construction difficulties. Alternative S10 requires significant new structures (a 4.1-mile tunnel connecting the Main Line and the 60th Street Tunnel). This conflicts with the initial study assumption that the alignments should use existing subway and rail rights-of-way
- S11: LRS/Howard Beach-Rockaway “A” Line-Rockaway Beach Branch-Atlantic Branch-Montague Tunnel-Broadway Line

Eliminated in fatal flaw analysis:

- Fatally flawed due to Manhattan Bridge/Montague Tunnel capacity constraints. The Montague Street Tunnel is currently operating at or beyond practical capacity with “N,” “R,” and “M” line service. Some residual capacity will be available upon restoration of both Manhattan Bridge routes tentatively scheduled for 2004. However, the availability of the bridge as a reliable transit route cannot be assured due to the need for continuing future maintenance. Any future closing of the bridge would remove it as a possible route for JFK

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Airport service and divert NYCT service back to the Montague Street Tunnel, which would again operate at or above capacity

- Fatally flawed due to 68-minute travel time
- Also eliminated due to Broadway Line capacity constraints. Current and future demand (for example, LaGuardia Airport access) leaves no excess Broadway Line capacity for JFK Airport service

- S12: LRS-Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Atlantic Branch-Manhattan Bridge-6th Avenue Line

Eliminated in fatal flaw analysis:

- Fatally flawed due to Manhattan Bridge/Montague Tunnel capacity constraints. The Montague Street Tunnel is currently operating at or beyond practical capacity with "N," "R," and "M" line service. Some residual capacity will be available upon restoration of both Manhattan Bridge routes tentatively scheduled for 2004. However, the availability of the bridge as a reliable transit route cannot be assured due to the need for continuing future maintenance. Any future closing of the bridge would remove it as a possible route for JFK Airport service and divert NYCT service back to the Montague Street Tunnel, which would again operate at or above capacity

- S13: LRS/Jamaica-LaGuardia Airport-19th Avenue-60th Street Tunnel-Broadway Line

Eliminated in preliminary feasibility analysis:

- Eliminated due to civil construction difficulties: elevated structure along the Van Wyck, beginning at the Jamaica station; structure through or under the Kew Gardens interchange; fly over Flushing Line at Willets Point; connection to the LaGuardia Airport access "N" Line extension; right-of-way likely needed in Flushing Meadows Park; substantial traffic mitigation required along the Van Wyck Expressway; and potential construction impact to 1,450 adjacent residential units
- Eliminated due to 60-minute travel time
- Also eliminated due to Broadway Line capacity constraints. Current and future demand (for example, LaGuardia Airport access) leaves no excess Broadway Line capacity for JFK Airport service

- S14: LRS/Howard Beach-Rockaway "A" Line-Fulton Street "A" Line-Rutgers Street Tunnel-6th Avenue Line

Eliminated in fatal flaw analysis:

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- Fatally flawed because this alternative requires diverging and merging movements—for which there is insufficient capacity—to switch between the Fulton Street Line and the Rutgers Street Tunnel between the Hoyt-Schermerhorn and Jay Street-Boro Hall stations
  - Fatally flawed due to 65-minute travel time
  - Also eliminated due to capacity constraints on the “A” Line
  - Also eliminated due to noncompetitive market access (no direct access to Midtown)
  - S15: LRS/Howard Beach-Rockaway “A” Line-Fulton Street “A” Line-Rutgers Street Tunnel-8th Avenue Line  
Eliminated in fatal flaw analysis:
    - Fatally flawed because this alternative requires diverging and merging movements—for which there is insufficient capacity—to switch between the 8th Avenue Line and the 6th Avenue Line at the West 4th Street interlocking
    - Fatally flawed due to 66-minute travel time
    - Also eliminated due to capacity constraints on the “A” Line
    - Also eliminated due to noncompetitive market access (no direct access to Midtown)
  - S16: LRS/Howard Beach-Rockaway “A” Line-Fulton Street “A” Line-Cranberry Street Tunnel-6th Avenue Line  
Eliminated in fatal flaw analysis:
    - Fatally flawed due to 67-minute travel time
    - Also eliminated because this alternative requires diverging and merging movements—for which there is insufficient capacity—to switch between the 8th Avenue Line and the 6th Avenue Line at the West 4th Street interlocking
    - Also eliminated due to capacity constraints on the “A” Line
    - Also eliminated due to noncompetitive market access (no direct access to Midtown)
  - S17: LRS/Howard Beach-Rockaway “A” Line-Fulton Street “A” Line-Cranberry Street Tunnel-8th Avenue Line  
Eliminated in fatal flaw analysis:
    - Fatally flawed due to 66-minute travel time
    - Also eliminated due to capacity constraints on the “A” Line
    - Also eliminated due to noncompetitive market access (no direct access to Midtown)

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- S18: LRS/Howard Beach-New Conduit Avenue Link-Fulton Street "A" Line-Cranberry Street Tunnel-8th Avenue Line

Eliminated in preliminary feasibility analysis:

- Eliminated due to 61-minute travel time
- Eliminated due to noncompetitive market access (no direct access to Midtown)

- S19: LRS/Howard Beach-Rockaway "A" Line-Fulton Street "A" Line-Canarsie Line-14th Street

Eliminated in fatal flaw analysis:

- Fatally flawed for the market access criterion because the 14th Street/Canarsie Line does not serve midtown or lower Manhattan, the origination or destination of most JFK Airport trips
- Fatally flawed due to 66-minute travel time

- S20: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Jamaica Avenue Line-Williamsburg Bridge-6th Avenue Line

Eliminated in fatal flaw analysis:

- Fatally flawed because this alternative requires diverging and merging movements—for which there is insufficient capacity—to switch between the 8th Avenue Line and the 6th Avenue Line between at the West 4th Street interlocking
- Fatally flawed due to 75-minute travel time

- S21: LRS/Howard Beach-Rockaway "A" Line-Rockaway Beach Branch-Jamaica Avenue Line-Williamsburg Bridge-8th Avenue Line

Eliminated in fatal flaw analysis:

- Fatally flawed due to 74-minute travel time

- S22: LRS/Jamaica-Montauk Branch-63rd Street Tunnel-Broadway Line

Eliminated in preliminary feasibility analysis:

- Eliminated due to Broadway Line capacity constraints. Current and future demand (for example, LaGuardia Airport Access) leaves no excess Broadway Line capacity for JFK Airport service
- Also eliminated due to single-track operating constraints on Montauk Branch. Four miles of right-of-way are wide enough for only two tracks, one NYCT and one LIRR. NYCT and LIRR cannot operate on the same tracks. Single-track operation will also cause operational unreliability and delays to passengers

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- Also eliminated due to civil construction difficulties of the Montauk Branch-63rd Street Tunnel connection: complicated layout, poor soil conditions and high groundwater level, extensive property takings along 31st Street, flyovers to maintain access to freight sidings, increased use of Rockaway Beach Branch right-of-way in Forest Park, and Montauk Branch grade crossing elimination
  - S23: LRS/Jamaica-Montauk Branch-63rd Street Tunnel-6th Avenue Line  
Eliminated in final feasibility analysis (see Appendix B for discussion)
  - S24: LRS/Jamaica-Queens Boulevard Line-53rd Street Tunnel-8th Avenue Line  
Eliminated in fatal flaw analysis:
    - Fatally flawed because of the 53rd Street Tunnel capacity constraints. Volume-to-capacity ratios for current operations using the 53rd Street Tunnel are so high that even with the benefits of new resignaling technology, such as CBTC, the minimal four operating slots per hour required for JFK Airport service would not be available
  - S25: LRS-New Liberty Avenue right-of-way-Fulton Street “A” Line-Cranberry Street Tunnel-8th Avenue Line  
Eliminated in preliminary feasibility analysis:
    - Eliminated due to 61-minute travel time
    - Eliminated due to noncompetitive market access (no direct access to Midtown)
  - S26: LRS/Jamaica-Jamaica Avenue Line-Williamsburg Bridge-8th Avenue Line  
Eliminated in fatal flaw analysis:
    - Fatally flawed for construction challenges because of the infeasibility of connecting the elevated LRS Jamaica station with the Archer Avenue subway
    - Fatally flawed due to 68-minute travel time
  - S27: LRS/Jamaica-Jamaica Avenue Line-Williamsburg Bridge-6th Avenue Line  
Eliminated in fatal flaw analysis:
    - Fatally flawed because of the infeasibility of connecting the elevated LRS Jamaica station with the Archer Avenue subway
    - Fatally flawed due to 67-minute travel time
  - S28: LRS/Howard Beach-New Conduit Avenue right-of-way-New Lots Avenue Line-Clark Street Tunnel-7th Avenue Line  
Eliminated in fatal flaw analysis:

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- Fatally flawed due to 70-minute travel time
  - Fatally flawed due to incompatibility between the LRS and NYCT Division "A" vehicle width requirements as described in the NYCT strategic issues section, above. A vehicle compatible with LRS specifications would be too wide to operate on the "A" Division. A vehicle operable on the "A" Division would produce an unacceptable horizontal gap between the vehicle and the LRS platforms of more than 6 inches